International Review of the Red Cross (2025), **107** (928), 200–237.
The Military
doi:10.1017/S1816383124000559

Humanity on the final frontier: Challenges in applying international humanitarian law to modern military space operations

G. Blair Kuplic[1,2]* and
Jonathan Sawmiller[3,4]†**
[1]Lieutenant Commander, US Navy
[2]Chief of National Security Law, US Space Command, Colorado Springs, CO, United States
[3]Lieutenant Colonel, US Air Force
[4]Deputy Staff Judge Advocate, US Space Command, Colorado Springs, CO, United States
*Corresponding author email: blair.kuplic@gmail.com
**Email: jonsawmiller@hotmail.com

Abstract

This article provides the personal perspectives of US military operational attorneys and analyzes three significant challenges in applying international humanitarian law (IHL) to modern military space operations: the lack of clear standards for assessing when IHL rules govern particular military activities in outer space; the

† The positions and opinions expressed herein are those of the authors and do not necessarily represent the views of the US government, Department of Defense, Department of the Air Force or Department of the Navy.

challenges of effectively distinguishing between civilian objects and military objectives when targeting space systems; and the difficulties of applying IHL rules of proportionality when attacking space systems. To address these challenges, the article argues that States should take steps to develop non-binding norms for military space operations that contribute to broader understanding of States' views on how IHL applies in space.

Keywords: military space operations, space law, international humanitarian law, law of war, distinction, proportionality.

: : : : : : :

Modern military space operations present unique challenges to practitioners of international humanitarian law (IHL), driven by the physical attributes of outer space, the *lex specialis* of international space law, increased commercialization of space systems and services, rapidly advancing space technology, and proliferation of counter-space weaponry. Military operational attorneys in this field face three significant challenges.

First, there is a lack of clear standards for assessing when IHL rules govern particular military activities in outer space, including agreement on how the *lex specialis* body of international space law limits military activity, the question of when unfriendly activities in outer space rise to the level of an armed conflict governed by IHL, and the issue of what constitutes an "attack" in space regulated by IHL rules for attacks. Second, it is challenging to effectively distinguish between civilian objects, military objectives of neutral States, and military objectives of belligerent States when targeting adversary space systems. The unsettled question of what portions of space systems constitute targeted objects for IHL analyses, the dual-use nature of most space systems, the increasing reliance by the military on commercial systems and services, and rapidly advancing technology all combine to complicate distinction in space system targeting decisions. Third, applying the principle of proportionality when attacking space systems, as well as policy requirements for collateral effects mitigation when conducting operations short of attack, is difficult. Space debris longevity, the potential for space debris to cause collisional cascading[1] and the difficulties of creating a standardized collateral damage methodology complicate proportionality analyses for kinetic and other destructive attacks. The practical difficulties of differentiating between direct and indirect harms caused by non-kinetic actions and creating a standardized collateral effects methodology complicate civilian harm analyses for employment of non-forcible means and methods of warfare.

This article addresses these challenges from the perspective of two US military attorneys who serve as legal advisers for military space operations.

1 Collisional cascading occurs when debris-caused collisions create more debris, resulting in a runaway chain reaction of collisions and more debris. It is also known as the Kessler Syndrome after the man who first proposed the issue, Donald Kessler. See Heather F. Riley, "Micrometeoroids and Orbital Debris (MMOD)", National Aeronautics and Space Administration (NASA), 14 June 2016, available at: www.nasa.gov/centers-and-facilities/white-sands/micrometeoroids-and-orbital-debris-mmod/ (all internet references were accessed in November 2024).

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

It provides their personal views and argues that States can address these challenges by developing non-binding norms for military space operations that will broaden understanding of States' views on how IHL applies. These norms can be developed through publicizing applicable domestic policy and State practice, as well as participating in multilateral processes to amplify and explain certain provisions of existing binding international law.

Modern military space operations

Modern military space operations present unique challenges to practitioners of IHL, driven by the physical attributes of outer space, the *lex specialis* of international space law, increased commercialization of space systems and services, rapidly advancing space technology and proliferation of counter-space weaponry.

Physical attributes of outer space

From a practical perspective, outer space is often argued to begin at the Von Karman line at approximately 100 km altitude, above which the atmosphere is too thin for winged aircraft to fly. From an international legal perspective, the boundary of outer space remains undefined, despite decades of discussion in United Nations (UN) forums.[2] Today, US Space Command's area of responsibility begins at 100 km above mean sea level.[3] As of 1 April 2023, there were approximately 10,290 satellites in earth orbit in this area, with nearly 7,800 in operational status, registered by seventy-two different States and intergovernmental organizations.[4]

These satellites generally operate in four different orbital regimes: low earth orbit (LEO), medium earth orbit (MEO), geosynchronous earth orbit (GEO), and highly elliptical orbit (HEO). LEO is up to 2,000 km altitude and is useful for communications using large constellations of satellites, remote earth sensing such as imagery and signals collection, and manned spaceflight.[5] Satellites here move rapidly, travelling around the earth in approximately ninety minutes.[6] MEO is approximately 2,000–20,000 km altitude and is used primarily for communications and position, navigation and timing services. The US Global Positioning System (GPS) and the European Space Agency's Galileo position,

2 For a discussion of the competing "spatial" and "functional" approaches to the legal boundary question and the lack of international consensus on the matter, see UN Committee on the Peaceful Uses of Outer Space, *Historical Summary on the Consideration of the Question on the Definition and Delimitation of Outer Space*, UN Doc. A/AC.105/769, 18 January 2002.

3 US Space Command, "Frequently Asked Questions", available at: www.spacecom.mil/About/Frequently-Asked-Questions.

4 UN Office for Outer Space Affairs, *Annual Report 2022*, June 2023, available at: www.unoosa.org/documents/pdf/annualreport/UNOOSA_Annual_Report_2022.pdf.

5 Defense Intelligence Agency, *2022 Challenges to Security in Space*, 2022, available at: www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Challenges_Security_Space_2022.pdf.

6 European Space Agency, "Types of Orbits", 30 March 2020, available at: www.esa.int/Enabling_Support/Space_Transportation/Types_of_orbits.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

navigation and timing satellite constellations are located here. GEO is located 35,786 km above earth's equator. Satellites here travel at the same speed as the earth's rotation, staying in stationary positions relative to the earth and terrestrial antennas pointed at them. GEO is a particularly useful orbit, where only three satellites spaced equidistantly can cover most of the globe. HEO, with a perigee close to earth and an apogee far from it, is useful for covering polar regions that satellites over the equator cannot reach.

All of these satellites rely on use of the electromagnetic spectrum to connect with terrestrial stations or each other. Space systems are generally described as being comprised of three segments: the on-orbit spacecraft segment, the terrestrial segment with ground, air and/or maritime stations, and the link segment that connects the two using the electromagnetic spectrum.[7]

The *lex specialis* of international space law

International space law is a relatively recent development. International agreements governing aircraft operations established that each State had sovereignty over the airspace above its territory, but never defined the extent of airspace.[8] In 1951, John C. Cooper, the founder of the Institute of Air and Space Law at McGill University in Montreal, argued in an influential article that recent rocket flights of 400 km travelled above airspace, showing the need for new rules governing high-altitude activity.[9] International space law developed rapidly following the launch of the first earth satellites by the Cold War superpowers, in October 1957 by the USSR and in January 1958 by the United States.[10] The US National Security Council observed that in "establish[ing] the principle of the freedom of outer space … the Soviets have now proved very helpful. Their earth satellite has overflown practically every nation on earth, and there have thus far been no protests."[11] In December 1958, the UN General Assembly established the Committee on the Peaceful Uses of Outer Space (COPUOS) to study legal problems arising from space exploration.[12] In 1963, with input from COPUOS, the General Assembly issued a declaration of nine legal principles for outer space, including that it was free for exploration and use by all States for peaceful purposes.[13] These principles were essentially codified in the 1967 Outer Space Treaty, which provides the core of international space law, along with the 1968

7 US Department of Defense (DoD), *Joint Space Operations*, Joint Publication 3-14, 23 August 2023.

8 Convention for the Regulation of Aerial Navigation, UKTS 002/1922, 13 October 1919, Art. 1; Convention on International Civil Aviation, TIAS 1591, 7 December 1944, Art. 1.

9 John C. Cooper, "High Altitude Flight and National Sovereignty", *International Law Quarterly*, Vol. 4, No. 3, 1951.

10 NASA, "Explorer 1", available at: www.jpl.nasa.gov/missions/explorer-1.

11 National Security Council, "Memorandum: Discussion at the 339th Meeting of the National Security Council", 10 October 1957, p. 4, available at: www.eisenhowerlibrary.gov/sites/default/files/research/online-documents/sputnik/10-11-57.pdf.

12 UNGA Res. 1348 (XIV), 13 December 1958.

13 UNGA Res. 1962 (XVIII), 13 December 1963.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

Rescue Agreement, the 1972 Liability Convention and the 1975 Registration Convention.[14]

Provisions governing some uses of outer space are also included in broader international agreements, such as the International Telecommunication Union (ITU) Constitution and Convention and its implementing Radio Regulations.[15] Of particular importance, to guarantee operability without harmful interference, the ITU allocates frequencies and positions (for satellites in GEO) or orbital characteristics (for satellites in other orbits) for every radio transmitting and/or receiving satellite in each orbital category, recording all these allocations in the Master International Frequency Register.[16] Notably for military space operations, Article 48 of the ITU Constitution generally exempts military radio installations from compliance with the Radio Regulations.

Increased commercialization of space systems and services

Today, numerous national and multinational companies own and operate space systems that provide services to customers everywhere on earth. In 2022, the global space economy, including equipment manufacturing and government space budgets, achieved revenues of $384 billion, with 30% of that ($113.3 billion) coming from commercial satellite communications and remote sensing services.[17] Intergovernmental organizations that traditionally provided most commercially available satellite communications began privatizing around the turn of the millennium, with INMARSAT becoming a UK company and EUTELSAT becoming a French company. The oldest such organization, INTELSAT, is now a private company incorporated in Luxembourg with operational headquarters in the United States. It remains a leading player in the commercial satellite market, operating the world's largest integrated space and terrestrial communications network.[18]

While communications account for the vast majority of the space services economy, commercial remote sensing services are a growing market. Once exclusively the province of militaries and government spy agencies, high-resolution (30 cm panchromatic) electro-optical imagery is sold on the commercial market by companies such as the United States' Maxar and Planet Labs and Europe's Airbus Space.[19] Airbus Space also sells images created from synthetic-aperture radar (SAR), which has the advantage of seeing through cloud

14 See UN Office for Outer Space Affairs, "Space Law Treaties and Principles", available at: www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html. The 1979 Moon Agreement also exists, but as of September 2024 it has only seventeen States Parties, none of which are major spacefaring nations.

15 Frans von der Dunk, "Legal Aspects of Satellite Communications", in Frans von der Dunk and Fabio Tronchetti (eds), *Handbook of Space Law*, Edward Elgar, Cheltenham, 2015.

16 ITU, "WRS-22: Regulation of Satellites in Earth's Orbit", 2 January 2023, available at: www.itu.int/hub/2023/01/satellite-regulation-leo-geo-wrs/.

17 Satellite Industry Association, *State of the Satellite Industry Report 2023*, 2023, available at: https://sia.org/news-resources/state-of-the-satellite-industry-report/.

18 Intelsat, "About Us", available at: www.intelsat.com/about-us/.

19 Airbus, "Satellite Imagery", available at: www.airbus.com/en/space/earth-observation/satellite-imagery.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

cover, smoke and darkness. The world's largest commercial SAR constellation is owned and operated by Finland's ICEYE, with over thirty satellites providing global coverage delivered to customers in near-real time as of September 2024.[20] In a first for international armed conflicts, in August 2022 a charity foundation crowdsourced funding and purchased exclusive use rights for one of ICEYE's on-orbit SAR satellites for the government of Ukraine.[21]

Sometimes commercial space relationships are complex and involve many States. For example, Romantis GmBH, a German company, sells bandwidth for television broadcasting, broadband internet, and enterprise communications transmitted by the Express AM7 satellite located in GEO at 40° east latitude to private and government customers in various States throughout Europe, the Middle East and Asia.[22] The Express AM7 satellite was manufactured by the European conglomerate Airbus Defence and Space for the Russian Satellite Communications Company, the State-owned company of the Russian Federation that owns and operates the satellite.[23] Russia is the Express AM7's launching State, with international responsibility for its activities in outer space, and Russia is also the State assigned radio frequencies for its use by the ITU.

Rapidly advancing space technology

The advent of reusable rockets pioneered by the United States' SpaceX has dramatically lowered the cost of launch, with SpaceX's Falcon 9 rocket placing payloads in LEO for $2,600 per kg (in FY21 dollars).[24] In contrast, China's modern Long March 4B expendable rocket, which first launched in 2013, still costs $7,600 per kg (FY21) to launch payloads to LEO.[25] Advances in semiconductor technology allow ever more powerful electronic circuits to be packed onto smaller microchips, making possible inexpensive satellites using commercial, off-the-shelf parts in small form factors. Global standards for construction, deployment and launch of small satellites have dramatically reduced research and development costs. The most popular of such satellites is the CubeSat, based on a 1999 design for satellites with a scalable 10 cm cube unit developed by two California universities and adopted by hundreds of educational institutions, private firms and government organizations worldwide.[26]

20 ICEYE, "Accurate, Near Real-Time Earth Monitoring with SAR Data", available at: www.iceye.com/sar-data.

21 ICEYE, "ICEYE Signs Contract to Provide Government of Ukraine with Access to Its SAR Satellite Constellation", 18 August 2022, available at: www.iceye.com/press/press-releases/iceye-signs-contract-to-provide-government-of-ukraine-with-access-to-its-sar-satellite-constellation.

22 Romantis, "Express AM7 (40°E)", available at: www.romantis.com/am7/.

23 Russian Satellite Communications Company, "About Us", available at: https://eng.rscc.ru/about/#!tab=panel-0.

24 Center for Strategic and International Security, "Space Launch to Low Earth Orbit: How Much Does It Cost?", 1 September 2022, available at: https://aerospace.csis.org/data/space-launch-to-low-earth-orbit-how-much-does-it-cost/.

25 *Ibid.*

26 California Polytechnic Institute, "The CubeSat Program", available at: www.cubesat.org/about.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

The combination of reduced launch costs and reduced small satellite costs is enabling the rise of proliferated LEO (pLEO) constellations, often called megaconstellations. As of August 2024, the US Starlink constellation consists of 6,350 satellites in LEO, providing low-latency, high-bandwidth internet connectivity to users globally.[27] Starlink is battle-tested. It has been employed effectively for communications and long-range control of unmanned aerial and maritime vehicles by Ukraine in the armed conflict that began with Russia's invasion in February 2022.

Starlink will not be the only pLEO communications constellation for long. Its competitor Eutelsat OneWeb already has 600 satellites in orbit with limited services online,[28] the European Union is planning to have a pLEO constellation called IRIS2 operational by 2027,[29] and in August 2024 China launched the first eighteen satellites of its planned Qianfan pLEO constellation.[30] Unlike traditional communications satellites in GEO, which often dedicate particular transponders, swathes of bandwidth or particular uplink and downlink frequencies to particular users, satellites in pLEO constellations communicate with a wide range of different users in different locations as they move in orbit around the earth.

Proliferation of counter-space weaponry

While space has been used for military communications and intelligence collection since the dawn of the space age, never before has there been such a rapid proliferation of counter-space weaponry fielded to hold adversary space systems at risk. Many States field counter-space electromagnetic warfare capabilities. The United States operates deployable ground-based systems capable of uplink jamming – directing radio frequency energy at receivers of satellites on orbit.[31] According to an assessment by the US Defense Intelligence Agency, Russia, China, Iran and North Korea have all demonstrated the ability to jam satellite communications and GPS systems.[32] In addition, Russia and China have fielded capabilities to jam satellite radar systems.[33]

Counter-space directed energy weapons include lasers and high-powered microwave weapons. Both Russia and China have deployed ground-based laser weapons designed to blind satellites' optical sensors, and by 2030 they may field high-powered lasers capable of damaging the structures of satellites, not just the

27 Tereza Pultarova and Elizabeth Howell, "Starlink Satellites: Facts, Tracking and Impact on Astronomy", *Space.com*, 29 August 2024, available at: www.space.com/spacex-starlink-satellites.html.

28 Jason Rainbow, "Eutelsat Scales Back OneWeb Gen 2 Upgrade Plan", *SpaceNews*, 16 February 2024, available at: https://spacenews.com/eutelsat-scales-back-oneweb-gen-2-upgrade-plan/.

29 European Commission, "IRIS²: The New EU Secure Satellite Constellation", available at: https://defence-industry-space.ec.europa.eu/eu-space-policy/iris2_en.

30 Simone McCarthy, "China Launches Satellites to Rival SpaceX's Starlink in Boost for Its Space Ambitions", *CNN*, 9 August 2024, available at: www.cnn.com/2024/08/09/china/china-satellite-qianfan-g60-starlink-intl-hnk/index.html.

31 L3Harris, "Counter Communications System", available at: www.l3harris.com/all-capabilities/counter-communications-system.

32 Defense Intelligence Agency, above note 5.

33 *Ibid.*

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

sensors.[34] In 2023, France released its 2024–2030 Military Programming Law, which includes plans for both orbital and ground-based laser counter-space systems.[35] Lasers under development for use against aerial targets, such as the UK's DragonFire and Israel's Iron Beam, could possibly be employed against satellites in the future.[36]

Direct-ascent anti-satellite (DA-ASAT) missiles are launched from earth and intercept satellites without completing a full earth orbit. Four nations have tested them. In 1985, the United States tested an air-launched DA-ASAT missile and destroyed a US satellite 550 km above the earth, but it never put the missile into operational service.[37] In 2007, China executed a destructive DA-ASAT missile test, destroying a defunct Chinese weather satellite at more than 800 km altitude.[38] In 2008, the United States used a modified ship-launched SM-3 surface-to-air missile to destroy a malfunctioning US government satellite in a decaying orbit at an altitude of about 240 km, with the stated purpose of mitigating the threat to humans posed by its hydrazine fuel after re-entry.[39] In 2019, India tested a DA-ASAT missile known as Mission Shakti, destroying a target satellite at around 300 km in a test designed to minimize long-lived debris.[40] In 2021 Russia tested its PL-19 Nudol DA-ASAT missile, destroying a defunct Russian satellite at around 480 km altitude and creating a debris cloud that endangered the International Space Station.[41]

Orbital ASAT weapons are launched into space and enter orbit, adjusting their orbital paths to eventually bring targeted satellites within their weapons engagement zone. From 1963 to 1971, the USSR conducted seven tests of an orbital ASAT weapon, including five detonations of high-explosive warheads in outer space.[42] In the last decade, Russia has tested satellites that "exhibited characteristics of a weapon system" and "launched a high-speed projectile into space", as well as manoeuvring Russian satellites with these characteristics into close proximity with US satellites.[43] The US government publicly stated in April 2024 that "Russia is developing a new satellite carrying a nuclear device" with the

34 *Ibid.*
35 Clayton Swope *et al.*, *Space Threat Assessment 2024*, Center for Strategic and International Studies, 17 April 2024, available at: www.csis.org/analysis/space-threat-assessment-2024.
36 *Ibid.*
37 National Museum of the United States Air Force, "Vought ASM-135A Anti-Satellite Missile", available at: www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198034/vought-asm-135a-anti-satellite-missile/.
38 Defense Intelligence Agency, above note 5.
39 Alan B. Hicks and Albert J. Grecco, "Aegis: A Continuum of Excellence", *US Naval Institute Proceedings*, Vol. 140, No. 2, 2014, available at: www.usni.org/magazines/proceedings/2014/february/aegis-continuum-excellence.
40 Jeff Foust, "India Tests Anti-Satellite Weapon", *Space.com*, 10 August 2022, available at: www.space.com/india-tests-anti-satellite-weapon.html.
41 Defense Intelligence Agency, above note 5.
42 Union of Concerned Scientists, "A History of Anti-Satellite Programs", 1 March 2012, available at: www.ucsusa.org/resources/history-anti-satellite-programs.
43 W. J. Hennigan, "Exclusive: Strange Russian Spacecraft Shadowing U.S. Spy Satellite, General Says", *Time*, 10 February 2020, available at: https://time.com/5779315/russian-spacecraft-spy-satellite-space-force/.

"intention of deploying nuclear weapons in space",[44] an allegation that Russia has denied.[45]

Recent years have seen the rise of satellites with dual-use rendezvous operations capability, which can be used for consensual on-orbit servicing and maintenance but may also be used for non-consensual grappling of adversary satellites. The US MEV-1 satellite demonstrated docking with a cooperative client satellite in 2020.[46] In September 2023, the US military reported to Congress that US military "operations to deny adversary hostile use of space could originate in any domain and target on-orbit, ground, cyber, and/or link segments to reduce the full spectrum of an adversary's ability to exploit the space domain."[47] In 2022, China used its Shijian-21 satellite to capture and move a derelict BeiDou navigation satellite to a graveyard orbit above GEO, demonstrating a capability that could also be used for ASAT purposes. Similarly, China has deployed the Shijian-17 satellite with a robotic arm, which could be used for grappling other satellites.[48] In February 2024, Japan's Astroscale launched the ADRAS-J spacecraft, which is designed to capture and remove large-scale debris from orbit.[49] These types of dual-use spacecraft will continue to proliferate.

The physical attributes of outer space, the *lex specialis* of international space law, increased commercialization of space systems and services, rapidly advancing space technology and proliferation of counter-space weaponry all combine to present unique challenges to military space operations legal advisers practicing IHL.

The first challenge: Determining what rules govern military activities in space

This section examines the lack of clear standards for assessing when IHL governs military activities in outer space. This includes a discussion of how the *lex specialis* body of international space law limits military activity, the question of when unfriendly activities in outer space rise to the level of armed conflict governed by IHL, and the issue of what constitutes an "attack" in space regulated by IHL rules for attacks.

44 The White House, "Statement from National Security Advisor Jake Sullivan on Russia's Veto of the UN Security Council Resolution on the Outer Space Treaty", 24 April 2024, available at: www.whitehouse.gov/briefing-room/statements-releases/2024/04/24/statement-from-national-security-advisor-jake-sullivan-on-russias-veto-of-the-un-security-council-resolution-on-the-outer-space-treaty/.

45 Guy Faulconbridge, "Russia Denies US Reports Moscow Plans to Put Nuclear Weapons In Space", *Reuters*, 20 February 2024, available at: www.reuters.com/world/europe/russia-denies-us-claims-that-moscow-plans-deploy-nuclear-weapons-space-2024-02-20/.

46 Northrop Grumman, "SpaceLogistics", available at: www.northropgrumman.com/space/space-logistics-services.

47 DoD, *Space Policy Review and Strategy on Protection of Satellites*, September 2023, available at: https://media.defense.gov/2023/Sep/14/2003301146/-1/-1/0/COMPREHENSIVE-REPORT-FOR-RELEASE.PDF.

48 *Ibid.*

49 Astroscale, "ADRAS-J", available at: https://astroscale.com/missions/adras-j/.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

The default rules: Limits on military activity from the *lex specialis* of international space law

In outer space, the conduct of States is governed by general public international law, as it is when acting in other domains. In addition, the space domain has its own *lex specialis*, or "special law", of international space law, formed from a core of space-specific international agreements.[50] In international law, "the principle that special law derogates from general law is a widely accepted maxim of legal interpretation" dating back to the sixth-century *Corpus Iuris Civilis*.[51] Under this principle, "if a matter is regulated by a general standard as well as by a more specific rule, then the latter should take precedence over the former".[52] In peacetime, the *lex specialis* of space law controls military operations in the space domain, along with *lex generalis* rules of public international law that do not conflict with international space law. During armed conflict, the *lex specialis* of IHL also applies.[53] So, what happens to obligations under international space law during armed conflict?

The International Law Commission (ILC) addressed this question generally in its 2011 Draft Articles on the Effects of Armed Conflicts on Treaties (ILC Draft Articles).[54] As a foundational principle, the existence of armed conflict does not *ipso facto* terminate or suspend treaties between States party to the conflict. Instead, if a treaty itself contains provisions on its operation during armed conflict, those provisions govern. If a treaty is silent, ordinary rules of international law on treaty interpretation, primarily Articles 31 and 32 of the Vienna Convention on the Law of Treaties,[55] apply to determine if the treaty is susceptible to termination, withdrawal or suspension. Unlike many other treaties, the four core space treaties do not contain any specific provisions relevant to their operation during armed conflict, leaving the ordinary rules of interpretation to apply.[56] One of those ordinary rules is described in Article 14 of the ILC Draft Articles, which sets out that

> [a] State exercising its inherent right of individual or collective self-defence in accordance with the Charter of the United Nations is entitled to suspend in whole or in part the operation of a treaty to which it is a party insofar as that operation is incompatible with the exercise of that right.[57]

50 See UN Office for Outer Space Affairs, above note 14.

51 International Law Commission (ILC) Study Group, *Fragmentation of International Law: Difficulties Arising from the Diversification and Expansion of International Law*, UN Doc. A/CN.4/L.682, 13 April 2006.

52 *Ibid.*

53 *Ibid.*

54 ILC, *Draft Articles on the Effects of Armed Conflicts on Treaties, with Commentaries*, in *Report of the International Law Commission on the Work of Its Sixty-Third Session*, UN Doc. A/66/10, 2011 (ILC Draft Articles).

55 Vienna Convention on the Law of Treaties, 1155 UNTS 331, 23 May 1969.

56 See Dale Stephens, "The International Legal Implications of Military Space Operations: Examining the Interplay between International Humanitarian Law and the Outer Space Legal Regime", *International Law Studies*, Vol. 94, 2018, p. 82.

57 ILC Draft Articles, above note 54, p. 194.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

The United States agrees with the ILC on this.[58]

In situations where a space law obligation conflicts with IHL provisions allowing attacks or other military operations necessary to exercise self-defence, the defending State would be entitled to suspend the conflicting space law obligations. An aggressor State would not receive the benefit of this suspension. However, the precise parameters of how IHL provisions would interact with space law provisions are unclear. State practice is not particularly illuminating, since no war has ever been fought that has included attacks in outer space, though space-based assets have supported terrestrial wars since the 1991 Persian Gulf War. IHL practitioners must be prepared for the challenging task of applying existing rules of treaty interpretation to the new sets of facts that an armed conflict which extends into outer space would present. In this regard, the forthcoming Woomera Manual, produced by a consortium of universities with consultation by twenty-four States and the International Committee of the Red Cross (ICRC), will likely be very useful to practitioners.[59]

Sovereignty and UN Charter interaction

Article I of the Outer Space Treaty (OST)[60] declares that "outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States". Article II of the OST establishes that outer space, including the moon and other celestial bodies, is not subject to national appropriation by States by any means, including use, occupation or claim of sovereignty. Under these two articles, States may not claim orbital positions, or territory on the moon, or make other claims to sovereign territory that would provide a legal basis for military operations to defend that sovereign territory, in contrast to defence of territory on earth. Article III of the OST requires States Parties to carry out their activities in outer space in accordance with international law, including the 1945 Charter of the United Nations (UN Charter), thus establishing the applicability of the Charter's prohibition on the use of force and recognition of the inherent right of self-defence in outer space.[61]

Weapons and military installations in outer space

Under Article IV of the OST, States Parties "undertake not to place in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction [WMDs], install such weapons on celestial bodies, or station

58 DoD, *Law of War Manual*, 2023 (DoD Manual), § 14.10.2.1.

59 University of Adelaide, "The Woomera Manual: State Engagement", available at: https://law.adelaide.edu.au/woomera/state-engagement.

60 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 8843 UNTS 610, 27 January 1967 (entered into force 10 October 1967) (OST).

61 See Ram S. Jakhu and Steven Freeland (eds), *McGill Manual on International Law Applicable to Military Uses of Outer Space*, Vol. 1: *Rules*, Centre for Research in Air and Space Law, Montreal, 2022, Rules 151–152.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

such weapons in outer space in any other manner". Article IV requires that the moon and other celestial bodies be used "exclusively for peaceful purposes" and prohibits "the establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies". However, military personnel may be used "for scientific research or for any other peaceful purposes" on celestial bodies. Notably, this provision does not prohibit WMDs which pass through space, such as intercontinental ballistic missiles with nuclear warheads, nor does it prohibit placement in orbit of conventional, non-WMD weapons. In 1974, the USSR placed the Almaz OPS-2 military space station into orbit, armed with a 23 mm automatic cannon.[62] Its test firing is believed to be the only time a gun has ever been fired in outer space.

Due regard and harmful interference

Article IX of the OST provides that States Parties "shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty". All States Parties have an interest in exercising their freedom to explore and use outer space under Article I. Military activities that preclude other States Parties from freely using outer space, such as repetitive jamming of radio frequency signals used in the link segment of space systems or use of directed energy weapons to damage the sensors or structures of on-orbit satellites, would, in the opinion of the present authors, likely violate the due regard obligation.

During an armed conflict, the OST due regard obligation of a defending State would be suspended if complying with it would be incompatible with exercising a State's inherent right of self-defence.[63] IHL obligations, of course, would not be suspended and would continue to apply.[64] However, in the era of great power competition, some States may engage in military activities outside of armed conflict that do not rise to the level of a use of force or armed attack but whose compliance with the OST due regard obligation is questionable, such as electromagnetic warfare against ground and orbital segments of space systems. Jamming of satellite navigation receivers on the high seas and in other nations' territory has grown in scope and scale in recent years, with interference regularly observed in various parts of the world.[65] Legal advisers must be prepared to

62 Joseph Trevithick, "Here's Our Best Look Yet at Russia's Secretive Space Cannon, the Only Gun Ever Fired in Space", *The War Zone*, 16 February 2021, available at: www.thedrive.com/the-war-zone/39277/heres-our-best-look-yet-at-russias-secretive-space-cannon-the-only-gun-ever-fired-in-space.

63 ILC Draft Articles, above note 54, Art. 14, p. 194: "A State exercising its inherent right of individual or collective self-defence in accordance with the Charter of the United Nations is entitled to suspend in whole or in part the operation of a treaty to which it is a party insofar as that operation is incompatible with the exercise of that right."

64 *Ibid.*, Art. 14 commentary, p. 194: "the right [to suspend] provided for does not prevail over treaty provisions that are designed to apply in armed conflict, in particular the provisions of treaties on international humanitarian law and on the law of armed conflict, such as the 1949 Geneva Conventions for the protection of war victims".

65 For examples, see C. Swope *et al.*, above note 35.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

provide cogent advice on the international law framework for responding to such activities, including the availability of retorsion and countermeasures.

Article IX of the OST states that

> [i]f a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment.

The meaning and scope of this provision, particularly in relation to military space operations outside of armed conflict, is unclear. In the fifty-six years since the OST entered into force, no State has ever actually undertaken international consultations under this provision or demanded that another State do so. During an armed conflict, this consultation obligation would be suspended if complying with it would be incompatible with exercising a State's inherent right of self-defence.[66] For example, a defending State would be highly unlikely to consult an aggressor State prior to attacking or otherwise harmfully interfering with that State's military space systems, as that would allow the aggressor State an opportunity to prepare for the attack.

When does armed conflict in space governed by IHL begin?

The trigger for the application of the full scope of IHL is the existence of an international armed conflict, a term which is generally accepted to have been defined by the four Geneva Conventions of 1949. Under Article 2 common to the Conventions, an international armed conflict exists in "all cases of declared war or of any other armed conflict which may arise between two or more of the High Contracting Parties, even if the state of war is not recognized by one of them".[67] Although treaty law does not define the term "armed conflict", the consensus view is that an international armed conflict requires "a resort to armed force between States".[68]

The body of customary and treaty international law governing the resort to armed force by States is the *jus ad bellum*. Its lodestar is the UN Charter. Article 2(4) of the Charter requires all member States to "refrain in their international relations

66 ILC Draft Articles, above note 54, Art. 14, p. 194.

67 See e.g. Geneva Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field of 12 August 1949, 75 UNTS 31 (entered into force 21 October 1950), Art. 2.

68 ICRC, *Commentary on the First Geneva Convention: Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field*, 2nd ed., Geneva, 2016, para. 218, citing International Tribunal for the former Yugoslavia, *Prosecutor v. Duško Tadić*, Case No. IT-94-1-T, Decision on the Defence Motion for Interlocutory Appeal on Jurisdiction, 1995, para. 70.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

from the threat or use of force against the territorial integrity or political independence of any State, or in any other manner inconsistent with the Purposes of the United Nations".[69] Article 2(4) thus prohibits all use of force in international relations, except as permitted by the Charter.[70] Chapter VII of the Charter allows the UN Security Council to authorize States to use force. Article 51 of the Charter recognizes the customary international law "inherent right of individual or collective self-defence if an armed attack occurs" against a State.

The phrases "use of force" and "armed attack" are not defined in the UN Charter, and international consensus is lacking over their precise meaning. In the scholarly view contemporaneous with the establishment of the Charter, there was little daylight between the two. Use of force was "commonly understood to imply a military attack, an 'armed attack,'" with a State-controlled entity using traditional weapons, or non-traditional weapons such as poison gas, "employed for the destruction of life and property" against another State,[71] with "armed force" as distinguished from political or economic pressure.[72]

In 1986, the International Court of Justice (ICJ) articulated in the *Nicaragua* case a view that "the most grave forms of the use of force" constitute an armed attack, distinguishing between an "armed attack" and a "mere frontier incident" based on "scale and effects".[73] Subsequently, in the *Oil Platforms* case, the ICJ indicated that damaging a single naval vessel with a mine might qualify as an armed attack.[74] How large the gap between use of force and armed attack may be is unclear. As the authors of the *Tallinn Manual 2.0 on the International Law Applicable to Cyber Operations* (Tallinn Manual 2.0) put it, "the parameters of the scale and effects criteria remain unsettled beyond the indication that they need to be grave".[75]

Rather than adopting the ICJ's reasoning from the *Nicaragua* case, the United States "has long taken the position that the inherent right of self-defense potentially applies against any illegal use of force".[76] Because Article 51 of the UN Charter refers to the inherent right of self-defence arising from State sovereignty that is not superseded by the Charter, the US construes the term "armed attack" in accordance with the long-standing "customary practice that enables any State to effectively protect itself and its citizens from every illegal use

69 Charter of the United Nations and Statute of the International Court of Justice, 26 June 1945 (entered into force 24 October 1945).

70 Yoram Dinstein, *War, Aggression, and Self-Defence*, 5th ed., Cambridge University Press, Cambridge, 2011, pp. 80–83.

71 Ian Brownlie, *International Law and the Use of Force by States*, Oxford University Press, Oxford, 1963, p. 362.

72 Lassa Oppenheim, *International Law: A Treatise*, Vol. 2: *Disputes, War and Neutrality*, 7th ed., Longmans, Green, London, 1952, p. 153.

73 ICJ, *Military and Paramilitary Activities in and against Nicaragua (Nicaragua. v. United States of America)*, Judgment, 27 June 1986, *ICJ Reports 1986*, para. 191.

74 ICJ, *Case Concerning Oil Platforms (Islamic Republic of Iran v. United States of America)*, Judgment, 6 November 2003, *ICJ Reports 2003*, para. 72.

75 Michael N. Schmitt (ed.), *Tallinn Manual 2.0 on the International Law Applicable to Cyber Operations*, Cambridge University Press, Cambridge, 2017 (Tallinn Manual 2.0), p. 341.

76 DoD Manual, above note 58, § 1.11.5.2.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

of force aimed at the State".[77] As the US State Department legal adviser once noted, requiring States to submit to the use of force against them without being allowed to defend themselves until the force reaches a certain level of gravity encourages aggressors to engage in a series of small-scale military attacks, hoping to stay below the threshold that allows a defensive response from the victim State.[78]

Neither the ICJ nor any other international tribunal has been asked to opine on what constitutes a use of force in outer space, as no State has ever publicly raised such an allegation. States often act in great secrecy in their military space operations, so the lack of public accusations does not mean that nefarious behaviour has not occurred – it may be that States value preserving a cloak of concealment around their own activities over the possibility of achieving symbolic vindication through litigation.

Nor has the US government publicly stated an official position on what actions generally constitute a use of force or armed attack in outer space under the *jus ad bellum*. The Department of Defense (DoD) *Law of War Manual* (DoD Manual) simply states that "*jus ad bellum* issues might raise questions of national policy that, in the Executive Branch, would be decided by the President".[79]

Counter-space capabilities include weapons that are analogous in many ways to terrestrial weapons, whose employment has the potential to constitute an armed attack when employed against the space objects of another State. Missiles, lasers, high-powered microwaves, electromagnetic pulses, rail guns, manoeuvring kinetic kill vehicles and other weapons designed to cause physical damage and destruction are still that – weapons – when used in outer space. Use of weapons to destroy another State's unmanned satellites on orbit providing military communications would likely be considered an armed attack[80] in the same way that use of weapons such as cruise missiles for long-range bombardment of another State's unmanned military munitions storage facilities would likely be considered an armed attack on earth,[81] though neither satellites nor storage bunkers have mothers.[82]

Some counter-space capabilities use the electromagnetic spectrum in ways that can be analogized to offensive cyber operations, and indeed, communications satellites and their networks form a critical component of cyberspace. Effects in cyberspace may be delivered by non-kinetic means and generally directly affect software and discrete hardware items rather than humans, but may proximately cause harm to humans and property more broadly. States generally apply an

77 *Ibid.*, § 1.11.5.2 fn. 224.
78 William H. Taft IV, "Self-Defense and the *Oil Platforms* Decision", *Yale Journal of International Law*, Vol. 29, No. 2, 2004, pp. 300–301.
79 DoD Manual, above note 58, § 1.11.
80 Y. Dinstein, above note 70.
81 See UNGA Res. 3314 (XXIX), "Definition of Aggression", 14 December 1974.
82 The adage "satellites don't have mothers" has been used to argue that if no human life is directly threatened by an armed attack in space, there is no self-defence right to protect or defend satellites through military means. See John J. Klein, "Space Warfare: Deterrence, Dissuasion and the Law of Armed Conflict", *War on the Rocks*, 30 August 2016, available at: https://warontherocks.com/2016/08/space-warfare-deterrence-dissuasion-and-the-law-of-armed-conflict/.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

effects-based test when assessing whether a particular cyber, electromagnetic warfare or other operation employing non-traditional tools constitutes an armed attack. In the view of the Tallinn Manual 2.0 authors, a cyber operation that "seriously injures or kills a number of persons or that causes significant damage to, or destruction of, property" would constitute an armed attack.[83]

The United States has publicly offered an example of a case where the physical effects of a hostile cyber action would be comparable to what a kinetic action could achieve and would qualify as "significant destruction": a cyber operation that would disable air traffic control services, resulting in aeroplane crashes.[84] This example is also applicable to military space operations. Today, modern aircraft rely extensively on global navigation satellite systems (GNSSs) not just for navigation but also for air traffic control using Automatic Dependent Surveillance – Broadcast technology.[85] Denying or spoofing a GNSS signal using an electronic warfare system could result in aeroplane crashes,[86] vehicle crashes, maritime vessels running aground or colliding, or a litany of other physical effects that might qualify as "significant destruction".

An effects-based framework assesses the effects of an attack after it has occurred. However, it is the long-standing position of some States that the inherent right of self-defence under customary international law as recognized by Article 51 of the UN Charter also allows States to act in self-defence in response to an imminent threat of armed attack.[87] Non-destructive actions to disrupt or completely deny the use of some space systems could be construed as an imminent threat of armed attack. For nuclear-armed States, space systems often provide warning of adversary missile launch, detection of nuclear detonation, and survivable command and control for launch of nuclear weapons in response. For example, in the United States, "the space-based component of NC3 is integral to the defense of the United States because it is the 'preferred means to transmit a presidential order to use nuclear weapons and would provide the first warning of

83 Tallinn Manual 2.0, above note 75, p. 341.

84 DoD Manual, above note 58, § 16.3.1, citing Harold Hongju Koh, "International Law in Cyberspace: Remarks as Prepared for Delivery to the USCYBERCOM Inter-agency Legal Conference", 18 September 2012, reprinted in *Harvard International Law Journal Online*, Vol. 54, December 2012, p. 4.

85 International Civil Aviation Organization, "Overview of Automatic Dependent Surveillance-Broadcast (ADS-B) Out", available at: www.icao.int/NACC/Documents/Meetings/2021/ADSB/P01-OverviewADSBOut-ENG.pdf.

86 Todd Walter, Zixi Liu and Sherman Lo, "Characterization of ADS-B Performance under GNSS Interference", Stanford University, August 2021, available at: www.unoosa.org/documents/pdf/icg/IDM/IDM9/2021_IDM_workshop_06.pdf.

87 Peter Henry Goldsmith, Oral Answers to Questions, *Hansard*, House of Commons Debates, Vol. 660, 21 April 2004, Cols 370–371: "It is argued by some that the language of Article 51 provides for a right of self-defence only in response to an actual armed attack. However, it has been the consistent position of successive United Kingdom Governments over many years that the right of self-defence under international law includes the right to use force where an armed attack is imminent. It is clear that the language of Article 51 was not intended to create a new right of self-defence. Article 51 recognises the inherent right of self-defence that states enjoy under international law. … It is not a new invention. The charter did not therefore affect the scope of the right of self-defence existing at that time in customary international law, which included the right to use force in anticipation of an imminent armed attack."

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

an incoming nuclear attack'".[88] That first warning is provided by the Space-Based Infrared System, a satellite constellation that uses infrared sensors to detect the thermal signatures of missile launches.[89] Dazzling or damaging the sensors on these satellites using ground-based lasers has the potential to be a highly provocative act that could indicate intent to launch a surprise first strike with nuclear-armed missiles. Some States possess such lasers and the doctrine to employ them. Public statements from the Russian Defense Ministry indicate that in 2019, Russia deployed its ground-mobile Peresvet laser system that is designed to blind enemy optical tracking systems, including those on satellites, to five strategic missile divisions.[90]

As militaries grow more dependent on space-based capabilities and counter-space weapons continue to proliferate, militaries will exercise how they plan to respond to both destructive and non-destructive actions in space. Military attorneys working in space operations units must be prepared to provide advice on the *jus ad bellum* during peacetime exercises, times of crisis, and even conflict should deterrence fail. They must understand when an armed conflict is triggered and IHL becomes applicable, and what effect that has on international space law rules.

What constitutes an "attack" under IHL in space?

IHL rules designed to protect civilian populations from the ravages of war have a long history, with one of the first codifications of a custom distinguishing between unarmed citizens and military personnel appearing in the US Lieber Code of 1863.[91] Today, many such customary rules have been codified in Part IV of the 1977 Additional Protocol I to the Geneva Conventions of 1949 (AP I).[92] Two of these rules, concerning distinction and proportionality, are challenging to apply to modern military space operations during armed conflicts. Article 52 of AP I declares that "civilian objects shall not be the object of attack", defines "civilian objects" as "all objects which are not military objectives", and provides a definition for military objectives.[93] States which are not a party to AP I generally recognize it as reflecting customary international law.[94] Article 57 requires "those who plan or decide upon an attack" to

88 Marie Villarreall Dean, *U.S. Space-Based Nuclear Command and Control: A Guide*, Center for Strategic and International Studies, 13 January 2023, p. 2, available at: https://aerospace.csis.org/wp-content/uploads/2023/01/130223_MV_SpaceNuclearFinal.pdf. The acronym NC3 refers to a nuclear command, control and communications system.

89 *Ibid.*

90 Defense Intelligence Agency, above note 5.

91 Yves Sandoz, Christophe Swinarski and Bruno Zimmermann (eds), *Commentary on the Additional Protocols*, ICRC, Geneva, 1987 (ICRC Commentary on the APs), para. 123.

92 Protocol Additional (I) to the Geneva Conventions of 12 August 1949, and relating to the Protection of Victims of International Armed Conflicts, 1125 UNTS 3, 8 June 1977 (entered into force 7 December 1978) (AP I).

93 *Ibid.*, Art. 52(2).

94 See e.g. DoD Manual, above note 58, § 5.5.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

> 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 and direct military advantage anticipated.[95]

States which are not a party to AP I also generally recognize this rule as reflecting customary international law.[96]

The trigger for obligations under both of these rules is an "attack", which is a term of art in IHL. Article 49 of AP I defines "attacks" as "acts of violence against the adversary, whether in offence or in defence". The ICRC Commentary on AP I takes the position that the term broadly means "combat action" and refers to "the use of armed force to carry out a military operation at the beginning or during the course of armed conflict".[97] With regard to space systems, the ICRC takes the position that "a non-kinetic operation that may be expected to disable an object without causing – even indirectly – physical damage qualifies as an attack as defined in IHL", while noting that divergent views exist on this issue.[98] Other commentators apply the words of Article 49 more literally to produce a narrower definition:

> [A]*n "attack" must involve an act of violence to produce physical injury or damage*. A *sine qua non* for an "attack" is an employment of force to produce violent consequences to the enemy. Violent consequences, in turn, are understood as death or injury in the case of persons, or physical damage or destruction in the case of objects. Notably, mere interference or impediment to the functionality of an object without causing it physical damage, such as electronic jamming, is insufficient to constitute an attack.[99]

Today, the cheapest and most widely available counter-space capabilities are electronic jammers that temporarily interfere with reception of radio frequency signals used in the link segment of space systems, and electronic spoofers that produce fake signals with erroneous information.[100] Cyber capabilities can raise

95 AP I, Art. 57(2).

96 See e.g. DoD Manual, above note 58, § 5.12.

97 ICRC Commentary on the APs, above note 91, p. 603, para. 1882.

98 Wen Zhou, "Protection of Civilians, Civilian Objects and the Natural Environment in Relation to Threats Arising from State Behaviours with Respect to Outer Space", Presentation to Open-ended Working Group on Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours, ICRC, Geneva, 11 May 2022, available at: https://documents.unoda.org/wp-content/uploads/2022/05/Presentation-by-Wen-Zhou-under-topic-3-at-the-first-session-of-OEWG-on-reducing-space-threats_11-May-2022.pdf.

99 Geoffrey S. Corn, Richard Jackson, M. Christopher Jenks, Eric Talbot Jensen and James A. Schoettler Jr, *Request for Leave to Submit Amicus Curiae Observations on the Legal Questions Presented in the "Order Inviting Expressions of Interest as Amici Curiae in Judicial Proceedings (Pursuant to Rule 103 of the Rules of Procedure and Evidence) of 24 July 2020 (ICC-01/04-02/06-2554)*, International Criminal Court, ICC-01/04-02/06 A2, 14 August 2020, p. 5, available at: www.icc-cpi.int/sites/default/files/CourtRecords/CR2020_04854.PDF (emphasis in original).

100 Kari A. Bingen, Kaitlyn Johnson, Makena Young and John Raymond, *Space Threat Assessment 2023*, Center for Strategic and International Studies, 14 April 2023, available at: www.csis.org/analysis/space-threat-assessment-2023.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

even more challenging categorization problems; for example, a hypothetical cyber capability could inject commands into a telemetry, tracking and control signal of a geostationary communications satellite, directing the satellite's flight control computer to reorient the attitude of the satellite so that its parabolic transponder antennas face the sun rather than the earth, then overwrite the control system firmware so that the effect is non-reversible. While there has been no physical damage or destruction, the result is a permanent loss of the satellite's communications functionality. Is this an "attack" under IHL? What about a cyber capability that injects commands into a payload control signal and seeds digital imagery data of a remote sensing satellite with arbitrary binary zeroes, resulting in corrupted and useless imagery being downlinked to users on earth?

When faced with proposals to employ or respond to the employment of such capabilities, military operational attorneys must be able to provide cogent advice on whether such employment under their State's interpretation of IHL constitutes an "attack" that triggers the applicability of certain IHL rules, including those concerning distinction and proportionality.

The second challenge: Distinction when targeting space systems

Distinction, sometimes referred to as "discrimination", is considered one of the "cardinal principles in the texts constituting the fabric of humanitarian law".[101] It requires that parties to an armed conflict distinguish between the armed forces and the civilian population, as well as between unprotected and protected objects.[102] This entails an obligation on the part of the attacker to only leverage attacks on enemy combatants (plus civilians taking direct part in hostilities) and military objectives,[103] and a requirement that the defender distinguish or separate its military forces and war-making activities from the civilian population to the maximum extent feasible in order to reduce the risk of civilian casualties and damage to civilian objects.[104] Space poses a particular set of challenges for distinction between military and civilian objects – namely, the dual-use nature of most space systems, the unsettled question of what portions of space systems can constitute military objectives, transmission practices like frequency hopping, and the heavy reliance on civilian services for military operations in space.

101 ICJ, *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, 8 July 1996, *ICJ Reports 1996*, § 78.

102 Jean-Marie Henckaerts and Louise Doswald-Beck (eds), *Customary International Humanitarian Law*, Vol. 1: *Rules*, Cambridge University Press, Cambridge, 2005 (ICRC Customary Law Study), Rules 1, 7, available at: https://ihl-databases.icrc.org/en/customary-ihl/rules; DoD Manual, above note 58, § 2.5.

103 DoD Manual, above note 58, § 2.5.2.

104 *Ibid.*, § 2.5.3.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

The dual-use nature of most space systems

The preponderance of space systems today are what is typically referred to as "dual-use", serving both civilian and military purposes.[105] For example, a commercial entity providing satellite communications like voice, data and video transmission might be contracted to provide services to militaries and civilians alike. Similarly, satellites that take high-resolution images can simultaneously be used for civilian purposes like urban planning and development, environmental monitoring and agriculture, while also providing imagery critical to military intelligence, surveillance and reconnaissance.

From an IHL perspective, however, an object is either a military objective, and may therefore be made the subject of attack directed against it, or not. Lawful military objectives are "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".[106] Both conditions – the effective contribution to military action and the definite military advantage if destroyed, captured or neutralized – must be met in order for an object to become a military objective under IHL.[107]

Satellites operated by militaries are categorically recognized as military objectives by their *nature*, just as military equipment on land or at sea constitutes a military objective by nature.[108] This includes military satellites providing services to civilians, like GPS, which is operated by the US Space Force and provides the military with position, navigation and timing data that is also ubiquitously used in civilian society all over the world.[109] Commercial or "civil space" satellites can become military objectives by their *use* or *purpose*. While "use" refers to an object's present function, "purpose" implicates the object's future use.[110]

With respect to "purpose", the DoD Manual notes that "runways at a civilian airport could qualify as military objectives because they may be subject to immediate military use in the event that runways at military air bases have been rendered unserviceable or inoperable".[111] By this analogy, some may argue that there is a wide aperture for civilian satellites to be considered military objectives, as the preponderance of commercial and civil satellites provide services that could be militarily useful, including communication, navigation and remote sensing, and could quickly be subject to military use by simply providing their data,

105 See "Who Owns our Orbit: Just How Many Satellites Are There in Space?", World Economic Forum, 23 October 2020, available at: www.weforum.org/agenda/2020/10/visualizing-easrth-satellites-sapce-spacex/.

106 AP I, Art. 52(2); ICRC Customary Law Study, above note 102, Rule 8.

107 ICRC, "The Principle of Distinction", March 2023, available at: www.icrc.org/sites/default/files/wysiwyg/war-and-law/03_distinction-0.pdf.

108 See DoD Manual, above note 58, § 5.6.6.1.

109 US Space Force, "Global Positioning System", October 2020, available at: www.spaceforce.mil/About-Us/Fact-Sheets/Article/2197765/global-positioning-system/.

110 DoD Manual, above note 58, § 5.6.6.1.

111 *Ibid.*, § 5.6.6.1.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

imagery or bandwidth to the military. However, while the DoD Manual defines "purpose" as "the intended or possible use in the future", the UK and Australian manuals reference only "future intended use", indicating that the "possible use in the future" approach may be a step further than what is generally accepted under international law.[112] Based on this, it is likely that most States would require some level of specific intelligence suggesting that the adversary intends to leverage a civilian satellite for military purposes. Examples of this type of intelligence might be military investment in the development of the technology, military collaboration or contracts with the satellite owner, modifications to the space system that indicate an intent for military use, or even changes in orbital behaviour that suggest a shift toward military purpose.

Becoming a military objective by "use" is more straightforward. A civilian satellite, whether commercial, NGO or government, potentially becomes a military objective when it serves a military purpose, provided it also satisfies the second prong of the definition of a military objective. Military contracts for commercial satellite services are becoming commonplace. Commercial satellite communication providers frequently lease bandwidth for military use – the Ukrainian military's use of secure space-based communications services provided by Viasat during its ongoing armed conflict with the Russian Federation is a recent example[113] – and military forces may rely on civilian satellite imagery to monitor adversary activities, assess (or even replicate) an operating environment and gather intelligence on potential threats. For example, Maxar Technologies' commercial satellites are used to take high-resolution images of earth for a variety of civilian purposes, but the company has also used that imagery to create 3-D representations of specific locations to be used in military training.[114] Maxar also recently obtained approval to use the same satellites to take pictures of objects in space and announced that it is discussing the use of this imagery with the US Space Force "to identify potential threats and monitor suspicious activity in space".[115]

In addition to nature, purpose or use, an object's *location* may be the way in which it makes an effective contribution to military action, making it possible to assess it as a military objective during times of armed conflict.[116] The DoD Manual notes that the word "location" in the test for military objective "also helps clarify that an area of land can be militarily important and therefore a

112 Australian Defence Force, *Law of Armed Conflict*, Australian Defense Doctrine Publication 06.4, 2006, § 5.29: "Purpose means the future intended use of an object." UK Ministry of Defence, *Joint Service Manual of the Law of Armed Conflict*, 2004, §5.4.4: "'Purpose' means the future intended use of an object."

113 Kari A. Bingen, Kaitlyn Johnson and Zhanna Malekos Smith, "Russia Threatens to Target Commercial Satellites", Center for Strategic and International Studies, 10 November 2022, available at: www.csis.org/analysis/russia-threatens-target-commercial-satellites/.

114 Sandra Erwin, "Maxar Eager to Launch New Satellites Amid Soaring Demand for Imagery over Ukraine", *SpaceNews*, 11 April 2022, available at: https://spacenews.com/maxar-eager-to-launch-new-satellites-amid-soaring-demand-for-imagery-over-ukraine/.

115 *Ibid.*

116 AP I, Art. 52(2); ICRC Customary Law Study, above note 102, Rule 8.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

military objective".[117] This raises the question of whether a particular orbit, because it is an area of military importance providing a definite military advantage, may be determined to be a military objective in itself, or whether a civilian satellite occupying that orbit, effectively denying adversary access, may be determined to be a military objective. For example, a particular location in the GEO belt may have strategic significance during an armed conflict, as GEO facilitates continuous coverage over a particular area on earth, allowing for persistent surveillance, communication, navigation, early warning or missile defence over that specific area.[118] Can a particular orbital slot be a military objective by location? Further, can a purely civilian satellite, by nature of its location in orbit, be assessed to make an effective contribution to military action by keeping an adversary out of that orbit? If it can, and it is determined that its removal from that orbit – in essence, its capture or neutralization – offers a definite military advantage, a purely civilian satellite may in theory be determined to be a military objective by its location.

Passive precautions or reverse distinction

States that blur the lines between military and commercial development of space technologies may be more vulnerable to lawful targeting of space objects and supporting infrastructure with civilian applications in the event of an armed conflict. For example, the People's Republic of China has been reported to have implemented a military–civil fusion strategy designed to ensure that new technological innovations simultaneously advance both military and economic development.[119] The European Union has implemented Infrastructure for Resilience, Interconnectivity and Security by Satellite, or IRIS2, which similarly focuses on developing technologies that benefit both civilian and military sectors.[120] The DoD has also recently announced its Commercial Space Integration Strategy, which intends to "drive integration [with commercial space] and ensure the availability of commercial space solutions during competition, crisis, and conflict".[121] These types of programmes have the potential to render space systems used for civilian applications lawful military objectives by use. They may also bolster arguments that the "future intended use" of a space system is for military purposes, when there is an institutionalized programme to acquire the technological advancements of private industry to serve military aims.

117 DoD Manual, above note 58, § 5.6.6.1.

118 See Robert Lea, "What Is a Geosynchronous Orbit?", *Space.com*, 26 December 2022, available at: www.space.com/29222-geosynchronous-orbit.html.

119 US Department of State, "The Chinese Communist Party's Military-Civil Fusion Policy", available at: https://2017-2021.state.gov/wp-content/uploads/2020/06/What-is-MCF-One-Pager.pdf.

120 European Commission, "Space: Commission Invites the Industry to Submit Proposals to Deploy the New EU Secure Connectivity Satellite Constellation, IRIS^2", 24 March 2023, available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1882.

121 Sandra Erwin, "Pentagon Looks to Commercial Space for an Edge", *SpaceNews*, 27 November 2023, available at: https://spacenews.com/pentagon-looks-to-commercial-space-for-an-edge/.

The practice of integrating military and commercial space has raised criticism in academic circles. Professor David Koplow has asserted that intermingling of military and private sector space functions violates the principle of "reverse distinction" that requires States to separate military and civilian assets.[122] The idea of reverse distinction, sometimes called "passive precautions",[123] is reflected in Article 58 of AP I and entails the obligation on the part of the party controlling the civilian population to remove those civilians and civilian objects from the vicinity of military objectives, to the extent feasible, in order to minimize civilian casualties and damage to civilian objects.[124] The requirement to take passive precautions "to the extent feasible" is important in the context of outer space.[125] With respect to space systems, the high cost of development, launch and operation, considered with the military advantages of leveraging commercial capabilities and the widespread State practice of intermingling with private industry in outer space, suggests that this practice is not in violation of the principle of passive precautions.[126]

The unsettled question of what portions of space systems constitute targeted military objectives for IHL analysis

The prevalent intermingling of civilian and military activities on orbit also raises the question of what portion of a space system is the targeted object. IHL requires that distinct structures be assessed separately for status as military objectives.[127] A space system is comprised of three segments: the space segment, the terrestrial segment or ground station, and the datalink between the two.[128]

Satellites or satellite constellations are the most common examples of the space segment. However, a satellite can be further divided into two

122 David A. Koplow, "Reverse Distinction: A U.S. Violation of the Law of Armed Conflict in Space", *Harvard National Security Journal*, Vol. 13, 2022.

123 ICRC, *Draft Rules for the Limitation of the Dangers incurred by the Civilian Population in Time of War*, 1956, Art. 11.

124 AP I, Art. 58. See also DoD Manual, above note 58, § 2.5.3.

125 The United States interprets this as precautions that are "practicable or practically possible". DoD Manual, above note 58, § 5.2.3.2.

126 See John Goehring, "The Legality of Intermingling Military and Civilian Capabilities in Space", *Articles of War*, 17 October 2022, available at: https://lieber.westpoint.edu/legality-intermingling-military-civilian-capabilities-space/; Svenja Berrang, "How Would IHL Apply to Hostilities in Outer Space", *Humanitarian Law and Policy Blog*, 2 November 2023, available at: https://blogs.icrc.org/law-and-policy/2023/11/02/how-would-ihl-apply-to-hostilities-in-outer-space/.

127 See Michael N. Schmitt, "Targeting Dual-Use Structures: An Alternative Interpretation", *Articles of War*, 28 June 2021, available at: https://lieber.westpoint.edu/targeting-dual-use-structures-alternative/: "[P]lainly distinct structures must be assessed independently against the military objective standard. For instance, if a tunnel or a covered walkway connects two adjacent buildings, they nevertheless are generally considered separate for the purpose of military objective status even though they are physically connected." International Law Association Study Group on the Conduct of Hostilities in the 21st Century, "The Conduct of Hostilities and International Law: Challenges of 21st Century Warfare", *International Law Studies*, Vol. 93, 2017, p. 334: "The delimitation of the building/structure should therefore be understood as narrowly as is reasonably possible in view of the circumstances of the case."

128 Brian Garino and Jane Gibson, "Space System Threats", in *AU-18 Space Primer*, Air University Press, Maxwell AFB, AL, 2009.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

subcomponents: the satellite bus and the payload.[129] A payload is the instrument carried onboard the satellite that performs a specific purpose.[130] Examples of satellite payloads are communications transponders, remote sensing cameras or sensors, navigation receivers and spectrometers.[131] The satellite bus, in contrast, consists of the "support" parts of the satellite designed to enable the payload by providing power, propulsion, thermal control, communication, command and data handling, and attitude control.[132] The link segment is comprised of signals connecting the two other segments and includes telemetry, tracking and commanding signals necessary to control the spacecraft and its payload.[133] The link segment may also provide direct downlinks of data (satellite imagery, for example), satellite communications between two terminals on the ground, or a positioning, navigation and timing signal.[134] Lastly, the ground segment of a space system consists of the personnel, facilities and equipment that are used to interact with the link or space segments.[135] While the space and ground segments are distinct and separate entities that warrant separate analysis under the principle of distinction, there remains some question about whether a satellite can – or should – be further subdivided.

The practice of deploying military payloads on civilian satellites, often referred to as "hosted payloads", complicates this analysis. This approach allows armed forces to leverage existing commercial or civil satellites and their supporting infrastructure for military purposes, making putting sensors and other equipment in space more timely and cost-effective.[136] For example, a military may contract with a commercial satellite operator to host a military communications payload consisting of secure communications equipment. The military payload would be affixed to and integrated with the bus of the civilian satellite, operating alongside the satellite's primary mission, leveraging its power, coverage, bandwidth and other resources for military communications purposes.

This gives rise to the question of whether the entire space system is the military objective, or whether only the hosted military payload is a military objective. Most would agree that while the payload is a military objective by nature, the satellite as a whole is a military objective by use. Despite its initial civilian nature, the satellite becomes a military objective when it serves a military purpose. In this case, the payload is not simply on – or attached to – the bus of the satellite, but is also integrated into the bus and benefiting from its subsystems, like power, attitude control and propulsion.[137] The same argument may be made

129 NASA, "Spacecraft Bus", available at: https://webb.nasa.gov/content/observatory/bus.html.
130 *Ibid.*
131 *Ibid.*
132 *Ibid.*
133 DoD, above note 7, p. I-8.
134 *Ibid.*, p. I-8.
135 *Ibid.*, p. I-9.
136 Sandra Erwin, "Space Force Touts Benefits of Deploying Military Payloads on Commercial Satellites", *SpaceNews*, 7 February 2023, available at: https://spacenews.com/space-force-touts-benefits-of-deploying-military-payloads-on-commercial-satellites/; Office of Space Commerce, "Hosted Payloads", available at: www.space.commerce.gov/category/government-business/hosted-payloads/.
137 See NASA, above note 129.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

about a ground segment of the space system: by providing command and control of the satellite hosting the military payload, the ground station becomes a military objective by use.

This distinction has implications for follow-on analysis. If the military payload alone is the targetable military objective, the remainder of the satellite must be factored into the proportionality and feasible precautions analysis. By contrast, if we conclude that the satellite as a whole is the military objective because it is used for military purposes, many States would not find a requirement in IHL to consider the civilian components of that military objective during the proportionality analysis.[138] This may, however, be a distinction without a difference. It is also worth noting, as will be discussed in the below section on proportionality, that an *effect* on civilian objects in space is distinct from *harm*. While undoubtedly still important and likely to be considered for policy reasons, an effect on the civilian population like loss of high-resolution imagery used to track shipping or loss of a television broadcast, to the extent that the effect was considered a "mere inconvenience" or "temporary disruption", would not be seen as legally required to have to be incorporated in the proportionality analysis under the current US application of the rule.[139]

Frequency hopping

Satellites are often valuable targets not because the satellite itself is inherently valuable to military operations, but because of the services it provides in support of terrestrial activities. This often means that the real military advantage lies in affecting the ability to relay a particular signal on the datalink between the space and ground segments. When an uplink or downlink signal is the true underlying military objective, however, the distinction analysis may grow even more complicated. A variety of transmission practices sometimes make it difficult to gain and maintain information indicating that a particular satellite is a military objective.

The practice of frequency hopping is a method of making interception difficult or reducing interference on the signal by rapidly switching a signal between frequencies.[140] This same principle could be applied to a constellation or network of satellites, in which frequencies are dynamically allocated based on factors like security, jam resistance, or simply channel conditions or traffic loads. In practice, this means that a frequency on the datalink segment of a space system may be a military objective one moment, and the next moment, the

138 See M. N. Schmitt, above note 127, noting that once an indivisible dual-use object or structure has been determined to be a military objective, a number of States, including the United States, Denmark and Israel, while they may choose to impose greater restrictions for policy reasons, do not find a legal obligation to factor damage to the military object into the proportionality analysis, despite the fact that it was dual-use.

139 DoD Manual, above note 58, § 5.12.1.2: "Expected loss of civilian life, injury to civilians, and damage to civilian objects must be considered. Mere inconveniences or temporary disruptions to civilian life need not be considered in applying this rule."

140 Rhode & Schwarz, "Fundamentals of Hopping Signals", available at: www.rohde-schwarz.com/us/knowledge-center/technology-fundamentals/hopper-signals/hopper-signals_256050.html.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

military user may have "hopped" to a different frequency – either on the same datalink, or to a link with a different satellite.

This practice may complicate efforts to distinguish a particular datalink, or its corresponding space and ground segments, as a military objective. This has a few follow-on effects: (1) while a temporary and reversible measure, like jamming, might present a much more palatable option to achieve a desired effect, the practice of signal hopping diminishes the feasibility of achieving that effect, possibly pushing military commanders toward destructive action, and (2) the fact that a signal may simply "hop" to another frequency on a different transponder or receiver may have implications for the necessity or "definite military advantage" analysis. As discussed above, the second part of the test for determining whether an object is a lawful military objective requires that the object's "total or partial destruction, capture, or neutralization, in the circumstances ruling at the time, offers a definite military advantage".[141] The military advantage that the attacker accrues from the engagement must be "definite" in the sense that it may not be merely "potential or indeterminate".[142] While the satellite relaying the signal may be a military object by use or purpose, if the adversary can easily move the signal over to another system, virtually uninterrupted, articulating the military advantage to be gained from attacking the satellite becomes difficult. This may push military commanders towards a different means of achieving the desired effect, including targeting the ground station or user terminal that is not as redundant.

Distinction between combatants and civilians

The principle of distinction mandates that parties to an armed conflict distinguish between the armed forces and the civilian population.[143] Civilians are those persons who are not members of the armed forces.[144] This includes members of the civilian population, but also a special category of persons who accompany the armed forces, or "persons authorized to accompany the armed forces".[145]

In the United States, persons authorized to accompany the armed forces include those civilians employed by the DoD or other government agencies, or by contract to support the armed forces.[146] These civilians have traditionally accompanied the armed forces into the theatre of operations in roles like transportation, clerks and food service workers.[147] While these civilians accept

141 AP I, Art. 52(2); ICRC Customary Law Study, above note 102, Rule 8.

142 ICRC Commentary on the APs, above note 91, para. 4789.

143 AP I, 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."

144 ICRC Customary Law Study, above note 102, Rule 17.

145 See Geneva Convention (III) relative to the Treatment of Prisoners of War of 12 August 1949, 75 UNTS 135 (entered into force 21 October 1950), Art. 4(A)(4).

146 DoD Manual, above note 58, § 4.15.1.

147 *Ibid.*, § 4.15.1.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

certain risks of incidental harm by accompanying the armed forces into an area of operations, they may not be made the object of attack.[148]

Civilians lose their protected status when they directly participate in hostilities, however.[149] The US position is that direct participation in hostilities (DPH) includes engaging in combat, but also "acts that are an integral part of combat operations or that effectively and substantially contribute to an adversary's ability to conduct or sustain operations".[150] This is an inherently context-driven analysis that requires consideration of "the weapons systems or methods of warfare employed by the civilian's side in the conflict".[151] One example of action that would generally be considered to be DPH is "providing or relaying information of immediate use in combat operations, such as acting as an artillery spotter or member of a ground observer corps or otherwise relaying information to be used to direct an airstrike, mortar attack, or ambush".[152]

The current structure of many military space architectures will challenge these rules in the event of an armed conflict. As discussed above in the context of distinguishing objects, militaries contract with commercial entities to provide a wide swath of space capabilities and services. These capabilities are operated by civilian employees of those commercial companies, working in terrestrial control centres, for example. Additionally, as more militaries adapt for military operations in space, creating military space forces or space commands, many may turn to civilian contractors to fill workforce gaps.[153] The leveraging of civilians and contractors in various aspects of planning and conducting military operations in space is driven by the recent rapid growth of this area of operations, the complexity of space operations and the need for specialized expertise. It is simply easier and quicker to hire or contract for civilians than to recruit and train the next generation of uniformed space operators.

The heavy reliance on civilians for military space operations presents the need for a more granular understanding of when a civilian is directly participating in hostilities. The United States' broad understanding of DPH, as currently set forth in the DoD Manual, almost certainly includes a civilian operating a space system that is being used to obtain or relay targeting information, as that information is of immediate use in combat operations, but has the potential to also include commercial launch providers who have been

148 *Ibid.*, § 4.15.2.

149 See *ibid.*, § 5.8.1.2, noting that the United States recognizes the underlying customary principle on which Article 51(3) of AP I is based.

150 *Ibid.*, § 5.8.3.

151 *Ibid.*, § 5.8.3.

152 *Ibid.*, § 5.8.3.

153 See Theresa Hitchens, "Growing the Space Force: Is Outsourcing Operations an Answer?", *Breaking Defense*, 20 February2024, available at: https://breakingdefense.com/2024/02/growing-the-space-force-is-outsourcing-operations-an-answer/: "As the Space Force rolls out plans for reorganizing its work force to meet the readiness demands of a potential fight with China, the service's command responsible for providing personnel to operate space systems is eyeing using contractors rather than Guardians to run some satellite networks." See also Chelsea Gohd, "Everyone Wants a Space Force – But Why?", *Space.com*, 11 September 2020, available at: www.space.com/every-country-wants-space-force.html.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

contracted to launch satellites with military applications.[154] The ICRC's guidance, in contrast to the US approach, lists cumulative criteria for DPH, requiring that a civilian's act be likely to adversely affect the military operations or military capacity of a party to the conflict, that there is a direct causal link between the act and the adverse effects, and that the act be specifically designed to inflict harm in support of a party to the armed conflict and to the detriment of another.[155] While this would almost certainly include the civilian operating the space system being used to obtain or relay targeting information, it likely does not extend so far as to consider a civilian launch provider capable of losing protected status. It is important to understand these nuances in the context of space operations, in which militaries are highly reliant on civilian services.

The third challenge: Proportionality when targeting space systems

This section explores the difficulties of applying the IHL rule of proportionality when attacking adversary space systems. It also addresses challenges in applying domestic policy requirements for collateral effects mitigation when conducting operations short of attack.

Collateral damage estimation

Once the principle of distinction has been met and a lawful military target has been identified, the basic rule of proportionality found in Article 57(2) of AP I requires "those who plan or decide upon an attack" to

> 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 and direct military advantage anticipated.[156]

States not party to AP I generally recognize this rule as reflecting customary international law. In policy, the United States refers collectively to incidental civilian injury or death and incidental damage to civilian objects as "collateral

154 DoD Manual, above note 58, §5.8.3, noting that DPH "also includes certain acts that are an integral part of combat operations or that effectively and substantially contribute to an adversary's ability to conduct or sustain combat operations".

155 Nils Melzer, *Interpretive Guidance on the Notion of Direct Participation in Hostilities under International Humanitarian Law*, ICRC, Geneva, 2009: "1. The act must be likely to adversely affect the military operations or military capacity of a party to an armed conflict or, alternatively, to inflict death, injury, or destruction on persons or objects protected against direct attack (threshold of harm), and 2. there must be a direct causal link between the act and the harm likely to result either from that act, or from a coordinated military operation of which that act constitutes an integral part (direct causation), and 3. the act must be specifically designed to directly cause the required threshold of harm in support of a party to the conflict and to the detriment of another (belligerent nexus)."

156 AP I, Art. 57(2)(a)(iii).

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

damage".[157] The United States has created a tool to help commanders and other personnel with authority to launch an attack, referred to as target engagement authorities, to make attack decisions. This tool is called the collateral damage estimation methodology (CDEM), and executing it results in a collateral damage estimate (CDE).[158] The CDEM uses software loaded with weapons characterization data, including data on explosive fill weights, fragmentation characteristics and weapons accuracy, to calculate risk estimate distances for employment of particular weapons.[159] Targeteers combine these distances with geospatial mapping data, known physical properties of different types of construction materials, and intelligence-based patterns of life to produce estimates of expected incidental damage to civilian objects and expected incidental civilian casualties predicted to result from a particular munition, with a particular fuse setting, travelling to the target from a particular direction at a particular angle, striking a particular joint desired point of impact expressed in map coordinates.

The CDEM is a standardized tool designed to help target engagement authorities apply the rule of proportionality for attacks that employ conventional munitions such as artillery shells, rockets, missiles and bombs against terrestrial targets. While the CDEM may apply to attacks against ground segments of space systems, it does not apply to attacks against non-ground targets, such as aircraft or satellites on orbit.[160] The nature of the space domain and spacecraft drives this. Modelling the physics of high-explosive detonations on the earth's surface and their interaction with various munition containers and construction materials is a challenging computational task, but is within the reach of software operators and military computers available at military operations centres. Modelling the expected fragmentation result of an explosive detonation near, kinetic impact with, or laser heating on a targeted spacecraft whose mass, mechanical structure and material composition is likely a State secret protected by the adversary, and whose orbital parameters are estimated based on observation, and then estimating the probability of any debris produced by the attack incidentally damaging a civilian satellite in a nearby (or perhaps distant) orbit, is a considerably more difficult problem. However, it is not necessarily impossible. Some level of debris modelling may be technically possible – for example, NASA has a software tool called the Satellite Breakup Risk Assessment Model used to make initial risk estimates to human spaceflight following a break-up in space, with debris cloud modelling based on laboratory tests and historical measurements from the seven catastrophic collisions that have occurred in space.[161] Legal advisers for space targeting should seek to understand what modelling capabilities may be available

157 See e.g. DoD Manual, above note 58, § 5.12.

158 Chairman of the Joint Chiefs of Staff Instruction 3160.01D, *No-Strike and the Collateral Damage Estimation Methodology*, 21 May 2021.

159 DoD, *Civilian Harm Mitigation and Response*, Instruction 3000.17, 21 December 2023, p. 17, available at: www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/300017p.pdf.

160 Chairman of the Joint Chiefs of Staff, above note 158.

161 Mark Matney, *Analysis of Russian ASAT Debris Cloud*, NASA Orbital Debris Program Office, available at: https://ntrs.nasa.gov/api/citations/20220008798/downloads/20220008798-Matney_Russian%20ASAT%20NESC%20Talk.pdf.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

to their organization and be prepared to learn from the subject-matter experts developing such modelling. For commanders and legal advisers accustomed to operating with CDE calls that inform deliberate targeting decisions, the lack of a standardized physics-based methodology to calculate risk of collateral damage in readily quantifiable ways is likely to be challenging. Good human judgement is always required for targeting decisions, but becomes even more critical when risk is difficult to quantify in a familiar way.

Long-lived space debris and collision cascading

The physics of how objects respond to physical damage are very different on orbit than on earth. On earth, no matter how powerful the high explosive or how large the munition used to target an object of comparable size to a satellite, the shrapnel from the munition and fragments of the object generated from the explosion will eventually be pulled down to the earth's surface by gravity. Usually, this happens before the fragments travel very far. This means that planners can select joint desired points of impact on a military barracks building for targeting with air-delivered precision guided munitions with 450 kg warheads and be essentially certain that a hospital located 3 km away will not suffer collateral damage.

On orbit, fragments created by an explosion are already moving at orbital speed, which decreases as the perpendicular distance of the satellite from the surface of the earth increases.[162] Orbital speed is incredibly fast. At GEO altitude of 35,786 km, orbital speed is about 11,069 km per hour. In LEO, it is even faster – for example, the satellite destroyed by the Russian Federation in its 2021 DA-ASAT test was orbiting at approximately 480 km altitude, with an orbital speed of more than 27,000 km per hour.[163] At such velocity, even fragments with tiny mass have massive amounts of kinetic energy.[164] NASA estimates that strikes of debris only 1 cm in diameter will damage most spacecraft.[165]

Employment of weapons that rely on kinetic impact or detonation of an explosive warhead to affect satellites will produce an ever-expanding cloud of debris moving at orbital speed. The altitude of the debris determines how long it stays in orbit before decay. The Chinese DA-ASAT test in 2007 destroyed a 960 kg satellite at 845 km altitude, high in LEO where atmospheric drag is negligible.[166] It created the most severe orbital debris cloud in history, which within three months

162 The orbital speed equation is the square root of [(G*M)/(R+h)], where G = earth's gravitational constant; M = earth's mass; R = earth's radius; and h = perpendicular distance of the satellite from the surface of the earth.

163 Chelsea Gohd, "Russian Anti-Satellite Missile Test Was the First of its Kind", *Space.com*, 10 August 2022, available at: www.space.com/russia-anti-satellite-missile-test-first-of-its-kind.

164 The kinetic energy equation is $KE = ½mv^2$, where KE = kinetic energy, m = mass and v = velocity.

165 Thomas J. Colvin, John Karcz and Grace Wusk, *Cost and Benefit Analysis of Orbital Debris Remediation*, NASA, 10 March 2023, available at: www.nasa.gov/wp-content/uploads/2023/03/otps_-_cost_and_benefit_analysis_of_orbital_debris_remediation_-_final.pdf.

166 NASA, "Chinese Anti-Satellite Test Creates Most Severe Orbital Debris Cloud in History", *Orbital Debris Quarterly News* Vol. 11, No. 2, 2007, available at: https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv11i2.pdf.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

had expanded from 200 km to more than 4,000 km in altitude and transited the orbits of hundreds of operational spacecraft. Today, over 2,800 pieces of trackable debris 10 cm or larger and hundreds of thousands of pieces of smaller debris generated by this test still litter LEO, most of which will remain on orbit for many decades.[167]

Long-lived debris resulting from an attack presents a significant proportionality concern. Under IHL, how does a target engagement authority assess the risk that an attack might cause collateral damage to civilian satellites, including those not even constructed or launched yet, for years after the attack? Under the time-honoured Rendulic Rule, reflected in decisions of war crimes tribunals and recognized by many States, decisions by military commanders or other persons responsible for planning, authorizing or executing military action must be made in good faith and based on their assessment of the information reasonably available to them at the time.[168] Ideally, this information will include modelling of projected debris dispersion, current and planned orbital regime usage, projected atmospheric debris reduction and overall estimated increase to the background risk of conjunction for civilian spacecraft. States which choose to develop DA-ASAT missiles should also develop methods of assessing expected collateral damage from employment of such weapons.

As debris fragments from ASAT attacks move into new orbits, the likelihood grows that they will strike satellites, rocket bodies, larger debris pieces and other objects already in space, creating more pieces of debris. The effect whereby the continued generation of space debris via collisions and explosions in orbit could lead to an exponential increase in the amount of debris in space, in a chain reaction which would render huge swathes of orbital regimes unusable for space flight, is known as the Kessler Syndrome, after the NASA researcher who first postulated it in 1978.[169] Under IHL, how does a target engagement authority account for the risk that an attack against a lawful military objective might render large areas of outer space – which is supposed to remain open to exploration and

167 US Space Command, *2023 Magazine*, 2023, available at: https://media.defense.gov/2023/Apr/14/2003199875/-1/-1/1/2023%20USSPACECOM%20MAGAZINE.PDF.

168 See e.g. Canada, *AP I Ratification and Accession, Reservations*, 1591 UNTS 462, 20 November 1990, p. 464: "It is the understanding of the Government of Canada that, in relation to Articles 48, 51 to 60 inclusive, 62 and 67, military commanders and others responsible for planning, deciding upon or executing attacks have to reach decisions on the basis of their assessment of the information reasonably available to them at the relevant time and that such decisions cannot be judged on the basis of information which has subsequently come to light." *United States v. List et al. (The Hostage Case)*, Opinion and Judgment of Military Tribunal V, in *Trials of War Criminals before the Nuernberg Military Tribunals*, Vol. 11, Washington, DC, 1950, pp. 1295–1296: "It was with this situation confronting him that he [the defendant, Rendulic] carried out the 'scorched earth' policy in the Norwegian province of Finmark which provided the basis for this charge [of wanton destruction of property] of the indictment. … There is evidence in the record that there was no military necessity for this destruction and devastation. An examination of the facts in retrospect can well sustain this conclusion. But we are obliged to judge the situation as it appeared to the defendant at the time. If the facts were such as would justify the action by the exercise of judgment, after giving consideration to all the factors and existing possibilities, even though the conclusion reached may have been faulty, it cannot be said to be criminal."

169 European Space Agency, *ESA's Annual Space Environment Report*, 12 September 2023, available at: www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

use by all States under the OST – completely and permanently unusable? Again, the answer is that they should do so in good faith and based on their assessment of the information available to them at the time.

Of course, the risk of collateral damage must be weighed against the concrete and direct military advantage anticipated from the attack, which may vary considerably with the target.

Collateral effects

The IHL basic rule of proportionality by its terms only covers "incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof" expected to be caused by "attacks".[170] Similarly, the IHL rule of feasible precautions requires "those who plan or decide upon an attack" to "take all feasible precautions in the choice of means and methods of attack with a view to avoiding, and in any event to minimizing, incidental loss of civilian life, injury to civilians and damage to civilian objects".[171] Some commentators take the position that these rules also cover "consequences for civilians of impairing the civilian use of [a] dual-use space object".[172] Such consequences can be imposed by counter-space capabilities that create temporary and reversible effects on space systems. Radio frequency jamming of datalink receivers or SAR receivers, dazzling of optical sensors with lasers, or cyberspace effects operations that delete payload data may disrupt or deny targets used for military purposes but also create incidental effects on civilian users of the same space systems. For example, noise jamming of the entire radio frequency bandwidth used by a particular transponder on a commercial communications satellite in GEO might result in temporary denial of communications to both military and civilian customers.

Such consequences constitute collateral effects caused by a non-forcible means or methods of warfare to be assessed under national policy and general principles of the law of armed conflict that apply to all military operations, rather than collateral damage caused by an attack to be assessed under IHL rules of proportionality and feasible precautions. In the analogous situation of cyberspace effects operations that do not result in injury, death, or damage to physical objects, but only cause temporary and reversible effects, the Tallinn Manual 2.0 position, shared by the United States, is that such operations do not constitute an attack.[173] The logical consequence, reflected in the Tallinn Manual 2.0, is that "inconvenience, irritation, stress, or fear … are not to be considered when applying" the rule of proportionality.[174] The DoD Manual is similarly clear that "mere inconveniences or temporary disruptions to civilian life need not be considered" in applying the rule of proportionality.[175] In contrast, such

170 AP I, Art. 57(2)(a)(iii).
171 *Ibid.*, Art. 57(2)(a)(ii).
172 W. Zhou, above note 98.
173 Tallinn Manual 2.0, above note 75, p. 415; DoD Manual, above note 58, § 16.5.2.
174 Tallinn Manual 2.0, above note 75, p. 472.
175 DoD Manual, above note 58, § 5.12.1.2.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

temporary disruptions are considered by US target engagement authorities as a matter of policy.

US civilian harm mitigation policy requires operational commanders to "mitigate civilian harm while conducting deliberate and dynamic targeting". It defines "civilian harm" as

> [c]ivilian casualties and damage to or destruction of civilian objects (which do not constitute military objectives under the law of war) resulting from military operations. As a matter of DoD policy, other adverse effects on the civilian population and the personnel, organizations, resources, infrastructure, essential services, and systems on which civilian life depends resulting from military operations are also considered in [civilian harm mitigation and response] efforts to the extent practicable. These other adverse effects do not include mere inconveniences.[176]

As a matter of policy that is *supplementary* to IHL, DoD policy requires operational commanders, including the commanders of US Space Command and its subordinate commands, to "take additional protective measures not required by the law of war as they deem appropriate to the circumstances when planning and conducting military operations".[177] One way that commanders responsible for space operations can address these policy requirements is through the creation of a command-level collateral effects estimate (CEE) methodology. In the US military, there is no standardized joint CEE for information-related capabilities like electromagnetic warfare and cyberspace attack, but commanders are directed to consider developing a repeatable methodology for identification and management of risks associated with employment of such capabilities.[178] While not physics-based like the CDEM, such a methodology can help categorize and standardize consideration of "other adverse effects on the civilian population" caused by the employment of counter-space capabilities that create temporary and reversible effects on space systems.

Proximate causation and indirect harm

When assessing both expected collateral damage and expected collateral effects, target engagement authorities and their legal advisers will likely have to grapple

176 DoD, above note 159, p. 49.

177 *Ibid*., p. 7. Listed examples include: "(1) Considering other possible alternatives to an attack against a military objective that poses risks of civilian harm, even when the attack would be lawful; (2) Issuing standards for the identification of targets above what the law of war requires; (3) Selecting for employment weapon systems or munitions that may help mitigate civilian harm (e.g., precision-guided munitions, non-lethal effects, non-kinetic effects, and systems that incorporate features such as render safe, pre-planned post-launch abort, and scalable yields) when employment of weapon systems or munitions without such features or effects would be lawful; or (4) Taking other precautions not required by the law of war."

178 Chairman of the Joint Chiefs of Staff, *Target Development Standards*, Instruction 3370.01D, 8 April 2022, Appendix B, Enclosure D.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

with a lack of factual and legal clarity with regard to where causation stops and direct harms become indirect harms.

Consider the hypothetical question of satellite uplink jamming using a barrage of radio frequency energy against the entire bandwidth of a Ku-band transponder on a commercial communications satellite in geosynchronous orbit. The decision to begin jamming is based on signals intelligence indicating that the enemy communications ministry leases some frequencies on that transponder and the enemy air force uses those frequencies to command and control armed unmanned aerial vehicles. Intelligence reporting also indicates that some frequencies on the same transponder are leased from the satellite operator BigSatCo by a commercial communications company, GlobalCommCo, which subcontracts with a second commercial communications company, RegionalCommCo, which in turn contracts with any users in the transponder footprint willing to pay for its voice and data transmission services. Such arrangements are common in the modern world of ever-increasing commercialization of space services.

The RegionalCommCo user terminals are very-small-aperture terminals, which can be used for both fixed-site and mobile applications, making it difficult to link user terminal geolocations with other intelligence sources identifying the users, and the signals themselves are encrypted. Approximately 60% of the targeted transponder footprint covers international waters and the territory of neutral States not involved in the armed conflict. RegionalCommCo publicly advertises that its network uses frequencies carried by this transponder and several others to provide services to a government agencies and NGOs, as well as private companies in the oil and gas industry, but is unwilling to provide any sort of client and frequency list to the belligerent militaries.

Given this scenario, how should a target engagement authority assess collateral damage and/or collateral effects from the desired uplink jamming? Is it possible that oil and gas extraction equipment might rely on these satellite links for remote operation in such a way that loss of communication results in physical damage to the equipment? Should such speculation matter in a collateral damage analysis under the IHL rule of proportionality? What about the effects on BigSatCo's business operations, or on GlobalCommCo's business operations, or on RegionalCommCo's business operations? What about the possible effects on the operations of the unnamed government agencies, or on the unnamed NGOs' ability to carry out their organizational missions? What about the effects on the oil and gas industry's ability to create diesel fuel, which might be used by trucks delivering foodstuffs to civilian populations? As this litany of questions demonstrates, there must be a limiting principle to such considerations.

In the US view, the applicable limiting principle focuses on directness and foreseeability. As the DoD Manual puts it with regard to assessing collateral damage under the IHL rule of proportionality,

> [t]he expected loss of civilian life, injury to civilians, and damage to civilian objects is generally understood to mean such immediate or direct harms

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

foreseeably resulting from the attack. Remote harms that could result from the attack do not need to be considered in applying this prohibition.[179]

When assessing collateral effects that may be caused by non-forcible means of warfare such as electromagnetic warfare, offensive cyberspace operations and some types of directed energy weapon deployment, US policy requires target engagement authorities to consider "adverse effects on the civilian population and the personnel, organizations, resources, infrastructure, essential services, and systems on which civilian life depends resulting from military operations". This raises the question of how proximate causation must be for an effect to be considered as "resulting from" the military operation. Applying the same limiting principle from the IHL rule of proportionality, the policy can be read to encompass only "immediate or direct harms foreseeably resulting from" the military operation.

The ICRC has recently considered the causal linkage between military space operations and incidental effects on civilians and civilian objects. In a January 2023 working paper submitted to a UN working group, it recommended that States refrain from conducting military operations "*designed or expected* to disrupt, damage, destroy or disable space systems *necessary* for the provision of essential civilian services and for the protection and functioning of persons and objects specifically protected under international law", including space systems "*critical* to the production and maintenance of objects indispensable to the survival of the civilian population" and "*critical* to the safety and maintenance of infrastructure containing hazardous or toxic materials".[180]

Applying these interpretations of IHL and US policy to the above scenario, a legal adviser would likely conclude that mere speculation about or possibility of physical damage to a third party's oil and gas equipment should not be considered in a collateral damage analysis for the proposed uplink jamming – such damage should only be considered if it is a *direct* harm that is *expected* as a *foreseeable result* of the operation. A legal adviser would also likely conclude that the potential economic harms from impacts on the business operations of BigSatCo, GlobalCommCo and RegionalCommCo are too remote of harms to be considered in a collateral effects analysis. Similarly, the potential effects on the unknown operations of the unnamed government agencies and NGOs, as well as the

179 DoD Manual, above note 58, § 5.12.1.13, explaining that "[t]he exclusion of remote harms is based on the difficulty in accurately predicting the myriad of remote harms from the attack (including the possibility of unrelated or intervening actions that might prevent or exacerbate such harms) as well as the primary responsibility of the party controlling the civilian population to take measures to ensure that population's protection. For example, if the destruction of a power plant would be expected to cause the loss of civilian life or injury to civilians very soon after the attack due to the loss of power at a connected hospital, then such harm should be considered in assessing whether an attack is expected to cause excessive harm. On the other hand, the attacker would not be required to consider the economic harm that the death of an enemy combatant would cause to his or her family, or the loss of jobs due to the destruction of a tank factory."

180 ICRC, *Preliminary Recommendations on Possible Norms, Rules and Principles of Responsible Behaviours Relating to Threats by States to Space Systems*, Working Paper Submitted to the UN Open-Ended Working Group on Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours, Geneva, 27 January 2023, available at: www.icrc.org/en/document/preliminary-recommendations-on-reducing-space-threats (emphasis added).

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

potential effects on refining of diesel fuel and its use by food delivery trucks, are far too speculative and remote, and thus not foreseeable, to warrant consideration in a US policy-based collateral effects analysis for the proposed uplink jamming.

The special case of global navigation satellite systems

GNSSs present a proportionality problem unique in scope and scale because they provide invaluable military advantage to their users but are also used extensively for civilian purposes. As noted earlier in this article, depending on the circumstances of employment, denying or spoofing a GNSS signal using an electronic warfare system could foreseeably result in aeroplane crashes,[181] vehicle crashes, maritime vessels running aground or colliding, or a litany of other types of damage and destruction to civilian objects, many of which are likely to result in death or injury to civilians. Damaging or destroying enough GNSS satellites to render the constellation unusable to terrestrial users could result in global damage and destruction for countless civilian users. On the other hand, disruption of GNSS signals may be localized using low-power or directed jamming or spoofing technologies that successfully limit their effects to lawfully targeted military objectives, such as commercial drones adapted to carry weapons threatening military bases.[182] Legal advisers must understand the counter-GNSS technology at issue in order to effectively provide advice on employment of such capabilities within the bounds of IHL.

Meeting the challenges

The complexities of applying IHL to modern military space operations in times of armed conflict require a pragmatic approach. At this juncture, new binding law is not the answer to address the challenges discussed above. As the sagas of the Moon Treaty and Prevention of an Arms Race in Outer Space programme at the UN show, broad multilateral treaties governing major spacefaring States' activity in outer space have been unworkable for decades. In addition to being politically unrealistic, the development of new binding law for military operations in outer space would be premature from a technological standpoint. There is already a robust body of law that applies to military operations in space, and that body of law simply requires further development toward shared interpretations and common understanding. Given the rapidly evolving technology and expanding practices in outer space, the appropriate path to that common understanding is non-legally binding norms for military operations in outer space before, during

181 T. Walter, Z. Liu and S. Lo, above note 86.

182 Oriana Pawlyk, "These Are the 7 Anti-Drone Weapons the US Military Plans to Invest In", *Military News*, 30 June 2020, available at: www.military.com/daily-news/2020/06/30/these-are-7-anti-drone-weapons-us-military-plans-invest.html.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

and after armed conflict, which States can work to develop as amplifications and explanations of existing law.

First, States can contribute to the development of non-binding norms for military space operations by establishing their own policy guidance and making those policies public, along with implementing those norms in their State practice. One example of this is the DoD's Tenets of Responsible Behavior in Space, published in 2021 and elaborated upon with the Tenet Derived Responsible Behaviors in Space in 2023, which are "intended to further establish a level of transparency about U.S. military space activities in order to reduce the risk of misunderstanding and miscalculation".[183] These tenets and tenet-derived behaviours elucidate what the United States views as responsible behaviour in space and provide examples of US interpretations of terms that lack a common understanding under international space law, such as "harmful interference" and "due regard".[184] While non-binding, these tenets assist in establishing a common understanding of certain binding obligations applicable to military operations in space. Another example is France setting out guidance for military space operations in its armed forces' manual on the law of war, explaining the French view of how IHL applies to certain space operations.[185] The DoD Manual similarly explains US positions on how some IHL provisions apply to military space operations, as referenced throughout this article.

Second, States can contribute to the development of non-binding norms for military space operations by engaging in non-binding multilateral processes which demonstrate shared interpretation of terms in binding international law. One example of this is the 2020 Artemis Accords, which are non-binding but set out for their forty-four signatories a shared interpretation of several provisions of the OST, including how Article II language prohibiting national appropriation of celestial bodies applies to lunar resource extraction.[186] More recently, twenty-four States provided consultation through the Soesterburg process at The Hague for the Woomera *Manual*, a forthcoming scholarly treatise on the application of IHL to military activities in outer space.[187]

183 Secretary of Defense, "Memorandum on Tenet Derived Responsible Behaviors in Space", 9 February 2023, available at: https://media.defense.gov/2023/Mar/03/2003172200/-1/-1/1/TENET%20DERIVED%20RESPONSIBLE%20BEHAVIORS%20IN%20SPACE%20OSD070983-22%20FINAL.PDF; US Space Command, "Tenets of Responsible Behaviors in Space", 12 April 2023, available at: www.spacecom.mil/Newsroom/Publications/Pub-Display/Article/3360751/tenets-of-responsible-behaviors-in-space/.

184 Secretary of Defense, above note 183, indicating that behaviours to support Tenet 3, "Avoid the creation of harmful interference", include taking steps to prevent affecting the command and control of space objects in a manner that increases the risk of loss, damage or destruction of a space object, and preventing interference with capabilities that contribute to strategic stability, including national technical means of verification, strategic missile warning space systems, and nuclear command, control and communications space systems.

185 Mickaël Dupenloup, "A New Silenus Box: The French Manual on the Law of Military Operations", *Articles of War*, 21 June 2023, available at: https://lieber.westpoint.edu/new-silenus-box-french-manual-law-military-operations/.

186 US Department of State, "Artemis Accords", available at: www.state.gov/artemis-accords/.

187 University of Adelaide, above note 59.

https://doi.org/10.1017/S1816383124000559 Published online by Cambridge University Press

Non-binding norms can still have legal significance. Legally binding mechanisms and non-legally binding norms are not mutually exclusive and can, in fact, be complimentary when the norms work to fill a gap in the law or serve as implementations of disputed or unclear legal obligations. A normative framework can lead to a common understanding of how legally binding rules apply or should be interpreted, and normative discussions push States to think more deeply about their legal interpretations. The more States contribute to this public dialogue surrounding national security space activities, the more likely it is that agreement may coalesce around norms and common understanding of how international law applies in outer space. Promulgating these policies and engaging in this conversation prior to an escalation of tensions, or even armed conflict, can serve to reduce misunderstanding and miscalculation, thereby helping to preserve the sustainability and security of outer space for all.