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AN INFERENCE ABOUT INTERFERENCE: A SURPRISING APPLICATION OF EXISTING INTERNATIONAL LAW TO INHIBIT ANTI-SATELLITE WEAPONS

DAVID A. KOPLOW*

Outer space presents an exceptionally challenging operational environment. The exoatmospheric world is simultaneously: a) tremendously important, with a growing population of satellites now essential for performing or supporting the full array of civil and military functions; b) inescapably hazardous, with spacecraft vulnerable to both parlous natural phenomena and human-caused disruptions; and c) politically resistant to additional regulation, with spacefaring countries, notably including the United States, reluctant to agree to meaningful new legal limitations.

This article examines the conjunction of these unique circumstances, in the particular case of dangerous and destabilizing anti-satellite (ASAT) weapons. It contends that existing international law can be patched together in a surprising way, to provide a modicum of unanticipated protection to satellites, even in the absence of any new treaty. Little-noticed shards of the existing arms control legal regime related to outer space can be reconceptualized, rendering illegal many current and future contemplated tests and operational uses of ASAT weapons,

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and thereby promoting international peace and security in a way that has to date escaped international attention.

The article is organized as follows. Section 1 provides the key background, concisely surveying the three critical characteristics of the outer space ecosystem noted above. It briefly presents the multifarious uses of satellites for peaceful and warlike purposes and the likely growth of this reliance in the future; it highlights the dangers that those spacecraft inevitably face, especially the emerging crisis of human-created orbital debris; and it notes the relative paucity of recent space law and the political stalemate occluding the development of new norms.

Section 2 collects more detail regarding one particular type of satellite: those that serve as critical components of the "national technical means (NTM) of verification." These include the photoreconnaissance and other sensor and communications satellites that enable a party to an arms control treaty to monitor the activities of the other participants, ensuring mutual compliance with the obligations. There are not many such NTM satellites, but they are among the most important breed, for their unencumbered operation is essential to promoting mutual confidence among suspicious armed rivals.

Section 3 marshals the law regarding NTM, especially the provisions, now common in arms control treaties, through which parties pledge not to "interfere" with these crucial yet delicate orbiters. Many treaties—but by no means all—include substantially similar passages, and more can be anticipated in the future.

Section 4 focuses on ASATs, highlighting the modern and emerging dangers inherent in the testing or use of these satellite-hunting weapons. The threat is especially pronounced regarding the types of ASATs that accomplish their functions via explosions or high-speed collisions with their targets (in contrast to systems relying upon "directed energy" mechanisms, such as lasers) because these generate plumes of long-lasting, hazardous orbital debris.

Section 5 presents the thesis: the argument that the NTM-protection provisions of arms control treaties already prohibit the testing and use of destructive, debris-creating ASATs, because it is foreseeable that the resulting cloud of space junk will, sooner or later, impermissibly interfere with the operation of another state's NTM satellite, such as by colliding with it or causing it to maneuver away from its preferred orbital parameters into a safer,

but less useful, location. If sustained, this thesis would be surprising, providing a heretofore-unnoticed legal constraint upon ASATs, and perhaps helping to catalyze other, more comprehensive efforts to rein in these devices and protect all satellites, regardless of function or nationality.

Finally, Section 6 offers some concluding thoughts, including the concession that a new treaty, or even a new non-legally-binding set of “rules of the road” for the safe and mutually-respectful conduct of activities in space, would be a much more advantageous method for dealing comprehensively with the ASAT problem. But if intractable political factors currently preclude additional explicit measures of arms control in the space domain, then this sort of incremental, unanticipated interpretation of existing international legal rules can make a small, useful contribution.

1. BACKGROUND

Despite a persistent constellation of dangers, outer space has assumed primary importance for the United States and much of the rest of the world, as the preferred venue for a swelling host of critical civil and military applications. An early flurry of innovative international lawmaking empowered and facilitated those enterprises, but has regrettably given way to a more recent legal hiatus, as elaborated below.

1.1. The Strong, Diverse, and Growing Exploitation of Outer Space

Almost 1100 operational satellites today perform or contribute to the full array of essential services to governments, industry, and consumers.¹ Space assets have revolutionized modern

¹ U.S. DEP'T OF DEF. & U.S. OFFICE OF THE DIR. OF NAT'L INTELLIGENCE, NATIONAL SECURITY SPACE STRATEGY: UNCLASSIFIED SUMMARY 1 (2011), *available at* http://www.defense.gov/home/features/2011/0111_nsss/docs/NationalSecuritySpaceStrategyUnclassifiedSummary_Jan2011.pdf; Ambassador Gregory L. Schulte, Deputy Assistant Sec'y of Def. for Space Policy, U.S. Dept. of Def., Presentation at the S. Rajaratnam School of International Studies: Protecting Global Security in Space 1 (May 9, 2012), *available at* http://photos.state.gov/libraries/singapore/231771/PDFs/Schulte_GlobalSecurityinSpace.pdf; SPACE SECURITY INDEX 24, 31 (Cesar Jaramillo ed., 2013) [hereinafter Space Security Index 2013], *available at* <http://www.spacesecurity.org/SSI2013.pdf>; UNION OF CONCERNED SCIENTISTS, UCS SATELLITE DATABASE, http://www.ucsusa.org/nuclear_weapons_and_global_security/space_weapons

communications, weather forecasting, banking, and navigation; advanced applications in mapping, earth resources monitoring, and search-and-rescue functions have likewise become so ubiquitous as to largely escape daily notice.² The satellite-enabled revolution in military affairs is no less striking: aircraft, ships, and drones guided by Global Positioning System (GPS) satellites, dispense their own GPS-reliant "smart bombs"; an insatiable demand for additional bandwidth for satellite communications in combat has forever altered command relationships; and the ability to use space assets to reconnoiter over the horizon has transformed battlefield operations.³

/technical_issues/ucs-satellite-database.html (last visited Sept. 13, 2013). See Brian Weeden, *The Numbers Game: What's in Earth Orbit and How Do We Know?*, SPACE REV. (July 13, 2009), <http://www.thespacereview.com/article/1417/1?iframe=true&width=95%&height=95%> (reporting uncertainty about the precise numbers of active and inactive artificial satellites in orbit).

² Space Security Index 2013, *supra* note 1, at 42–43; SPACE SECURITY INDEX 85, 89–99 (Cesar Jaramillo ed., 2012) [hereinafter Space Security Index 2012], available at <http://www.spacesecurity.org/SpaceSecurityReport2012.pdf>. See EUR. SPACE POLICY INST., REPORT 25, CURRENT LEGAL ISSUES FOR SATELLITE EARTH OBSERVATION (Matxalen Sanchez Aranzamendi, Rainer Sandau & Kai-Uwe Schrogl eds., 2010); Peter L. Hays, *Space and the Military*, in SPACE AND DEFENSE POLICY 150, 155–56 (Damon Coletta & Frances T. Pilch eds., 2009) (identifying space as an "economic center of gravity" for the United States, subject to a "gold rush" of commercial exploitation); FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 3, 411–14 (2009) (surveying use of space assets for multiple purposes, especially remote sensing); NASA, OFF. OF THE CHIEF TECHNOLOGIST, SPINOFF 2012 (2012), available at <http://spinoff.nasa.gov/Spinoff2012/pdf/Spinoff2012.pdf> (identifying forty-four technologies that were developed for the U.S. space program that now have terrestrial economic and commercial applications in robotics, biomedicine, semiconductors, solar energy, and elsewhere); GPS Applications, GPS.GOV, <http://www.gps.gov/applications/> (last visited Sept. 22, 2013) (providing "Official U.S. Government information about the Global Positioning System (GPS) and related topics"). See generally EVIDENCE FROM EARTH OBSERVATION SATELLITES: EMERGING LEGAL ISSUES (Ray Purdy & Denise Leung eds., 2013) (discussing applications of satellite data in environmental monitoring and domestic and international criminal prosecutions).

³ See CENAN AL-EKABI, EUR. SPACE POLICY INST., REPORT 42, SPACE POLICIES, ISSUES AND TRENDS IN 2011/2012, 63 (2012), available at http://www.espi.or.at/images/stories/dokumente/studies/ESPI_Report_42.pdf (highlighting the use of military and commercial space assets in the hunt for Osama Bin Laden); TODD HARRISON, CTR. FOR STRATEGIC & BUDGETARY ASSESSMENTS, THE FUTURE OF MILSATCOM 3 (2013), available at <http://www.csbaonline.org/publications/2013/07/the-future-of-milsatcom/> ("The U.S. military now relies on space-based systems for a number of core enabling capabilities."); Hays, *supra* note 2, at 159–72; Space Security Index 2013, *supra* note 1, at 65–66; Space Security Index 2012, *supra* note 2, at 105–15; Peter L.

The United States is the path-breaker on many of these space applications. For example, the U.S. military outspends the rest of the world combined on military space applications and commands half the world's dedicated military space assets.⁴ But other countries have not ceded the "high ground" to the United States, and they, too, appreciate the strategic and tactical advantages satellites can offer.⁵ On the civilian side, the global commercial

Hays, *Space and Sino-American Security Relations*, in 2 SPACE AND DEFENSE 18, at 19, 28 (Winter 2009) [hereinafter Hays, *Sino-American*], available at http://www.usafa.edu/df/dfe/dfer/centers/ecsd/docs/Space_and_Defense_2_3.pdf (observing that in Operation Desert Storm in 1991, less than eight percent of the air-delivered ordnance used by U.S. forces was precision-guided (none guided by GPS satellites), while in Operation Iraqi Freedom in 2003, almost seventy percent of U.S. air-delivered bombs were precision-guided, mostly by GPS); LYALL & LARSEN, *supra* note 2, at 499-532 (surveying the military use of outer space); Petr Topychkanov, *Features of the Outer Space Environment*, in OUTER SPACE: WEAPONS, DIPLOMACY, AND SECURITY 3, 10-13 (Alexei Arbatov & Vladimir Dvorkin eds., 2010) (providing Russian perspective on outer space as a sphere of military operations).

⁴ AL-EKABI, *supra* note 3, at 16, 60 (estimating the U.S. military space budget as constituting between seventy-five percent and ninety-five percent of the world's total); Space Security Index 2013, *supra* note 1, at 67-70; Space Security Index 2012, *supra* note 2, at 20, 105-06; Paul Meyer, *Failure to Launch? Why the EU's Proposed International Code of Conduct for Outer Space is Running Low on Diplomatic Fuel*, OPENCANADA.ORG (Feb. 28, 2013), <http://opencanada.org/features/the-think-tank/essays/failure-to-launch/> (chart listing number of military satellites by country); Debra Werner, *US Military Space Spending Set at \$8 Billion for 2014*, SPACE.COM (Apr. 17, 2013, 6:00 AM), <http://www.space.com/20702-united-states-military-space-budget-2014.html> (outlining key aspects of the U.S. Defense Department's budget plan request for 2014).

⁵ Space Security Index 2013, *supra* note 1, at 67, 71-72 (Russia), 72-73 (China), 73 (India), 68, 73-75 (other countries); Space Security Index 2012, *supra* note 2, at 115-118 (Russia), 118-120 (China), 120-21 (India), 122-25 (other countries); AL-EKABI, *supra* note 3, at 63-69 (describing military space programs of several countries; Russia, in particular, operates sixty to seventy military satellites and plans to launch 100 additional satellites in the next decade); Hays, *Sino-American*, *supra* note 3, at 29-30 (describing China's increasing use of military satellites); HARRISON, *supra* note 3, at 1 (noting that during the Cold War, space was a sanctuary for the U.S. military, but conditions have changed since then); U.S. DEP'T OF DEF., ANNUAL REPORT TO CONGRESS: MILITARY AND SECURITY DEVELOPMENTS INVOLVING THE PEOPLE'S REPUBLIC OF CHINA 2013 65 (2013), available at http://www.defense.gov/pubs/2013_china_report_final.pdf (describing China's increasing use of space-based imaging systems); Barry D. Watts, Ctr. for Strategic & Budgetary Assessments, Testimony Presented Before the U.S.-China Econ. & Sec. Rev. Comm'n: The Implications of China's Military and Civil Space Programs 4 (2011), available at <http://www.csbaonline.org/publications/2011/05/the-implications-of-chinas-military-and-civil-space-programs/> (presenting a view of the vital role that information will play in future high-tech wars, and stating that China "has no choice but to invest in the capability to get information

space industry has largely rebounded from the economic downturn and today posts annual revenues estimated as exceeding \$200 billion.⁶ Increasingly, the traditional dividing lines between public and private, or between military and civilian, satellites have become obscured, as governments rely more heavily upon the private sector for routine needs or to supply a sudden surge capacity.⁷ The United States, for example, has decreed an official

for its forces from space"); Jos Heyman, *Briefing: MilComSats of the USSR/Russia*, MILSAT MAG., Mar. 2009, at 36, available at http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=1643982016 (describing Russia's extensive use of satellites for military communications); *Japan Plans Satellites to Monitor Foreign Ships in Territorial Waters*, S. CHINA MORNING POST (July 8, 2013, 3:34 AM), <http://www.scmp.com/news/asia/article/1277340/japan-launch-satellites-monitor-oceans> (noting Japanese plan to launch nine military satellites in the next five years); *Spacecraft*, GUNTER'S SPACE PAGE, <http://space.skyrocket.de/directories/sat.htm> (last visited Sept. 22, 2013) (listing earth observation and military satellites operated by many countries). See also Donna Miles, Am. Forces Press Serv., *Stratcom Strives to Build Coalitions for Space Operations*, U.S. DEP'T OF DEF. (May 14, 2013), <http://www.defense.gov/News/NewsArticle.aspx?ID=120029> (stating that the U.S. military hopes to forge an international coalition that shares assets and capabilities in space, comparable to the tight international military-to-military cooperation that exists in other sectors).

⁶ AL-EKABI, *supra* note 3, at 15 (estimating global space revenue in 2011 at \$216.99 billion, reflecting substantial growth over prior years); NANCY GALLAGHER & JOHN D. STEINBRUNER, AM. ACAD. OF ARTS & SCI., *RECONSIDERING THE RULES FOR SPACE SECURITY* 16-18 (2008), available at <http://www.cissm.umd.edu/papers/files/spacesecuritymonograph.pdf> (noting that commercial activities and spending in space have displaced government activities and spending as the predominant forces shaping space security); Space Security Index 2013, *supra* note 1, at 15, 54-63; SATELLITE INDUS. ASS'N, *STATE OF THE SATELLITE INDUSTRY REPORT 6* (2012), available at <http://www.sia.org/wp-content/uploads/2012/06/Final-2012-State-of-Satellite-Industry-Report.pdf> (reporting growth in satellite revenue and overall space industry revenue).

⁷ *COMMERCIAL SATELLITE IMAGERY AND UNITED NATIONS PEACEKEEPING: A VIEW FROM ABOVE passim* (James F. Keeley & Rob Huebert eds., 2004); *EVIDENCE FROM EARTH OBSERVATION SATELLITES*, *supra* note 2, at xxx ("Commercialization and privatization of remote sensing activities started quite early."); Raymond Jeanloz, *Comprehensive Nuclear-Test-Ban Treaty and U.S. Security*, in REYKJAVIK REVISITED: STEPS TOWARD A WORLD FREE OF NUCLEAR WEAPONS 369, 384 (George P. Shultz, Steven P. Andreasen, Sidney D. Drell & James E. Goodby eds., 2008) (noting that non-governmental organizations complement governments' efforts to monitor compliance with arms control treaties, independently focusing additional observation assets on sensitive targets); MICHAEL KREPON & CHRISTOPHER CLARY, HENRY L. STIMSON CTR., *SPACE ASSURANCE OR SPACE DOMINANCE? THE CASE AGAINST WEAPONIZING SPACE* 16 (2003) (noting that during Operations Desert Shield and Desert Storm, forty-five percent of U.S. military communications flowed through commercial satellites, whereas by the time of the Kosovo campaign, that rate was up to eighty percent); Frank Pabian, *Commercial Satellite Imagery: Another Tool in the Nonproliferation Verification and Monitoring Toolkit*, in

policy of employing private sector satellite services for governmental purposes—including military and intelligence operations—as fully as possible.⁸

Moreover, the exploitation of outer space by an expanding array of countries and private sector companies is likely to continue to grow. The rate of launching new spacecraft was higher

NUCLEAR SAFEGUARDS, SECURITY, AND NONPROLIFERATION: ACHIEVING SECURITY WITH TECHNOLOGY AND POLICY 221 (James E. Doyle ed., 2008); Space Security Index 2013, *supra* note 1, at 61–66; U.N. INST. FOR DISARMAMENT RESEARCH, THE ROLE OF NORMS OF BEHAVIOUR IN AFRICAN OUTER SPACE ACTIVITIES 3 (2013) [hereinafter AFRICAN OUTER SPACE ACTIVITIES], available at <http://unidir.org/files/publications/pdfs/the-role-of-norms-of-behaviour-in-african-outer-space-activities-en-418.pdf> (citing examples of South African satellites used for both civilian and security purposes); P.J. Blount, *Targeting in Outer Space: Legal Aspects of Operational Military Actions in Space*, HARVARD NAT'L SEC. J., Nov. 25, 2012, at 1, 9–15, <http://harvardnsj.org/wp-content/uploads/2012/11/Targeting-in-Outerspace-Blount-Final.pdf> (describing military, civilian, commercial and other types of satellites); Roger G. Harrison, Collins G. Shackelford & Deron R. Jackson, *Space Deterrence: The Delicate Balance of Risk*, 3 SPACE & DEF., no. 1, Summer 2009, at 1, 22 n.35, available at http://www.usafa.edu/df/dfe/dfer/centers/ecsd/docs/Space_and_Defense_3_1.pdf (quoting Air Force leader saying “[t]he health and safety of some civilian satellites may become just as important to the outcome of an armed conflict as those of dedicated military satellites”).

⁸ Fact Sheet from the White House on the U.S. Commercial Remote Sensing Policy 2 (Apr. 25, 2003), available at http://www.whitehouse.gov/files/documents/ostp/press_release_files/fact_sheet_commercial_remote_sensing_policy_april_25_2003.pdf (directing federal agencies to “[r]ely to the maximum practical extent on U.S. commercial remote sensing space capabilities for filling imagery and geospatial needs for military, intelligence, foreign policy, homeland security, and civil users”); U.S. Dep’t of Def., Directive 3100.10, Space Policy 4 (Oct. 18, 2012) [hereinafter DoD Directive 3100.10] (“[P]roven commercial systems and technologies will be used to the maximum practical extent.”); Space Security Index 2012, *supra* note 2, at 100–02 (reporting that the U.S. government partners with the private sector in remote sensing); *id.* at 100, 122 (noting that other countries also use privately owned satellites to perform military functions or purchase data and services from private space companies); Press Release, Off. of the Dir. of Nat’l Intelligence, DNI Blair Announces Plan for the Next Generation of Electro-optical Satellites (Apr. 7, 2009), available at <http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB404/docs/27.pdf> (stating that the Department of Defense and Intelligence Community will increase their use of satellite imagery available through U.S. commercial providers); Sandra I. Erwin, *Satellite Shortages May Choke Off Military Drone Expansion*, NAT’L DEF. MAG., Apr. 2013, <http://www.nationaldefensemagazine.org/archive/2013/April/Pages/SatelliteShortagesMayChokeOffMilitaryDroneExpansion.aspx> (forecasting increased collaboration between public and private satellite systems to support military’s increasing demand for bandwidth); William L. Shelton, *Military Space—At a Strategic Crossroad*, MILSAT MAG., Oct. 2013, at 66, available at <http://www.milsatmagazine.com/story.php?number=228336512> (detailing how the U.S. Air Force stresses the value of commercially-hosted satellite payloads).

in 2011 than at any point in the prior decade, totaling 80 launches, and placing 126 satellites into orbit.⁹ New countries and new companies have continued to enter the market—Estonia recently became the forty-first country to command its own satellite¹⁰—and polyglot consortia of public and private operators from multiple states have proliferated. For example, the U.S. military recently leased satellite services from erstwhile rival China. This one-year \$10.7 million deal for a Chinese Apstar-7 satellite will provide essential communications services for American troops in Africa, where Chinese telecommunications coverage is expansive.¹¹ Novel applications of simple, low-cost, miniaturized “nanosatellites” are the latest fad in space, as diverse schemes for accelerating exploitation of the regime continue to proliferate.¹²

⁹ Space Security Index 2013, *supra* note 1, at 120–23 (listing spacecraft launched in 2012); Space Security Index 2012, *supra* note 2, at 11, 31. *But see* *Satellite Statistics: Launches*, JONATHAN'S SPACE REPORT, <http://www.planet4589.org/space/log/stats1.html> (last visited Mar. 31, 2014) (noting that the annual rate of satellite launches was much higher during the Cold War era than today).

¹⁰ AFRICAN OUTER SPACE ACTIVITIES, *supra* note 7, at 1 (“Space-based services, once the privilege of a select few states, have reached users of every level of economic and social development, including in the Asia-Pacific region, Latin America, and particularly Africa.”); Ajey Lele, *Outer Space Comes Closer to a Regime*, INST. FOR DEF. STUDIES & ANALYSES (May 20, 2013), http://www.idsa.in/idsacomments/Outerspacecomesclosertoaregime_alele_200513. *See also* Space Security Index 2013, *supra* note 1, at 44–46, 53 (discussing the plethora of nations beginning or expanding existing outer space presence); Donna Miles, Am. Forces Press Serv., *Stratcom Shares Space Data to Promote Safety, Transparency*, U.S. DEP'T OF DEF. (Apr. 15, 2013), <http://www.defense.gov/news/newsarticle.aspx?id=119775> (“Sixty nations are now considered ‘space-faring,’ with others anxious to join them . . .”).

¹¹ Tony Capaccio, *Pentagon Continues Use of China Satellite in New Lease*, BLOOMBERG NEWS (May 15, 2013), <http://www.bloomberg.com/news/2013-05-15/pentagon-continues-use-of-china-satellite-in-new-lease.html>; Noah Shachtman, *Pentagon Paying China—Yes, China—to Carry Data*, WIRED.COM (Apr. 29, 2013), <http://www.wired.com/dangerroom/2013/04/china-pentagon-satellite/>.

¹² Werner Balogh, *The Role of Binding and Non-Binding Norms in the Implementation of Small Satellite Programmes*, in *SOFT LAW IN OUTER SPACE: THE FUNCTION OF NON-BINDING NORMS IN INTERNATIONAL SPACE LAW* 325–42 (Irmgard Marboe ed., 2012); Space Security Index 2013, *supra* note 1, at 44–46; U.S. AIR FORCE SPACE COMMAND, *RESILIENCY AND DISAGGREGATED SPACE ARCHITECTURES: WHITE PAPER* (2013), available at <http://www.afspc.af.mil/shared/media/document/AFD-130821-034.pdf>; David Axe, *After \$200 Million, Darpa Gives Up on Formation-Flying Satellites*, WIRED.COM (May 17, 2013), <http://www.wired.com/dangerroom/2013/05/formation-flying-satellites>; Anita Bernie, *Small Satellites: In-Orbit Operational Solutions Are at Hand*, MILSAT MAG., Jan. 2013, at 20, available at http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=1517707

With this increased usefulness of outer space has arisen an inescapable vulnerability. As the world appreciates and exploits the benefits of satellite operations, growing accustomed to the reliable delivery of essential services, it is inevitable that countries have become reliant upon those satellites and have forgotten or discarded some of the alternative routines. Some crucial terrestrial assets, for both civilian and military application, may be falling into desuetude, and serious, prolonged interruption of satellite services could now have grave consequences.¹³ Pursuit of ASAT

651; David Samuels, *The Watchers*, WIRED.COM (June 19, 2013), <http://www.wired.com/wiredscience/2013/06/startup-skybox>; Noah Shachtman, *With New Mini-Satellites, Special Ops Takes Its Manhunt Into Space*, WIRED.COM (May 21, 2013) <http://www.wired.com/dangerroom/2013/05/special-ops-mini-sats-manhunts>; Andrea Shalal-Esa, *U.S. Air Force Eyes Mixed Approach for Next Weather Satellite*, REUTERS (Apr. 9, 2013, 2:21 PM), <http://www.reuters.com/article/2013/04/09/us-airforce-satellites-idUSBRE9380XD20130409> (explaining that the next generation of U.S. Air Force weather satellites will include smaller, less expensive craft); Shelton, *supra* note 8 (discussing the U.S. Air Force pursuit of "disaggregation," favoring multiple small, simple, inexpensive satellites); Theresa Hitchens, *Saving Space: Threat Proliferation and Mitigation 7* (Int'l Comm'n on Nuclear Non-proliferation & Disarmament, Research Paper, 2009) [hereinafter Hitchens, *Saving Space*], available at http://icnnd.org/Documents/Hitchens_Saving_Space.pdf, ("400 micro-sats have been orbited over the last 20 years."); News Release, NASA, *NASA Successfully Launches Three Smartphone Satellites* (Apr. 22, 2013), available at http://www.nasa.gov/home/hqnews/2013/apr/HQ_13-107_PhoneSat.html.

¹³ Space Security Index 2012, *supra* note 2, at 106 ("[T]he United States is the nation most dependent on its space systems."); U.S. DEP'T OF DEF., REPORT OF THE COMMISSION TO ASSESS UNITED STATES NATIONAL SECURITY SPACE MANAGEMENT AND ORGANIZATION 9 (2001) [hereinafter Rumsfeld Commission], available at <http://www.dod.mil/pubs/space20010111.html> (expressing concern about growing U.S. dependence on space, and the vulnerabilities it creates); Jesse Oppenheim, *Danger at 700,000 Feet: Why the United States Needs to Develop a Kinetic Anti-Satellite Missile Technology Test-Ban Treaty*, 38 BROOK. J. INT'L L. 761, 789-90 (2013) (identifying the extreme reliance upon satellites as the U.S. military's "Achilles heel"); Tom Wilson, *Threats to United States Space Capabilities*, FED'N OF AM. SCIENTISTS, Jan. 2001, at 1, 2, 9, available at <http://www.fas.org/spp/eprint/article05.html> ("[T]he United States' increasing economic and military dependence on space creates a vulnerability that is an attractive target for our foreign adversaries."); *US Army Seeks New Technology to Replace GPS*, PHYS.ORG (Apr. 25, 2013), <http://phys.org/news/2013-04-army-technology-gps.html> (explaining that U.S. reliance upon Global Positioning Satellites has become a vulnerability).

capabilities, as elaborated *infra*, is therefore neither surprising nor recent.¹⁴

1.2. *The Permanent and Growing Hazards to Space Operations*

The milieu in which this growing assembly of satellites operates is far from benign and stable. As the U.S. Department of Defense describes it, space is “increasingly congested, competitive and contested.”¹⁵ While the growing population of satellites continuously jockeys for position, both natural and human-caused risks persist.

Inescapable natural phenomena, ranging from solar flares to radiation belts to meteoroids, make the remote vacuum a most unforgiving and costly habitation.¹⁶ Anthropogenic problems include competition for the best satellite “parking places” — outer space is a big place, but not all locations within it are equally valuable, and the first to occupy a particular orbit may pre-empt,

¹⁴ See *infra* section 4; Shelton, *supra* note 8 (noting the U.S. Air Force Space Command leader’s warning that U.S. reliance upon satellites carries great advantages, but also vulnerabilities).

¹⁵ NATIONAL SECURITY SPACE STRATEGY, *supra* note 1, at 1 (emphasis removed); William J. Lynn, III, Deputy Sec’y of Def., Remarks on Space Policy at U.S. Strategic Command Space Symposium (Nov. 3, 2010), *available at* <http://www.defense.gov/speeches/speech.aspx?speechid=1515>; Schulte, *supra* note 1, at 1-2. See also Rep. of the Grp. of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities, at 9, U.N. Doc. A/68/189 (July 29, 2013) [hereinafter Group of Governmental Experts], *available at* <http://www.unidir.org/files/medias/pdfs/final-report-29-july-2013-eng-0-512.pdf> (documenting UN expert group adopting the concept that space is “congested, contested, and competitive”); JOAN JOHNSON-FREESE, HEAVENLY AMBITIONS: AMERICA’S QUEST TO DOMINATE SPACE (2009) [hereinafter JOHNSON-FREESE, HEAVENLY AMBITIONS] (discussing origins of the current U.S. approach to space security).

¹⁶ DAVID WRIGHT, LAURA GREGO & LISBETH GRONLUND, THE PHYSICS OF SPACE SECURITY: A REFERENCE MANUAL 37-40 (2005) [hereinafter WRIGHT, GREGO & GRONLUND] (discussing effects of radiation, atmosphere, and gravity on satellites); Space Security Index 2013, *supra* note 1, at 33-37 (discussing threat of collisions with “Near Earth Objects,” including asteroids and comets); James Marson & Gautam Naik, *Falling Meteor Explodes Over Russia*, WALL ST. J. (Feb. 15, 2013, 6:37 PM), <http://online.wsj.com/article/SB10001424127887324162304578305163574597722.html> (describing two dangerous and prominent near-simultaneous space events: a meteorite falling into Siberia, causing significant damage, and a larger asteroid passing close enough to earth to be inside the orbit of many satellites); Brad Plumer, *When Space Weather Attacks!*, WASH. POST (July 13, 2013), *available at* <http://www.washingtonpost.com/blogs/wonkblog/wp/2013/07/13/when-space-weather-attacks>.

or be jostled by, late arrivals.¹⁷ Electronic communications to and from satellites similarly rely upon a relatively narrow selection of optimal frequency bands, and the demand for those communications links exceeds the supply.¹⁸ Satellites are inherently vulnerable; efforts to improve resiliency, by physically or technically hardening them against the various hazards, are expensive and can have only limited effect.¹⁹

Among the worst, and most rapidly growing, perils for space operations is the specter of space debris—the leftover “junk” from earlier launches, including expended rocket bodies, dysfunctional satellites, castoff parts, bolts that are used to hold and release a satellite from its launching rocket, discarded hardware, lost equipment, and human garbage.²⁰ Satellite breakups—explosions

¹⁷ Space Security Index 2012, *supra* note 2, at 27-28, 39 (noting international friction over the limited availability of the optimal orbital slots); Phillip J. Baines, *The Security Dimensions of Space Traffic Management*, in UNITED NATIONS INST. FOR DISARMAMENT RESEARCH, *CELEBRATING THE SPACE AGE: 50 YEARS OF SPACE TECHNOLOGY, 40 YEARS OF THE OUTER SPACE TREATY: CONFERENCE REPORT 189* (2007) [hereinafter *CELEBRATING THE SPACE AGE*]; Petr Lála, *Study on Space Traffic Management by the International Academy of Astronautics*, in *CELEBRATING THE SPACE AGE*, *supra*; Peter Hulsroj, *Three Sources—No River: A Hard Look at the Sources of Public International Law with Particular Emphasis on Custom and “General Principles of Law,”* 54 *ZEITSCHRIFT FÜR OFFENTLICHES RECHT* 219 (1999); Miles, *supra* note 5 (quoting a U.S. military official discussing geosynchronous orbit: “Those specific spots and those orbits are increasingly scarce, increasingly expensive and increasingly sought after”).

¹⁸ Space Security Index 2013, *supra* note 1, at 31-33; Space Security Index 2012, *supra* note 2, at 27-28, 38-39 (noting that competition over radiofrequency is currently not epidemic, but is a growing concern). *See also id.* at 63-64 (describing alleged incidents of deliberate radiofrequency interference). *See also* NATIONAL SECURITY SPACE STRATEGY, *supra* note 1, at 2 (noting “increasing congestion in the radiofrequency spectrum”); Amaani Lyle, *Official Addresses Diminishing Government Frequency Spectrum*, AM. FORCES PRESS SERV. (May 15, 2013), <http://www.defense.gov/News/NewsArticle.aspx?ID=120052> (reporting reduced frequency bandwidth available to U.S. military users).

¹⁹ Space Security Index 2013, *supra* note 1, at 78-82; Space Security Index 2012, *supra* note 2, at 129-36; GALLAGHER & STEINBRUNER, *supra* note 6, at 3-4; U.S. CONGRESS, OFFICE OF TECH. ASSESSMENT, *ANTI-SATELLITE WEAPONS, COUNTERMEASURES, AND ARMS CONTROL* 75-86 (1985) [hereinafter *OTA*] (discussing possible responses to an ASAT threat); Harrison, Shackelford & Jackson, *supra* note 7, at 12; Yousaf Butt, *Can Space Weapons Protect U.S. Satellites?*, BULL. OF THE ATOMIC SCIENTISTS (July 22, 2008, 9:07 AM), <http://thebulletin.org/can-space-weapons-protect-us-satellites>.

²⁰ Comm. on the Peaceful Uses of Outer Space, Scientific & Technical Subcomm., Technical Report on Space Debris, U.N. Doc. A/AC.105/720 (1999) [hereinafter *Technical Report*]; HEINER KLINKRAD, *SPACE DEBRIS: MODELS AND RISK ANALYSIS* 5-58 (2006); LYALL & LARSEN, *supra* note 2, at 304, nn. 125-27 (discussing

caused by unexpended fuel in abandoned booster rockets or chemical reactions in batteries—are a major, erratic, and unpredictable contributor to the problem.²¹ Every space launch and other activity produces some quantity of this litter, but careless operations or unforeseen accidents can contribute excessively to the miasma.²²

a glove, a camera, a tool bag, a golf ball, garbage, and urine lost in space at various times); ORBITAL DEBRIS PROGRAM OFF., NASA, HISTORY OF ON-ORBIT SATELLITE FRAGMENTATIONS (14th ed., 2008), available at <http://orbitaldebris.jsc.nasa.gov/library/SatelliteFragHistory/TM-2008-214779.pdf>; Steven A. Mirmina, *Reducing the Proliferation of Orbital Debris: Alternatives to a Legally Binding Instrument*, 99 AM. J. INT'L L. 649 (2005) [hereinafter Mirmina, Alternatives]; Peter B. de Selding, *Debris-Control Report Card Cites Improvement by Geo Sat Owners*, SPACE NEWS (Oct. 25, 2013), <http://www.spacenews.com/article/satellite-telecom/37861debris-control-report-card-cites-improvement-by-geo-sat-owners> (observing that debris, including defunct satellites, is becoming an increasing problem even at high altitude orbits); *Orbital Debris: Frequently Asked Questions*, NASA ORBITAL DEBRIS PROGRAM OFF., <http://orbitaldebris.jsc.nasa.gov/faqs.html> (last updated Mar. 2012); Peter Vorsmann, *Space Debris*, TECHNISCHE UNIVERSITÄT BRAUNSCHWIG (Dec. 18, 2010), <https://www.tu-braunschweig.de/ilr/forschung/raumfahrttechnik/spacedebris>.

²¹ ORBITAL DEBRIS PROGRAM OFF., NASA, HISTORY OF ON-ORBIT SATELLITE FRAGMENTATIONS (14th ed. 2008), available at <http://orbitaldebris.jsc.nasa.gov/library/SatelliteFragHistory/TM-2008-214779.pdf>; NASA, *Four Satellite Breakups in February Add to Debris Population*, ORBITAL DEBRIS Q. NEWS, Apr. 2007, at 1, 3, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv11i2.pdf>; *Orbital Debris: Frequently Asked Questions*, *supra* note 20. See generally Steven A. Hildreth and Allison Arnold, *Threats to U.S. National Security Interests in Space: Orbital Debris Mitigation and Removal*, CONG. RESEARCH SERV., R43353 (2014), available at <http://www.fas.org/sgp/crs/natsec/R43353.pdf>.

²² Space Security Index 2013, *supra* note 1, at 23-30; Space Security Index 2012, *supra* note 2, at 32-33, 36-37 (noting increased awareness about space debris, and the development and implementation of additional efforts to mitigate the problem); Technical Report, *supra* note 20, at 31 (reporting that in 1999, approximately twelve percent of the catalogued space debris consisted of objects discarded during normal satellite operations); GALLAGHER & STEINBRUNER, *supra* note 6, at 21 (noting frustrated expectations that outer space might be regulated as a "global commons" to reduce incidence of unregulated pollution); NASA, HANDBOOK FOR LIMITING ORBITAL DEBRIS, 8719.14, (2008) [hereinafter NASA HANDBOOK], available at <http://www.hq.nasa.gov/office/codeq/doctree/NHBK871914.pdf>; Jessica West, *Next Generation Space Security Challenges*, in U.N. INST. FOR DISARMAMENT RESEARCH, SEC. IN SPACE: THE NEXT GENERATION, CONFERENCE REPORT 35, 38-39, (noting the space situational awareness capabilities of several countries); David Wright, *Space Debris*, PHYSICS TODAY, Oct. 2007, at 35 available at <http://scitation.aip.org/content/aip/magazine/physicstoday/article/60/10/10.1063/1.2800252>; Paul B. Larsen, *Outer Space Traffic Safety Standards* (paper presented at McGill University May 2013) (forthcoming, on file with author). Some of what is now considered harmful debris was originally sent into space with benign motivations. For example, in Project West Ford, 1961-63, the

The distinctive feature of this orbital debris is its persistence. Debris deposited at relatively low altitudes will sooner or later degrade and fall back to earth, but junk that initiates at altitudes above about 600 kilometers can remain aloft for years, decades, or even centuries.²³

It is impossible to know precisely how much space debris is now whizzing around in orbit. The U.S. military's Space Surveillance Network, comprising some two dozen radars and telescopes, is generally able to monitor objects that are roughly ten centimeters in diameter or larger; it tracks some 22,000 such items. There are an estimated 500,000 objects of orbital debris larger than one centimeter, and perhaps 100 million that are smaller.²⁴

U.S. military placed into orbit 480 million magnetized two-centimeter copper needles, intending to facilitate global radio communications. Clumps of these dipoles have remained in space, posing a hazard. LYALL & LARSEN, *supra* note 2, at 297; DELBERT R. TERRILL JR., *THE AIR FORCE ROLE IN DEVELOPING INTERNATIONAL OUTER SPACE LAW 63-68* (2009); Oppenheim, *supra* note 13, at 769; *West Ford Needles: Where Are They Now*, ORBITAL DEBRIS Q. NEWS, Oct. 2013, at 3, 4, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV17i4.pdf>.

²³ Space Security Index 2012, *supra* note 2, at 28, 32.

²⁴ Space Security Index 2013, *supra* note 1, at 23-26; Space Security Index 2012, *supra* note 2, at 11, 29, 31, 45-47 (noting that the system is able to track 22,000 objects in space, and to catalog (i.e., to identify and attribute to a particular launching state) 17,000 of those); TIFFANY CHOW, SECURE WORLD FOUND., SPACE SITUATIONAL AWARENESS SHARING PROGRAM: AN SWF ISSUE BRIEF (2011), available at swfound.org/media/3584/ssa_sharing_program_issue_brief_nov2011.pdf; KLINKRAD, *supra* note 20, at 27-47 (describing other systems for tracking space objects); NASA HANDBOOK, *supra* note 22, at 42-61 (describing capabilities and operations of Space Surveillance Network); JEFFREY T. RICHELSON, *THE U.S. INTELLIGENCE COMMUNITY* (6th ed. 2012) at 270-91; MICHAEL T. VALLEY, SEAN P. KEARNEY & MARK ACKERMANN, SANDIA NAT'L LABORATORIES, SMALL SPACE OBJECT IMAGING: LDRD FINAL REPORT (2009), available at <http://prod.sandia.gov/techlib/access-control.cgi/2009/090692.pdf>; BRIAN WEEDEN, SECURE WORLD FOUND., GOING BLIND: WHY AMERICA IS ON THE VERGE OF LOSING ITS SITUATIONAL AWARENESS IN SPACE AND WHAT CAN BE DONE ABOUT IT (2012) [hereinafter WEEDEN, BLIND], available at http://swfound.org/media/90775/going_blind_final.pdf; Bryan Bender, *Raytheon Is in the Hunt for a \$3B Space Project*, BOSTON GLOBE (May 21, 2013), available at <http://www.bostonglobe.com/news/nation/2013/05/20/defense-dollars-dwindle-fight-for-space-shield-contract-rages/FOWIc4FEVzcsfXzTWCA4HN/story.html> (describing efforts to develop the improved Space Fence); *Debris Detection Devs. – The Space Fence*, MILSAT MAG., Feb. 2013, at 42, available at http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=1554778712 (describing development of the next generation of radar, denominated as a replacement "Space Fence," for improved tracking of space objects); Miles, *supra* note 10; Brian Weeden, *Gambling with a Space Fence: An Analysis of the Decision to Shut Down the Air Force Space Surveillance Fence*, SPACE REVIEW (Aug. 26, 2013) [hereinafter Weeden, *Gambling*], available at

The inventory of space debris continues to increase inexorably; the catalogued population grew by 7.8% from 2010 to 2011, despite a period of good luck in avoiding any new major fragmentation events.²⁵

The reason why space experts are sounding such shrill alarms over space debris is the clear, present, and growing danger of damaging and even disastrous collisions. The indiscriminate detritus travels through space at speeds up to 7.8 kilometers per second in low orbit, so any wayward piece that strikes a satellite can inflict calamitous harm.²⁶ The European Space Agency has

<http://www.thespacereview.com/article/2357/1>; *Orbital Debris: Frequently Asked Questions*, *supra* note 20. See generally, EUR. SPACE AGENCY, 6TH EUROPEAN CONFERENCE ON SPACE DEBRIS (2013), available at <http://www.slideshare.net/esaops/6th-european-conference-on-space-debris>; Space Security Index 2013, *supra* note 1, at 39; Space Security Index 2012, *supra* note 2, at 47-49 (discussing space observational capabilities of other countries); *Don't Touch Their Junk: USAF's SSA Tracking Space Debris*, DEF. INDUS. DAILY (July 23, 2013), available at <http://www.defenseindustrydaily.com/air-force-awards-first-phase-of-next-generation-space-fence-05511>; *Space Debris*, EUR. SPACE AGENCY, available at http://www.esa.int/Our_Activities/Operations/Space_Debris (last visited Mar. 31, 2014). But see Mike Gruss, *Space Fence Shutdown Expected to Weaken Orbit Surveillance Network*, SPACE NEWS (Aug. 9, 2013), available at <http://www.spacenews.com/article/military-space/36720space-fence-shutdown-expected-to-weaken-orbit-surveillance-network> (noting that Air Force funding shortfalls are leading to the termination of a key component in the existing space surveillance system).

²⁵ Space Security Index 2013, *supra* note 1, at 24 (noting a decrease, for the first time in recent years, of 7.6% in the population of cataloged orbital debris in 2012); Space Security Index 2012, *supra* note 2, at 11, 29-31. See also Joseph S. Imburgia, *Space Debris and Its Threat to National Security: A Proposal for a Binding International Agreement to Clean Up the Junk*, 44 VAND. J. TRANSNAT'L L. 589, 599 (2011) (discussing the ever-increasing amount of space junk and its concomitant dangers); Nicholas L. Johnson, *Orbital Debris: The Growing Threat to Space Operations*, AM. ASTRONOMICAL SOC., 2010, at 1, available at http://www.ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20100004498_2010003521.pdf (discussing the unprecedented rate of increase of space debris and the increased need for "collision avoidance maneuvers" in space). In 2012, the total inventory of tracked orbital debris declined slightly because the quantity that de-orbited slightly exceeded the amount of new debris created. *Satellite Statistics: Space Debris Population*, JONATHAN'S SPACE REPORT, <http://www.planet4589.org/space/log/stats1.html>.

²⁶ Space Security Index 2012, *supra* note 2, at 27; MISSILE DEF. AGENCY, U.S. DEP'T OF DEF., BALLISTIC MISSILE DEF. SYS. (BMDS), 1 PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT 4-116, 4-132 (2007) (reporting that a space impact with a fragment of debris ten centimeters long would be comparable to twenty-five sticks of dynamite, and an one centimeter fragment collides with a force comparable to a 400 pound weight traveling sixty miles per hour. Even a speck of debris only 0.1 millimeter in size could penetrate an astronaut's

concluded that any impact in space with an object as large as ten centimeters (roughly the size of a softball) “will most likely entail a catastrophic disintegration of the target.”²⁷ Even a relatively small pellet, if it happened to strike a satellite at a vulnerable spot, could prove fatal.²⁸ One evocative illustration: segments of the windshield of the U.S. Space Shuttle, designed and built to withstand the enormous stresses of re-entry into the earth’s atmosphere, had to be repeatedly replaced because they were irretrievably scratched by collisions with minute flecks of dried paint space debris.²⁹

Much more massive and consequential space crashes have occurred, too. In July 1996, a small French military reconnaissance satellite, *Cerise*, collided with debris from an Ariane rocket stage.

protective suit on a space walk); Technical Report, *supra* note 20, at 35; Kathy Jones, Krista Fuentes & David Wright, *A Minefield in Earth Orbit: How Space Debris Is Spinning Out of Control* [Interactive], SCI. AM. (Feb. 1, 2012), <http://www.scientificamerican.com/article.cfm?id=how-space-debris-spinning-out-of-control> (noting that Russia, the United States, and China together account for ninety percent of space debris); Steven A. Mirmina, *The Ballistic Missile Defense System and Its Effects on the Outer Space Environment*, 31 J. SPACE L. 287, 301-02 (2005); Joel R. Primack, *Debris and Future Space Activities*, in FUTURE SEC. IN SPACE: COMMERCIAL, MILITARY, AND ARMS CONTROL TRADE-OFFS 18 (James Clay Moltz ed., Monterey Inst., Ctr. for Nonproliferation Studies, Occasional Paper No. 10, July 2002).

²⁷ *Space Debris*, EUR. SPACE AGENCY, http://www.esa.int/Our_Activities/Operations/Space_Debris/Hypervelocity_impacts_and_protecting_spacecraft (last visited Apr. 20, 2013).

²⁸ Space Security Index 2012, *supra* note 2, at 27 (assessing that a high-speed impact in space with a ten centimeter piece of debris would carry the same kinetic energy as a 35,000 kilogram truck traveling at 190 kilometers per hour); *id.* at 28 (concluding that it is impractical to shield satellites against impacts with space debris).

²⁹ COMM. FOR THE ASSESSMENT OF NASA’S ORBITAL DEBRIS PROGRAMS, NAT’L RESEARCH COUNCIL, LIMITING FUTURE COLLISION RISK TO SPACECRAFT: AN ASSESSMENT OF NASA’S METEOROID AND ORBITAL DEBRIS PROGRAMS 50-51 (2011) [hereinafter NATIONAL ACADEMY], available at http://www.nap.edu/catalog.php?record_id=13244; MISSILE DEF. AGENCY, *supra* note 26, at 4-132; *Orbital Debris Success Story – A Decade in the Making*, ORBITAL DEBRIS Q. NEWS, Apr. 2010, at 1, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv14i2.pdf> (noting that a collision with 0.2mm paint chip required Space Shuttle window to be replaced); Primack, *supra* note 26 (quoting astronaut Sally Ride regarding paint debris gouging space shuttle window on her first flight into space); *Space Debris and Human Spacecraft*, NASA (Sept. 27, 2013) http://www.nasa.gov/mission_pages/station/news/orbital_debris.html.

The impact severed a critical stabilizing boom and knocked Cerise off course.³⁰

Even more spectacularly, in February 2009, an operational U.S. Iridium 33 satellite was blind-sided at 800 kilometers altitude by a defunct Russian Cosmos 2251 satellite, fracturing both orbiters into immense clouds of debris.³¹ No one is immune from this danger: in May 2013, Pegasus (or Pegaso), a miniature Ecuadorian satellite—the country's first space effort—was operational for only one week before it was bashed by debris fragments from a long-defunct Soviet rocket at 650 kilometers altitude, spinning it off kilter and rendering it non-functional.³² In fact, the specter of a

³⁰ Space Security Index 2012, *supra* note 2, at 30; KLINKRAD, *supra* note 20, at 233-34; Timothy P. Payne, *First "Confirmed" Natural Collision Between Two Cataloged Satellites*, 393 EUR. SPACE AGENCY 597 (1997), available at http://articles.adsabs.harvard.edu/cgi-bin/nph-iarticle_query?1997ESASP.393..597P&defaultprint=YES&filetype=.pdf; F. Alby, E. Lansard & T. Michal, *Collision of Cerise with Space Debris, Proceedings of the Second European Conference on Space Debris*, 393 EUR. SPACE AGENCY 587 (1997), available at <http://adsabs.harvard.edu/full/1997ESASP.393..589A> (confirming the collision and noting that Cerise continued to function even without its boom). See also NATIONAL ACADEMY, *supra* note 29, at 13 (discussing four space collisions); *Accidental Collisions of Catalogued Satellites Identified*, ORBITAL DEBRIS Q. NEWS, Apr. 2005, at 1, available at <http://www.spaceref.com/news/viewsr.html?pid=16201> (identifying earlier instances of destructive collisions between catalogued items of space debris).

³¹ NATIONAL ACADEMY, *supra* note 29, at 66-67; M. Matney, *Small Debris Observations from the Iridium 33/Cosmos 2251 Collision*, ORBITAL DEBRIS Q. NEWS, Apr. 2010, at 6, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV14i2.pdf> (reporting 1600 debris objects from that collision are being catalogued and more than 2000 are being actively tracked). See also Tariq Malik, *Space Junk Forces ISS Astronauts to Take Shelter in 'Lifeboat' Capsules*, HUFFINGTON POST (Mar. 24, 2012), http://www.huffingtonpost.com/2012/03/24/space-junk-iss-astronauts_n_1376963.html (noting that three years after the collision with the Iridium satellite, debris from Cosmos 2251 flew so close to the International Space Station that six astronauts aboard it entered escape pods).

³² *Ecuador Pegasus Satellite Fears over Space Debris Crash*, BBC NEWS (May 23, 2013), <http://www.bbc.co.uk/news/world-latin-america-22635671>; *EXA Space Agency's First Satellite Is Silent after Cube Is Hit + Run*, SATNEWS.COM (Sept. 9, 2013), <http://www.satnews.com/story.php?number=2071574060>; *High-Speed Particle Impacts Suspected in Two Spacecraft Anomalies*, ORBITAL DEBRIS Q. NEWS, July 2013, at 1, 2, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV17i3.pdf> (noting that investigation continues into the cause of Pegasus's disruption); Ian Steadman, *Ecuador's First Satellite Collides with Soviet Rocket Debris, Possibly Survives*, WIRED UK (May 24, 2013), <http://www.wired.co.uk/news/archive/2013-05/24/ecuador-satellite-crash>; Ian Steadman, *Ecuador Launches its First Satellite, Has Webcam, Will Search for Asteroids*, WIRED UK (Apr. 26, 2013), <http://www.wired.co.uk/news/archive/2013-04/26/first-ecuador-satellite>.

“chain reaction” collision—in which one impact generates a spray of wreckage that cascades into other satellites or fragments, in turn spinning additional percussions—is now all too likely.³³

The ability to anticipate and dodge these hypervelocity collisions is still under-developed, and shielding can be effective against only the smallest particles.³⁴ The U.S. monitoring capability represents the global state of the art in space “situational awareness,” and the United States has begun a practice of providing “conjunction warnings” to some domestic and foreign satellite operators whose assets are projected to come dangerously close to known objects. It now sends these alerts twenty to thirty times per day.³⁵ But this remains a very inexact science: ninety-

³³ See Space Security Index 2013, *supra* note 1, at 23–24 (listing major collisions between space objects); Space Security Index 2012, *supra* note 2, at 34–36 (warning that the prevalence of space debris may already approach a “tipping point” known as the Kessler Syndrome, in which cascading collisions become inevitable and irreversible); Technical Report, *supra* note 21, at 26; NATIONAL ACADEMY, *supra* note 29, at 10–13; Inter-Agency Space Debris Coordination Comm., *Stability of the Future LEO Environment* 2, 17, Working Group 2, Action Item 27.1, IADC-12-08, Rev. 1 (Jan. 2013), <http://www.iadc-online.org/Documents/IADC-2012-08,%20Rev%201,%20Stability%20of%20Future%20LEO%20Environment.pdf> (stating that the debris population in low earth orbit is already unstable, and will continue to grow despite remediation efforts; catastrophic collisions are likely every five to nine years); J.-C. Liou, *An Update on LEO Environmental Remediation with Active Debris Removal*, ORBITAL DEBRIS Q. NEWS, Apr. 2011, at 4, 5, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv15i2.pdf> (estimating numbers of “catastrophic collisions” in low earth orbit in coming years, under various assumptions about the prevalence of debris); Brian Weeden, *Overview of the Legal and Policy Challenges of Orbital Debris Removal*, 27 SPACE POLICY 38 (2011); Darren McKnight & Donald Kessler, *We’ve Already Passed the Tipping Point for Orbital Debris*, IEEE SPECTRUM (Sept. 26, 2012), <http://spectrum.ieee.org/aerospace/satellites/weve-already-passed-the-tipping-point-for-orbital-debris> (arguing that the “chain reaction” phenomenon has already started); Mike Wall, *Destroyed Russian Satellite Highlights Space Junk Threat*, NBC NEWS (March 11, 2013), http://science.nbcnews.com/_news/2013/03/11/17269924-destroyed-russian-satellite-highlights-space-junk-threat?lite (quoting estimates that the danger of a collision in space has roughly doubled since 2007).

³⁴ Technical Report, *supra* note 20, at 34 (concluding that protection against debris particles smaller than 1 centimeter can be achieved, but larger objects cannot be dealt with successfully); NASA HANDBOOK, *supra* note 22, at 151–52; Johnson, *supra* note 25, at 6.

³⁵ DoD Directive 3100.10, *supra* note 8, at sec. 4.j(1) (determining that the Department of Defense will provide ample warning and timely attribution of hostile and natural events in space); Space Security Index 2013, *supra* note 1, at 26, 37–40; Space Security Index 2012, *supra* note 2, at 52–53; CHOW, *supra* note 24, at 6; WEEDEN, BLIND, *supra* note 24, at 6 (stating that the U.S. military plans to spend \$4

nine percent of the danger comes from particles too small to track; sometimes the warnings do not come early enough to enable evasive maneuvers; and no one can confidently specify exactly how close the two space objects will come, or even which direction or how far the risk-averse satellite should be moved.³⁶ Moreover, not all satellites have great maneuver capability; in any event, significant course adjustments consume scarce fuel and require the satellite to depart from its preferred trajectory, to adopt a less-than-optimal position for some period of time.³⁷

Collision-avoiding displacements have become more common, as the population of space debris mushrooms and as awareness of the threat grows; seventy-five such maneuvers were conducted in 2012.³⁸ In March 2011, for example, the International Space Station

billion to improve space situational awareness); Miles, *supra* note 10 (detailing that Stratcom has issued more than 10,000 warnings of potential collisions and supported seventy-five "avoidance maneuvers"); Schulte, *supra* note 1, at 2 (reporting 1300 warnings issued in the past year).

³⁶ CHOW, *supra* note 24, at 8 (noting that the information supplied by the SSA sharing program "can be untimely and inaccurate," and that U.S. legislation shields the program from legal liability associated with defects or delays in the information it provides); WEEDEN, BLIND, *supra* note 24, at 9 (noting a fifty percent error rate in conjunction warnings); Johnson, *supra* note 25, at 6, 7 (noting that "predicting the collision of two satellites remains a probabilistic endeavor" and ninety percent of the risk comes from untrackable fragments); Malik, *supra* note 31 (noting that when debris from Cosmos 2251 flew dangerously close to the International Space Station, the surveillance system did not provide sufficient advance warning to enable the space station to undertake evasive maneuvers); Brian Weeden, *Dancing in the Dark: The Orbital Rendezvous of SJ-12 and SJ-06F*, SPACE REVIEW (Aug. 30, 2010), <http://www.thespacereview.com/article/1689/1> (describing large error margins in calculating the exact location of space objects; just before the 2009 Iridium-Cosmos collision, the best calculations had estimated that the two spacecraft would miss each other by 600 meters).

³⁷ See GALLAGHER & STEINBRUNER, *supra* note 6, at 3; JOHNSON-FREESE, HEAVENLY AMBITIONS, *supra* note 15, at 70-71 (discussing the cost and difficulty of changing a satellite's orbit; a satellite carries only a fixed amount of fuel, giving it only a limited capacity for maneuvering); NATIONAL ACADEMY, *supra* note 29, at 92 ("Shielding, debris avoidance maneuvers, and other efforts to avoid debris impact increase the cost of spacecraft design and operation." Some estimate these expenditures as adding zero to ten percent to the mission cost); *Orbital Debris: Collision Avoidance: Conjunction Analysis*, NASA, orbitaldebris.jsc.nasa.gov/protect/collision_avoidance.html (last visited Nov. 14, 2013) ("Typically, satellites cannot afford to maneuver unnecessarily . . ."). But see Johnson, *supra* note 25, at 7 (stating that, in most cases, collision avoidance maneuvers "can be conducted in a manner which does not waste propellant resources").

³⁸ Weeden, *Gambling*, *supra* note 24. See also Space Security Index 2013, *supra* note 1, at 26-27, 40; CHOW, *supra* note 24, at 6 (reporting 126 evasive maneuvers in 2010).

(ISS) was alerted to the near approach of debris from the 2009 Iridium-Cosmos collision, and forced to initiate evasive maneuvers.³⁹ This was the fifth time in thirty months that the ISS had been required to undertake avoidance operations,⁴⁰ and the frequency of those demands increased in the following year, with four more required “dodge-ball” operations, and two additional instances in which maneuvers would have been initiated, if the conjunction warning had been more timely.⁴¹ When the alert comes too late, the protocol calls for the ISS astronauts to board escape modules, for a hasty undocking and return to earth, if the debris fatally impairs the space station’s life support operations.⁴²

Beyond ISS experiences, two Canadian radar satellites experienced a combined total of twenty-eight close approach alerts in 2011 and were forced to maneuver out of harm’s way five times.⁴³ France reported thirteen evasive maneuvers for satellites under its control in 2010,⁴⁴ and the European Space Agency recorded nine further comparable incidents.⁴⁵

³⁹ *International Space Station Again Dodges Debris*, ORBITAL DEBRIS Q. NEWS, July 2011, at 1, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV15i3.pdf>; Malik, *supra* note 31.

⁴⁰ *International Space Station Again Dodges Debris*, *supra* note 39. See also Space Security Index 2013, *supra* note 1, at 25–27; Space Security Index 2012, *supra* note 2, at 34; KLINKRAD, *supra* note 20, at 234 (detailing that on six occasions between June 1999 and May 2002 the International Space Station initiated maneuvers to evade dangers of collision with space debris).

⁴¹ See *Increase in ISS Debris Avoidance Maneuvers*, ORBITAL DEBRIS Q. NEWS, Apr. 2011, at 1, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV16i2.pdf>. See also *International Space Station Maneuvers Twice to Avoid Tracked Debris*, ORBITAL DEBRIS Q. NEWS, Apr. 2014, at 1, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV18i2.pdf> (reporting that the International Space Station was required to alter its trajectory twice in early 2014 to avoid debris; this brings to eighteen the total number of such maneuvers since 1999).

⁴² *International Space Station Again Dodges Debris*, *supra* note 39; Malik, *supra* note 31 (noting another near miss between debris from Cosmos 2251 and the International Space Station); Traci Watson, *Station Crew Has Close Call with Space Junk*, ABC NEWS (Mar. 12, 2009), <http://abcnews.go.com/Technology/story?id=7069746&page=1>; *Space Debris and Human Spacecraft*, *supra* note 29 (describing procedures for maneuvering the International Space Station to avoid debris, and for moving the astronauts into the escape module as a precaution against oncoming debris).

⁴³ Space Security Index 2013, *supra* note 1, at 34.

⁴⁴ *United Nations Discusses Space Debris and Long-Term Sustainability of Activities in Outer Space*, ORBITAL DEBRIS Q. NEWS, Apr. 2011, at 1, available at

Aggravating the problem is the predictable fact that space debris is most plentiful—and the jeopardy for safe space operations is therefore greatest—in the most useful orbits. Those are the altitudes, orbital inclinations, and positions that satellite operators most prefer to occupy, in order to optimally perform their various missions, so that is where the most flotsam is found. Collisions in those regions, accordingly, have the greatest propensity to spawn additional jeopardy.⁴⁶

The international space community has been seized with the issue of debris, and NASA and the relevant United Nations office have promulgated voluntary guidelines, now widely accepted, on “best practices” for minimizing (but not eliminating) the creation of additional space junk in normal operations.⁴⁷ On the other

<http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV15i2.pdf> (addressing numerous countries’ reports on space debris and related issues).

⁴⁵ *Id.*

⁴⁶ See, e.g., Bhupendra Jasani, *Satellite Capabilities and Orbits*, in INTERNATIONAL SAFEGUARDS AND SATELLITE IMAGERY: KEY FEATURES OF THE NUCLEAR FUEL CYCLE AND COMPUTER-BASED ANALYSIS 19 (Bhupendra Jasani, Irmgard Niemeyer, Sven Nussbaum, Bernd Richter & Gotthard Stein eds., 2009) (noting that the mission of a satellite determines the orbit at which it is placed; civil remote sensing satellites, for example, are operated at altitudes between 400 kilometers and 700 kilometers); Weeden, *supra* note 33, at 38 (reporting that space debris “is concentrated in the regions of Earth orbit that are most heavily utilized”). Sometimes, it is difficult to determine whether a particular satellite failure has been caused by a collision with a piece of human-created space debris, a collision with a small fragment of natural space material, or an internal malfunction. Attempts to improve “space situational awareness” can ameliorate this problem, but not quickly or completely. See, e.g., *High-Speed Particle Impacts Suspected in Two Spacecraft Anomalies*, ORBITAL DEBRIS Q. NEWS, July 2013, at 1, 2, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV17i3.pdf> (noting ongoing uncertainty about the cause of recent satellite disruptions); Amy Butler, *Pentagon: No Evidence Chinese Debris Damaged Russian Satellite*, AVIATION WEEK & SPACE TECH. (Mar. 25, 2013), http://www.aviationweek.com/Article.aspx?id=/article-xml/AW_03_25_2013_p31-561065.xml (reporting that “debate continues about what caused the breakup of a Russian satellite in orbit”); Weeden, *Gambling*, *supra* note 24.

⁴⁷ UN Inter-Agency Space Debris Coordination Comm., IADC Space Debris Mitigation Guidelines, IADC Action Item No. 22.4 (2007), available at http://iadc-online.org/index.cgi?item=docs_pub (promulgating non-binding recommendations, approved by U.N. General Assembly, to reduce the creation of additional space debris); Tom Graham & Darren Huskisson, *Cooperation in Space: International Institutions*, in SPACE AND DEFENSE POLICY, *supra* note 2, at 104, 120-21; LYALL & LARSEN, *supra* note 2, at 301-11; Irmgard Marboe, *The Importance of Guidelines and Codes of Conduct for Liability of States and Private Actors*, in SOFT LAW IN OUTER SPACE, *supra* note 12, at 139-43; NATIONAL ACADEMY, *supra* note 29, at 57-59; NATIONAL SPACE POLICY OF THE UNITED STATES OF AMERICA 7 (2010), available at

hand, efforts at—or even concepts for—removal of persistent abandoned material that already pollutes the space environment are barely at the conceptual stage.⁴⁸

1.3. *The rise and pause of outer space law*

http://www.whitehouse.gov/sites/default/files/national_space_policy_6-28-10.pdf (stating Obama Administration U.S. policy for minimizing debris and preserving the space environment); U.S. NATIONAL SPACE POLICY (2006), available at <http://www.nss.org/resources/library/spacepolicy/2006NationalSpacePolicy.htm> (stating Bush Administration U.S. government policy to minimize the creation of orbital debris, “in order to preserve the space environment for future generations”); Carsten Wiedemann, *Space Debris Mitigation*, in *SOFT LAW IN OUTER SPACE*, *supra* note 12, at 315-24; *United Nations Adopts Space Debris Mitigation Guidelines*, ORBITAL DEBRIS Q. NEWS, Apr. 2011, at 1, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv15i2.pdf>; Space Security Index 2013, *supra* note 1, at 27-30 (“As in previous years, compliance with international orbital debris mitigation guidelines was mixed in 2012.”); Space Security Index 2012, *supra* note 2, at 32-33, 36-37 (noting the development and implementation of additional efforts to mitigate the generation of debris); Mirmina, *Alternatives*, *supra* note 20 (calling for strengthened guidelines to restrict space debris). See also NAT’L SCIENCE & TECH. COUNCIL, WHITE HOUSE, FACT SHEET: NATIONAL SPACE POLICY 14, PDD/NSC 49 (PDD/NSC 8) (Sept. 19, 1996) [hereinafter *1996 National Space Policy*] (emphasizing that official U.S. policy is to minimize the creation of space debris and to ensure that other nations do likewise); Maureen Williams, *Safeguarding Outer Space: On the Road to Debris Mitigation*, in UN INST. FOR DISARMAMENT RESEARCH, *SECURITY IN SPACE: THE NEXT GENERATION*, CONFERENCE REPORT 81, 89-98 (2008) (presenting draft of Buenos Aires International Instrument on the Protection of the Environment from Damage Caused by Space Debris).

⁴⁸ DAVE BAIocchi & WILLIAM WELSER IV, RAND NAT’L DEF. RES. INST. *CONFRONTING SPACE DEBRIS: STRATEGIES AND WARNINGS FROM COMPARABLE EXAMPLES INCLUDING DEEPWATER HORIZON* (2010), available at http://www.rand.org/content/dam/rand/pubs/monographs/2010/RAND_MG1042.pdf; VALLEY, KEARNEY & ACKERMANN, *supra* note 24 (noting difficulty in imaging small objects in space, a precondition for removing them); Weeden, *supra* note 33; Imburgia, *supra* note 25; Space Security Index 2013, *supra* note 1, at 29-30; Space Security Index 2012, *supra* note 2, at 32-33, 36-37 (noting that there is currently no practical capability for collecting debris and removing it from space); Sarah Cruddas, *ESA Plans to Clear Up Space Junk*, SEN (Oct. 3, 2012), <http://www.sen.com/news/esa-plans-to-clear-up-space-junk.html>; Jason Palmer, *Space Junk Could Be Tackled by Housekeeping Spacecraft*, BBC NEWS (Aug. 11, 2011, 8:43 PM), <http://www.bbc.com/news/science-environment-14405118> (reporting a proposal that could, at most, remove five to ten large space objects per year); Claude Phipps, *Clearing Space Debris with Lasers*, SPIE (Jan. 20, 2012), <http://spie.org/x84761.xml>; Lionel Pousaz, *The Time Has Come to Destroy Debris; The Clean Space One Mission*, SAT MAG., Oct. 2013, at 30, available at <http://www.satmagazine.com/story.php?number=140549881>.

Outer space evoked an impressive outpouring of legal institutions, norms, and treaties in the early years, as space exploration and use were just beginning,⁴⁹ but the global legislative process has stultified in recent decades.

The 1967 Outer Space Treaty (OST)⁵⁰ is the foundational document, joined by virtually all space-faring states.⁵¹ It establishes certain critical legal concepts, including: that the exploration and use of outer space "shall be carried out for the benefit and in the interests of all countries";⁵² that outer space and celestial bodies shall not be "subject to national appropriation by claim of sovereignty" or by any other means;⁵³ that international law, including the Charter of the United Nations, applies in outer space;⁵⁴ and that specified weapons-related activities are banned.⁵⁵ These contributions are vital and virtually universally accepted, but in reality, they do not much inhibit practical satellite weapons programs or constrain various countries' military aspirations in space.

⁴⁹ LYALL & LARSEN, *supra* note 2, at 4-9 (discussing early antecedents of space law); Jonty Kasku-Jackson & Elizabeth Waldrop, *Understanding Space Law: Legal Framework for Space*, in SPACE AND DEFENSE POLICY, *supra* note 2, at 64; TERRILL, *supra* note 22; Steven Weber & Sidney Drell, *Attempts to Regulate Military Activities in Space*, in U.S.-SOVIET SECURITY COOPERATION: ACHIEVEMENTS, FAILURES, LESSONS 373-431 (Alexander L. George, Philip J. Farley & Alexander Dallin eds., 1988); Michael C. Mineiro, *The United States and the Legality of Outer Space Weaponization: A Proposal for Greater Transparency and a Dispute Resolution Mechanism*, 33 ANNALS OF AIR & SPACE L. 441 (2008).

⁵⁰ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205 [hereinafter OST].

⁵¹ OST Signatory List, U.S. DEP'T OF STATE (last updated Oct. 8, 2013), <http://www.state.gov/t/isn/5181.htm#signatory> (listing 102 parties to the OST). See Raymond L. Garthoff, *The Outer Space Treaty: 1967 to the Present*, in ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 877 (Richard Dean Burns ed., 1993); LYALL & LARSEN, *supra* note 2, at 53-57 (noting that the OST is frequently referred to as "the Magna Carta of Space").

⁵² OST, *supra* note 50, at art. I, ¶ 1.

⁵³ *Id.* at art. II.

⁵⁴ *Id.* at art. III.

⁵⁵ *Id.* at art. IV (prohibiting, inter alia, the placement of nuclear weapons or other kinds of weapons of mass destruction in outer space, the establishment of military bases on the moon, and the testing of weapons on the moon). See generally Michel Bourbonniere & Ricky J. Lee, *Legality of the Deployment of Conventional Weapons in Earth Orbit: Balancing Space Law and the Law of Armed Conflict*, 18 EUR. J. INT'L L. 873 (2008).

Subsequent to the OST, states promptly crafted three additional widely-accepted agreements elaborating the legal regime for space: the 1968 Rescue and Return Agreement (safeguarding astronauts and space vehicles);⁵⁶ the 1972 Liability Convention (establishing absolute tort liability for damage caused on earth by a space object, and liability for fault caused by a space object upon another space object);⁵⁷ and the 1975 Registration Convention (requiring a launching state to publish basic information about its space objects).⁵⁸

In addition, norms of customary international law,⁵⁹ reflected in canonical resolutions of the United Nations General Assembly,⁶⁰

⁵⁶ Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, T.I.A.S. No. 6559, 672 U.N.T.S. 119; *Status of International Agreements Relating to Activities in Outer Space*, U.N. OFFICE FOR OUTER SPACE AFF., <http://www.oosa.unvienna.org/oosa/en/SpaceLaw/treatystatus/index.html> (last visited Oct. 8, 2013). See generally LYALL & LARSEN, *supra* note 2, at 96–102, 134–41.

⁵⁷ Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, T.I.A.S. No. 7762, 961 U.N.T.S. 187; *Status of International Agreements*, *supra* note 56. See generally LYALL & LARSEN, *supra* note 2, at 103–16.

⁵⁸ Convention on Registration of Objects Launched into Outer Space, Nov. 12, 1974, 28 U.S.T. 695, T.I.A.S. No. 8480, 1023 U.N.T.S. 15; *Status of International Agreements*, *supra* note 56. See generally LYALL & LARSEN, *supra* note 2, at 84–96.

⁵⁹ See RESTATEMENT (THIRD) OF FOREIGN RELATIONS LAW § 102(2), § 102 cmt. b (1986) (defining customary international law as a leading source of international law); LYALL & LARSEN, *supra* note 2, at 70–80 (arguing that “elements of the OST have passed into customary international law,” as evidenced by various resolutions by the U.N.’s General Assembly and the space treaties adopted after the OST); Bin Cheng, *United Nations Resolutions on Outer Space: “Instant” International Customary Law?*, 5 INDIAN J. INT’L L. 23 (1965) (examining the legal status and impact of U.N. resolutions on space law).

⁶⁰ See Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries, G.A. Res. 51/122, U.N. Doc. A/RES/51/122 (Dec. 13, 1996) (“International cooperation in the exploration and use of outer space for peaceful purposes . . . shall be conducted in accordance with the provisions of international law”); Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, G.A. Res. 1962 (XVIII), U.N. Doc. A/RES/1962(XVIII) (Dec. 13, 1963) (“Outer space and celestial bodies are free for exploration and use by all States on a basis of equality and in accordance with international law.”); LYALL & LARSEN, *supra* note 2, at 43–50, 56–57 (discussing the impact of the 1963 Outer Space Resolution as crystallizing customary international law and leading to the OST); Space Security Index 2013, *supra* note 1, at 96 (citing six key U.N. resolutions); Karin Traunmüller, *The Declaration of Legal Principles Governing the Activities of States in the Exploration*

also pursued similar principles, and an international institutional infrastructure arose to entrench the peaceful, shared, and mutually advantageous exploitation of space.⁶¹ Particularly noteworthy in this regard was the 1986 U.N. General Assembly resolution on "Principles Relating to Remote Sensing of the Earth from Outer Space."⁶² Although this resolution was directed at the use of satellites for earth resources management and protection, rather than at national security issues,⁶³ it called for remote sensing to "be carried out for the benefit and in the interests of all countries,"⁶⁴ and for the resulting data to be made available to the sensed

and Use of Outer Space': The Starting Point for the United Nations' Law of Outer Space, in *SOFT LAW IN OUTER SPACE*, *supra* note 12, at 145 (enumerating the events and discussions that ultimately led to the passage of the 1963 Outer Space Resolution); see also Paul B. Larsen, *Application of the Precautionary Principle to the Moon*, 71 J. AIR L. & COM. 295 (2006) (calling for the broad application of the precautionary principle from environmental law).

⁶¹ Particularly noteworthy elements of this international diplomatic and legal infrastructure are the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS) and its Legal Subcommittee, and the U.N. Office for Outer Space Affairs, which serves as its secretariat. See LYALL & LARSEN, *supra* note 2, at 17–22 (introducing the functions and structures of the United Nations Office for Outer Space Affairs (UN OOSA) and the Committee on the Peaceful Uses of Outer Space (COPUOS)); Graham & Huskisson, *supra* note 47, at 106–08 (discussing international organization with respect to space cooperation); Munish Sharma, *Space Treaty Mechanisms*, in *DECODING THE INTERNATIONAL CODE OF CONDUCT FOR OUTER SPACE ACTIVITIES* 53–61 (Ajey Lele ed., 2012) (discussing legal mechanisms that have been developed to govern space security); Theresa Hitchens, *Transparency and Confidence Building in Outer Space: Inching Toward Action*, ISN (May 9, 2013), <http://www.isn.ethz.ch/Digital-Library/Articles/Special-Feature/Detail/?id=163379&contextid774=163379&contextid775=163367&tabid=1454268614> (discussing COPUOS's actions to improve safety and security in outer space).

⁶² Principles Relating to Remote Sensing of the Earth from Outer Space, G.A. Res. 41/65, U.N. Doc. A/RES/41/65 (Dec. 3, 1986) [hereinafter U.N. Remote Sensing Principles]. See generally Joanne Irene Gabrynowicz, *The UN Principles Relating to Remote Sensing of the Earth from Outer Space and Soft Law*, in *SOFT LAW IN OUTER SPACE*, *supra* note 12, at 183 (analyzing the *travaux préparatoires* of the U.N. Remote Sensing Principles as part of a broader discussion of its place in soft law); LYALL & LARSEN, *supra* note 2, at 420–29 (noting that the Principles are not regarded as constituting customary international law, but may have been influential in shaping state behavior).

⁶³ U.N. Remote Sensing Principles, *supra* note 62, at Annex, Principle I (a).

⁶⁴ *Id.* at Annex, Principle IV.

state⁶⁵—but did not incorporate a regime requiring the consent of the sensed state.⁶⁶

However, the episodic efforts to promote additional agreements to restrain the development, testing, and use of ASATs and other space weapons were always stillborn. During the Jimmy Carter Administration, for example, the United States and the Soviet Union undertook three fitful rounds of bilateral negotiations on a proposed ASAT treaty during 1978 and 1979, but never came close to an agreement.⁶⁷ Likewise, during the Ronald Reagan Administration, bilateral negotiations on space weaponry were initiated in 1985, but were characterized by neither vigor nor success.⁶⁸

Multilateral efforts in pursuit of new measures of space arms control have also been thoroughly frustrated. The Conference on Disarmament (CD) (a sixty-five-member UN affiliate, responsible for negotiating numerous successful international accords on

⁶⁵ *Id.* at Annex, Principle XII.

⁶⁶ Ray Harris, *Science, Policy and Evidence in EO*, in EVIDENCE FROM EARTH OBSERVATION SATELLITES, *supra* note 2, at 43, 44.

⁶⁷ See ROGER G. HARRISON, EISENHOWER CTR. FOR SPACE & DEF. STUDIES, 1 SPACE AND VERIFICATION: POLICY IMPLICATIONS 6-7 (2011), available at <http://swfound.org/media/37101/Space%20and%20Verification%20Vol%201%20-%20Policy%20Implications.pdf>; Hays, *Sino-American*, *supra* note 3, at 24-25; MILTON LEITENBERG, MINISTRY OF FOREIGN AFF. OF SWEDEN, STUDIES OF MILITARY R&D AND WEAPONS DEVELOPMENT: CASE STUDY 1 – THE HISTORY OF US ANTI-SATELLITE WEAPONS (1984), available at <http://www.fas.org/man/eprint/leitenberg/asat.pdf> (describing the failed 1977-79 U.S.-U.S.S.R. ASAT treaty negotiations); Viktor Mizin, *Non-Weaponization of Outer Space: Lessons from Negotiations*, in OUTER SPACE: WEAPONS, DIPLOMACY, AND SECURITY, *supra* note 3, at 48, 52-53 (providing the Russian perspective on the negotiations); NAT'L ACAD. OF SCI., COMM. ON INT'L SEC. & ARMS CONTROL, NUCLEAR ARMS CONTROL: BACKGROUND AND ISSUES 161-63 (1985); OTA, *supra* note 19, at 96; John Pike & Eric Stambler, *Anti-Satellite Weapons and Arms Control*, in 2 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 991, 995 (Richard Dean Burns ed., 1993); PAUL B. STARES, THE MILITARIZATION OF SPACE: U.S. POLICY, 1945-1985 180-200 (1985); John Wertheimer, *The Antisatellite Negotiations*, in SUPERPOWER ARMS CONTROL: SETTING THE RECORD STRAIGHT 139, 139-63 (Albert Carnesale & Richard N. Haass eds., 1987); Ambassador Donald A. Mahley, Acting Deputy Assistant Sec'y for Threat Reduction, Export Controls, & the State of Space Sec., Remarks at the Space Policy Institute at George Washington University: The State of Space Security (Jan. 24, 2008), available at <http://2001-2009.state.gov/t/isn/rm/2008/99746.htm>.

⁶⁸ Hays, *Sino-American*, *supra* note 3, at 27 (observing that the space talks were “the only category of superpower arms control negotiations started in the 1980s that did not produce a treaty”); Mizin, *supra* note 67, at 56-63 (noting the Russian perspective on the negotiations); NAT'L ACAD. OF SCI., *supra* note 67, at 164-86; Pike & Stambler, *supra* note 67, at 995; Mahley, *supra* note 67.

nuclear, chemical, and biological weapons)⁶⁹ has carried on its proposed agenda the task of articulating a new agreement on "Prevention of an Arms Race in Outer Space" (PAROS). Incredibly, however, the lack of a consensus among its members has rendered the CD utterly unable—since 1996—even to initiate meaningful talks on the topic.⁷⁰ The United Nations General Assembly, for its part, annually adopts a PAROS resolution, but conspicuously lacks the authority to compel states to undertake negotiations or to alter their behaviors in space.⁷¹ The General Assembly and the Secretary General have also twice sponsored a "Group of Governmental Experts" on outer space transparency and confidence-building measures, to pursue the possible elaboration of elusive agreed principles.⁷²

⁶⁹ See *An Introduction to the Conference*, UN OFF. AT GENEVA, <http://www.unog.ch/80256EE600585943/%28httpPages%29/BF18ABFEF5D344DC1256F3100311CE9?OpenDocument> (last visited Jan. 30, 2014) (describing the nature of the CD).

⁷⁰ Graham & Huskisson, *supra* note 47, at 108–10; Kasku-Jackson & Waldrop, *supra* note 49, at 89–90; Laura Grego, *A History of Anti-Satellite Programs*, UNION OF CONCERNED SCIENTISTS, Jan. 2012, at 1, 13, available at http://www.ucsusa.org/assets/documents/nwgs/a-history-of-ASAT-programs_lo-res.pdf.

⁷¹ Prevention of an Arms Race in Outer Space, G.A. Res. 67/30, U.N. Doc. A/RES/67/30 (Dec. 3, 2012); Prevention of an Arms Race in Outer Space, G.A. Res. 66/27, U.N. Doc. A/RES/66/27 (Dec. 2, 2011); Prevention of an Arms Race in Outer Space, G.A. Res. 65/44, U.N. Doc. A/RES/65/44 (Dec. 8, 2010). Notably, the United States has routinely voted against or abstained on the annual U.N.G.A. PAROS resolution. Grego, *supra* note 70, at 13.

⁷² Group of Governmental Experts, *supra* note 15; Transparency and Confidence-Building Measures in Outer Space Activities, G.A. Res. 65/68, U.N. Doc. A/RES/65/68 (Dec. 8, 2010); Hitchens, *supra* note 61, at 2–3; Frank A. Rose, *Addressing the Challenges of Space Security*, SPACE NEWS (Apr. 8, 2013), <http://www.spacenews.com/article/opinion/34757addressing-the-challenges-of-space-security>; Frank A. Rose, *A Golden Opportunity on a Golden Anniversary*, SPACE NEWS (Aug. 26, 2013), <http://www.spacenews.com/article/opinion/36946a-golden-opportunity-on-a-golden-anniversary>; Press Release, U.S. Dep't of State, Statement on Consensus Achieved by the UN Group of Governmental Experts on Transparency and Confidence-Building Measures for Outer Space Activities (July 18, 2013), available at <http://www.state.gov/r/pa/prs/ps/2013/07/212095.htm> (stating that the United States welcomes the consensus on international cooperation and coordination in voluntary non-legally-binding measures). See also U.N. Secretary General, *Prevention of an Arms Race in Outer Space: Study on the Application of Confidence-Building Measures in Outer Space*, U.N. Doc. A/48/305 (Oct. 15, 1993), available at http://www.un.org/ga/search/view_doc.asp?symbol=A/48/305 (detailing a previous United Nations study of similar dangers and possibilities).

Some states have tentatively stepped into this void, attempting to spur the development of new international law regulating the weaponization of space. Russia and China have promulgated successive iterations of a draft Treaty on the Prohibition of the Placement of Weapons in Space,⁷³ but well-placed opposition from the United States and others has kept it on the international back burner.⁷⁴ The European Union has likewise sponsored a draft non-legally-binding “Code of Conduct” for safe and mutually-accommodating space operations⁷⁵—a modest, but still disproportionately controversial advancement.⁷⁶

⁷³ Conference on Disarmament, *Letter Dated 12 February 2008 from the Permanent Representative of the Russian Federation and the Permanent Representative of China Addressed to the Secretary-General of the Conference Transmitting the Russian and Chinese Texts of the Draft “Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT)”*, CD/1839 (Feb. 29, 2008), available at <http://daccess-dds-ny.un.org/doc/UNDOC/GEN/G08/604/02/PDF/G0860402.pdf?OpenElement>; <http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/cd/2008/documents/Draft%20PPWT.pdf>. This draft treaty would establish limitations on the use, but not on the development or deployment, of space weapons, and does not include provisions for verification or enforcement of compliance. See Alexei Arbatov, *Preventing an Arms Race in Space*, in *OUTER SPACE: WEAPONS, DIPLOMACY, AND SECURITY*, *supra* note 3, at 78, 82–86; Mizin, *supra* note 67, at 54–55; Gunjan Singh, *PPWT: An Overview*, in *DECODING THE INTERNATIONAL CODE OF CONDUCT, supra* note 61, at 47, 47–49; Victor Vasiliev, *The Draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects*, in *SECURITY IN SPACE*, *supra* note 47, at 145, 145–51 (2008); Grego, *supra* note 70, at 13. See also OTA, *supra* note 19, at 96–99, 145–46 (discussing previous draft space weaponization treaties proposed by U.S.S.R. in 1981 and 1983); PAUL B. STARES, *SPACE AND NATIONAL SECURITY* 148–50 (1987) (describing U.S. rejection of early Soviet proposals for arms control in space).

⁷⁴ For the official 2008 U.S. comments on the draft Russia-Chinese treaty, see Conference on Disarmament, *Letter Dated 19 August 2008 from the Permanent Representative of the United States of America Addressed to the Secretary-General of the Conference Transmitting Comments on the Draft “Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT)”*, CD/1847 (Aug. 26, 2008), available at <http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/cd/2008/documents/1847.pdf> (critiquing provisions regarding the scope of the proposed treaty, lack of verification provisions, amendment process, and other matters). See Grego, *supra* note 70, at 14 (noting that the Russia-China “proposal was not well received by the United States, which offered a critique but no counter-proposal”).

⁷⁵ Council Decision 2012/281/CFSP, *In the Framework of the European Security Strategy in Support of the Union Proposal for an International Code of Conduct on Outer-Space Activities*, 2012 O.J. (L140/68), available at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:140:0068:0073:EN:PDF>; *International Code of Conduct for Outer Space Activities (Revised Draft)*, EUROPEAN UNION (Working Document, Sept. 16, 2013), available at <http://eeas.europa.eu/>

non-proliferation-and-disarmament/pdf/space_code_conduct_draft_vers_16_sept_2013_en.pdf; DECODING THE INTERNATIONAL CODE OF CONDUCT, *supra* note 61; STIMSON CTR., A CODE OF CONDUCT FOR RESPONSIBLE SPACE-FARING NATIONS (Michael Krepon ed., 2010) (discussing a proposed code of conduct that preceded the EU draft); Jean-Francois Mayence, *The European Union's Initiative for a Code of Conduct on Space Activities: A Model of Soft Law for Outer Space?*, in *SOFT LAW IN OUTER SPACE*, *supra* note 12, at 343-60; *Awaiting Launch: Perspectives on the Draft ICOC for Outer Space Activities* (Rajeswari Pillai Rajagopalan and Daniel A. Porras eds., 2014), OBSERVER RESEARCH FOUNDATION, available at http://orfonline.org/cms/export/orfonline/modules/report/attachments/AwaitingLaunch_1397728623369.pdf; Sergey Oznobishchev, *Codes of Conduct for Outer Space*, in *OUTER SPACE: WEAPONS, DIPLOMACY, AND SECURITY*, *supra* note 3, at 68, 71-76 (providing a Russian perspective on the EU Code); Gregory L. Schulte & Audrey M. Schaffer, *Enhancing Security by Promoting Responsible Behavior in Space*, 6 STRATEGIC STUD. Q., Spring 2012, at 9, 9-17 (describing several approaches, including the EU Code, for developing non-legally-binding norms for space); Grego, *supra* note 70, at 14 (describing proposed EU Code as "a good starting point" and "a modest step forward"); Hitchens, *supra* note 61, at 5-6; Meyer, *supra* note 4; Dylan Rebstock, *A Revised and Stronger International Code of Conduct for Space*, STIMSON CTR. (Nov. 5, 2013), <http://www.stimson.org/summaries/a-revised-and-stronger-international-code-of-conduct-for-space/> (comparing the September 16, 2013 draft of the code to the June 5, 2012 version); Jana Robinson, *Advancing an International Space Code of Conduct*, E-INTERNATIONAL RELATIONS (July 13, 2012), <http://www.e-ir.info/2012/07/13/transparency-and-confidence-building-measures-as-practical-tools-for-advancing-an-international-space-code-of-conduct/>.

⁷⁶ Letter from Senators to Hillary Clinton, U.S. Sec'y of State (Feb. 2, 2011) (on file with author) (expressing deep concern about the EU Code of Conduct);

John R. Bolton & John C. Yoo, *Hands Off the Heavens*, N.Y. TIMES, Mar. 8, 2012, http://www.nytimes.com/2012/03/09/opinion/hands-off-the-heavens.html?_r=0; Omri Ceren, *Obama's New Anti-Satellite Weapons Push to Cede Space to the Chinese?*, COMMENTARY (Jan. 28, 2011, 4:12 PM), <http://www.commentarymagazine.com/2011/01/28/obamas-new-anti-satellite-weapons-push-to-cede-space-to-the-chinese>; Peter B. de Selding, *Europe Changes Tactics in Push for Space Code of Conduct*, SPACE NEWS (Apr. 24, 2013), <http://www.spacenews.com/article/military-space/35033europe-changes-tactics-in-push-for-space-code-of-conduct>; Sydney J. Freedberg Jr., *Safe Passage: Why the Pentagon Wants an International "Code of Conduct" for Space*, BREAKINGDEFENSE.COM (Mar. 22, 2012), <http://breakingdefense.com/2012/03/22/safe-passage-why-the-pentagon-wants-an-international-code-of-c>; Michael Krepon, *Weak Arguments Against a Space Code of Conduct*, STIMSON CTR. (Jan. 17, 2012), <http://www.stimson.org/spotlight/space-code-of-conduct-advances/> (rebutting the opposition to a space code); John R. Jeff Kueter & John B. Sheldon, *An Investment Strategy for National Security Space*, HERITAGE FOUND., Feb. 20, 2013, at 10, available at <http://www.heritage.org/research/reports/2013/02/an-investment-strategy-for-national-security-space> (arguing that the EU Code of Conduct "is not in the interests of the United States and can leave U.S. national security space capabilities needlessly vulnerable"); Eli Lake, U.S., *EU Eye Anti-Satellite Weapons Pact*, WASH. TIMES, Jan. 27, 2011, <http://www.washingtontimes.com/news/2011/jan/27/us-eu-eye-anti-satellite-weapons-pact/?page=all>; Michael J. Listner, *Geopolitical Challenges to Implementing the Code of Conduct for Outer Space Activities*, E-INTERNATIONAL RELATIONS (June 26, 2012), www.e-ir.info/2012/06/26/geopolitical-challenges-to-implementing-the-code-of-conduct-for-outer-space-activities.

A new multilateral treaty on ASATs and other military activity related to space would certainly be difficult to negotiate, even under the best of circumstances. Complex issues regarding the specific definition of the to-be-prohibited objects and activities,⁷⁷ the mechanisms for verification of compliance with the new obligations,⁷⁸ the overlap between ASAT and missile defense programs,⁷⁹ and the relationships with states that do not join the treaty⁸⁰ could all be show-stoppers.

Even more importantly, leading space actors have been ambivalent about the desirability of limiting ASATs—or, at least, a blocking minority clings to the view that the weaponization of outer space is inevitable (because all other domains have seen human conflict, and space may be especially prized by various

ir.info/2012/06/26/geopolitical-challenges-to-implementing-the-code-of-conduct-for-outer-space-activities; Rose, *Addressing the Challenges*, *supra* note 72.

⁷⁷ The definition of an “ASAT” or a “space weapon” for purposes of a treaty would be complex, because any system (including even the Space Shuttle) that is capable of closely approaching and docking with another space object would simultaneously be capable of attacking it. Differentiating between benign and hostile actions – especially to regulate the testing of those capabilities – would therefore be difficult. Arbatov, *supra* note 73, at 86-93; HARRISON, *supra* note 67, at 6; Ross Liemer & Christopher F. Chyba, *A Verifiable Limited Test Ban for Anti-satellite Weapons*, 33 WASH. Q., no. 3, July 2010, at 149, 153-54; Weeden, *supra* note 33, at 42; Richard L. Garwin, *Taming Antisatellite and Space Weapons*, BULL. OF THE ATOMIC SCIENTISTS (May 29, 2007), <http://thebulletin.org/taming-antisatellite-and-space-weapons>; Joan Johnson-Freese, *China's Anti-Satellite Program: They're Learning*, CHINA FOCUS (July 12, 2013) [hereinafter Johnson-Freese, *Learning*], <http://www.chinausfocus.com/peace-security/chinas-anti-satellite-program-theyre-learning> (highlighting the difficulty in defining what constitutes an ASAT weapon); Krepon, *supra* note 76; Mahley, *supra* note 67, at 7.

⁷⁸ Richard A. Bruneau & Scott G. Lofquist-Morgan, *Verification Models for Space Weapons Treaties: A Flexible, Layered Approach as a Negotiating Tool*, in U.N. INST. FOR DISARMAMENT RESEARCH, BUILDING THE ARCHITECTURE FOR SUSTAINABLE SPACE SECURITY: CONFERENCE REPORT 73 (2006); William J. Durch, *Verification of Limitations on Antisatellite Weapons*, in VERIFICATION AND ARMS CONTROL 81-106 (William C. Potter ed., 1985); DAVID FINKLEMAN, EISENHOWER CTR. FOR SPACE & DEF. STUDIES, 2 SPACE AND VERIFICATION: TECHNICAL ASSESSMENT (2011); GALLAGHER & STEINBRUNER, *supra* note 6, at 79; Richard L. Garwin, *ASAT Treaty Verification*, in ARMS CONTROL VERIFICATION: THE TECHNOLOGIES THAT MAKE IT POSSIBLE 208 (Kosta Tsipis, David W. Hafemeister & Penny Janeway eds., 1986); HARRISON, *supra* note 67; Liemer & Chyba, *supra* note 77, at 153-54.

⁷⁹ See *infra* text accompanying note 182.

⁸⁰ To be effective in securing outer space, a treaty would require the participation of all the major spacefaring states, but in current political circumstances, several of them may be unwilling to participate.

militaries as the ultimate "high ground")⁸¹ and perhaps even desirable (because a high-tech arms race in space is a winnable contest).⁸² In the United States, for example, there is considerable sympathy for the view that we should develop and deploy a range of ASAT capabilities, in order to deter other countries from threatening or attacking our satellites, and to defeat an enemy's potential exploitation of its space assets in a war against us.⁸³ Some of this hawkish ambition was associated with the George W. Bush Administration,⁸⁴ but the predecessor Bill Clinton Administration

⁸¹ GALLAGHER & STEINBRUNER, *supra* note 6, at 24-25 (quoting U.S. military officials who assert that war in space is inevitable and that a competitive "gold rush" is already under way in space); Hays, *supra* note 2, at 177 (referring to "inevitable weaponizers"); LYALL & LARSEN, *supra* note 2, at 499; Rumsfeld Commission, *supra* note 13, at 10.

⁸² GALLAGHER & STEINBRUNER, *supra* note 6, at 25 (pointing out how U.S. military publications assert that the United States could maintain "full spectrum dominance" in space); Hays, *supra* note 2, at 176-77 (referring to "space hawks"). See HARRISON, *supra* note 67, at 12, n.19 (describing the internal divisions of the U.S. government on space weaponization by citing the comments of the negotiator for a previous arms control treaty who commented: "It was, and remains, difficult to find common ground between those who believe that, in general, the national security of the United States would be strengthened if no limits were placed on the weapons it could have, even if that would mean that there would be no limits on the same type of Soviet (or some other adversaries) weapons, and those who believe that the national security of the United States would be strengthened if limits were placed on the Soviet (or some other adversaries) weapon systems, even if that would mean limits on the same type of U.S. system"); Paul Oh, *Assessing Chinese Intentions for the Military Use of the Space Domain*, 64 JOINT FORCE Q., no. 1, 2012, at 91 (suggesting that the government of China may similarly be divided concerning militarization of space).

⁸³ See Everett C. Dolman & Henry F. Cooper, Jr., *Increasing the Military Uses of Space*, in TOWARD A THEORY OF SPACEPOWER: SELECTED ESSAYS 97 (Charles D. Lutes & Peter L. Hays eds., 2011); GALLAGHER & STEINBRUNER, *supra* note 6 (presenting and critiquing perspectives on militarization of space); Elizabeth S. Waldrop, *Weaponization of Outer Space: US National Policy*, 29 ANNALS OF AIR & SPACE L. 329, 331-36 (2004) (explaining the "weaponization" of space); Butt, *supra* note 19 (explaining the need for improved space security); Kueter & Sheldon, *supra* note 76 (discussing potential investments in national space security); Baker Spring, *Slipping the Surly Bonds of the Real World: The Unworkable Effort to Prevent the Weaponization of Space*, Heritage Foundation Lectures No. 877 (Apr. 14, 2005), available at <http://www.heritage.org/research/lecture/slipping-the-surly-bonds-of-the-real-world-the-unworkable-effort-to-prevent-the-weaponization-of-space> (lecturing on "weaponization of space").

⁸⁴ Christine Rocca, U.S. Permanent Rep. to the CD, Statement to the Conference on Disarmament, Prevention of an Arms Race in Outer Space (Feb. 13, 2007) (presenting the Bush Administration perspective that there is no need for additional measures of arms control in outer space because there is currently no arms race under way there); Jeremy Singer & Colin Clark, *China's Anti-Satellite*

and successor Barack Obama Administration were little more sympathetic to (or little more vigorous in pursuit of) the concept of arms control in space.⁸⁵

An important modern feature of the international dialog about space weapons policy is the expanding cast of relevant players. As more countries have joined the roster of participants, the task of securing consensus about ASAT restrictions only becomes more complex. The United States, Russia, China, France, the European Union, Japan, Israel, and India remain the predominant space actors, but several other states are increasingly engaged, too. As

Test Widely Criticized, U.S. Says No New Treaties Needed, SPACE.COM (Jan. 19, 2007), <http://www.space.com/3370-chinas-anti-satellite-test-widely-criticized-treaties-needed.html> (quoting Bush Administration official saying “[a]rms control is not a viable solution for space”); *U.S. National Space Policy*, NAT’L SPACE SOC’Y (Aug. 31, 2006), www.nss.org/resources/library/spacepolicy/2006NationalSpacePolicy.htm (stating that “The United States will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space.”). See also GALLAGHER & STEINBRUNER, *supra* note 6, at 24-26 (summarizing U.S. military publications favoring U.S. control of space); Carl Kaysen & Paul K. MacDonald, *Foreword*, in GALLAGHER & STEINBRUNER, *supra* note 6, at v (commenting that “a policy of national military space domination prevails within the U.S. government at the moment [2008]”); Grego, *supra* note 70, at 8, 13.

⁸⁵ DoD Directive 3100.10, *supra* note 8, at § 4j(5) (stating that U.S. space control plans and activities will maintain capability to deter and, if necessary, defeat efforts to interfere with U.S. space capabilities); Todd Barnet, *United States National Space Policy, 2006 & 2010*, 23 FLA. J. INT’L L. 277 (2011) (comparing Bush and Obama Administrations space policies); NATIONAL SECURITY SPACE STRATEGY, *supra* note 1, at 5 (stating that the United States “will consider proposals and concepts for arms control measures,” but not suggesting that the Obama Administration will exercise leadership in initiating efforts in this area); NATIONAL SPACE POLICY, *supra* note 47, at 7 (stating Obama Administration U.S. policy to pursue transparency and confidence-building measures for space and to consider proposals and concepts for arms control, but also to maintain the capabilities to execute “space control, and force application missions”); Grego, *supra* note 70, at 14 (characterizing the Obama space policy as indicating “greater openness” to diplomatic initiatives in space, but not as suggesting that the United States will exercise “an active leadership role in drafting and submitting proposals”). See also NATIONAL SPACE POLICY, *supra* note 47, at 13-14 (describing the Clinton Administration policy that the United States will consider and formulate policy positions on arms control in space and will conclude agreements if they are equitable, effectively verifiable, and enhance U.S. security); Andrea Shalal-Esa, *Pentagon Cites New Drive to Develop Anti-Satellite Weapons*, REUTERS (May 7, 2013), <http://www.reuters.com/article/2013/05/07/us-pentagon-satellites-idUSBRE94614E20130507> (quoting Deputy Secretary of Defense Ashton Carter saying that the U.S. military has launched a “‘long overdue’ effort” to counter the space capabilities of rival states and to deny them the use of space assets against U.S. forces in combat).

many as sixty states now have a presence in space, promoting their interests in ways that further disrupt the prospects for easy new space arms control agreements.⁸⁶

Overall, the point is that military activities in space remain largely unregulated. The world beyond air is not a world beyond law, but to a distressing extent, countries have legally obligated themselves only to refrain from the particular weapons behaviors that they did not want to—or did not have the capacity to—undertake anyway. Space is certainly not as “weaponized” as the land, sea or air domains, but the shared commitment to reserve space for “peaceful purposes” is fragile,⁸⁷ and the legal safeguards against regrettable movement in the opposite direction are still sparse and underdeveloped.

2. NTM SATELLITES

It is difficult to be very precise and detailed about National Technical Means of verification; this is a topic traditionally shrouded in intense secrecy. Indeed, although the United States had launched its first military observation satellites in 1959, as part of the famous Corona program,⁸⁸ (as soon as the relevant

⁸⁶ Miles, *supra* note 10 (reporting that sixty states are now considered “space-faring”); News Briefing with Dep. Sec’y of Defense William Lynn & Dep. Assistant Sec’y of Defense Gregory Schulte (Feb. 4, 2011), *available at* <http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4765> (noting that eleven countries can launch objects into space, and “space is no longer sort of the preserve of the U.S. and the Soviet Union at the time from which we can operate with impunity.”).

⁸⁷ OST, *supra* note 50, at art. IV (limiting certain military uses of space). The United States has traditionally defined “peaceful” as meaning “non-aggressive” in character; several other states have asserted that “peaceful” carries a stronger meaning, closer to “non-military,” and would restrict more defense-related activities in space. Kasku-Jackson & Waldrop, *supra* note 49, at 66-67; LYALL & LARSEN, *supra* note 2, at 510-25; Andrew T. Park, *Incremental Steps for Achieving Space Security: The Need for a New Way of Thinking to Enhance the Legal Regime for Space*, 28 HOUS. J. INT’L L. 871, 883-84 (2006) (noting the ambiguity that has led to military use being considered “peaceful” in most circumstances); Waldrop, *supra* note 83, at 338-39 (discussing the differing definitions of “peaceful” in regards to the limits on space use).

⁸⁸ David Christopher Arnold, *Space and Intelligence*, in SPACE AND DEFENSE POLICY, *supra* note 2, at 202, 216 (tracking the milestones of the “CORONA program”); WILLIAM E. BURROWS, DEEP BLACK: SPACE ESPIONAGE AND NATIONAL SECURITY 132-42, 151-52 (1986) (analyzing the history of space reconnaissance); John Lewis Gaddis, *The Evolution of a Reconnaissance Satellite Regime*, in U.S.-SOVIET SECURITY COOPERATION: ACHIEVEMENTS, FAILURES, LESSONS 353, 353-73 (Alexander

technology became available), it was only in 1979 that the United States finally (and despite considerable controversy) declassified the sheer fact that arms control treaty verification relied in part upon satellite photoreconnaissance.⁸⁹

L. George, Philip J. Farley, & Alexander Dallin eds., 1988) (analyzing the change in the U.S.-Soviet acceptance of reconnaissance); Hays, *Space and Sino-American*, *supra* note 3, at 19; Jasani, *supra* note 46, at 29; GERALD M. STEINBERG, *SATELLITE RECONNAISSANCE: THE ROLE OF INFORMAL BARGAINING* 23-26, 39-48 (1983) (describing the history of reconnaissance and the acceptance thereof). *See also* INGARD CLAUSEN & EDWARD A. MILLER, CTR. FOR THE STUDY OF NAT'L RECONNAISSANCE, *INTELLIGENCE REVOLUTION 1960: RETRIEVING THE CORONA IMAGERY THAT HELPED WIN THE COLD WAR* (2012), available at http://www.nro.gov/history/csnr/corona/Intel_Revolution_Web.pdf; GALLAGHER & STEINBRUNER, *supra* note 6, at 7 (citing a 1950 RAND study of the concept of reconnaissance from space, long before the advent of the first satellites); STEINBERG, *supra*, at 26-29, 51-56 (discussing early Soviet responses); Jos Heyman, *Intel: Early U.S. Recon Satellites*, MILSAT MAG., Oct. 2011, at 32, available at http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=1728840 346; Grego, *supra* note 70, at 2, n.2 (noting failed 1962 diplomatic efforts by the Soviet Union to oppose satellite reconnaissance). The program of satellite overflight complemented the prior programs using aircraft (such as the famous U-2) to conduct reconnaissance. Satellites were less vulnerable to interception from ground defenses, more politically acceptable to the U.S.S.R., and more consistent with international law. BRUCE BERKOWITZ, CTR. FOR THE STUDY OF NAT'L RECONNAISSANCE, *THE NATIONAL RECONNAISSANCE OFFICE AT 50 YEARS: A BRIEF HISTORY* 16 (2011), available at http://www.nro.gov/history/csnr/programs/NRO_Brief_History.pdf (recounting the history and purpose of the National Reconnaissance Office); THOMAS GRAHAM JR., *DISARMAMENT SKETCHES: THREE DECADES OF ARMS CONTROL AND INTERNATIONAL LAW* 37, 58-59 (2002) (describing reliance upon satellite photoreconnaissance in early SALT negotiations, even though the fact of their use was classified); Robert A. McDonald & Patrick Widlake, *Looking Closer and Looking Broader: Gambit and Hexagon - The Peak of Film Return Space Reconnaissance After Corona*, NAT'L RECONNAISSANCE J. OF THE DISCIPLINE & PRAC., Spring 2012, at 39, 39-40, available at http://www.nro.gov/history/csnr/articles/docs/gh%20journal_web.pdf (noting the brief timeline leading up to the initiation of the space programs). At the same time, the U.S.S.R. undertook a comparable development program for its own series of increasingly sophisticated photoreconnaissance satellites. Valery Babintsev, *The Peaceful and Military Development of Space: A Historical Perspective*, in *OUTER SPACE: WEAPONS, DIPLOMACY, AND SECURITY*, *supra* note 3, at 16, 22-23; BURROWS, *supra*, at 252-72; Asa Bates, Jr., *National Technical Means of Verification*, 123 ROYAL UNITED SERVICES INST. J., No. 2, June 1978, at 64 (describing early Soviet NTM satellites); Jos Heyman, *The Photo Reconnaissance Satellites of the USSR/Russia*, MILSAT MAG., Oct. 2012, at 48, available at http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=30747315&method=print (documenting the Soviet Union's satellites).

⁸⁹ BERKOWITZ, *supra* note 88, at 16 (observing that changes in arms control led to changed opinions about reconnaissance); Stuart A. Cohen, *The Evolution of Soviet Views on SALT Verification: Implications for the Future*, in *VERIFICATION AND SALT: THE CHALLENGE OF STRATEGIC DECEPTION* 49, 54-56 (William C. Potter ed.,

Broadly, the term "NTM" is understood to refer to a wide array of mechanical apparatus (in contrast to "human sources," such as diplomats and spies⁹⁰) that are under the sole control of a single country⁹¹ and that do not depend (very much) upon the sufferance or cooperation of the monitored country (in contrast to on-site inspection, where the host state must provide considerable toleration and support⁹²). NTM constitute the "crown jewels" of arms control treaty verification—uniquely powerful, reliable, and independent.⁹³ Verification, in turn, is widely regarded as critical

1980) (discussing the acknowledgment of satellite programs); GRAHAM, *supra* note 88, at 82-83 (recounting anecdote from SALT II negotiations, revealing that neither United States nor Soviet Union wanted to define or even to discuss NTM); *How Satellites May Help to Sell SALT*, U.S. NEWS & WORLD REPORT, May 21, 1979, at 25 (revealing satellite reconnaissance programs as the Senate evaluated the SALT II Treaty); Memorandum for Mr. John P. Snow, Comments on Draft Report of 156 Committee (Nov. 5, 1971), available at <http://www.nro.gov/foia/declass/NROStaffRecords/692.PDF> (detailing selected functions of the National Reconnaissance Office); Memorandum from Robert A. Rosenberg to Zbigniew Brzezinski on "Guidance on Public Queries Related to Declassification of the 'Fact of' Photoreconnaissance Satellites" (Sept. 18, 1978), available at <http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB231/doc29.pdf> (discussing the advisability of declassifying satellite operations). See also 1996 *National Space Policy*, *supra* note 47, at 7 (listing specific facts about U.S. satellite photoreconnaissance and related activities that are unclassified).

⁹⁰ Alan S. Krass, *Arms Control Treaty Verification*, in *ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT* 297, 305-06 (Richard Dean Burns ed., 1993) (discussing different tools and techniques for treaty verification); RICHELSON, *supra* note 24, at 292-320 (explaining that Human Intelligence includes information derived from spies, diplomats, defectors, travelers, and others).

⁹¹ See *infra* text accompanying notes 112-113 concerning intelligence-collection assets that are jointly operated by multiple countries - multilateral technical means (MTM).

⁹² Several arms control treaties supplement the activities of NTM by including carefully-negotiated provisions pursuant to which inspectors from another state or from an international organization are empowered to conduct on-site inspections, to resolve ambiguities and assess a party's compliance with the treaty. See, e.g., Comprehensive Nuclear Test Ban Treaty, art. IV, Protocol Part II, Sept. 24, 1996, S. TREATY DOC. NO. 105-28 (1997) 35 I.L.M. 1439 [hereinafter CTBT]; Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction, art. IX, Verification Annex, IV(A).D, Jan. 13, 1993 [hereinafter CWC], available at <http://www.opcw.org/chemical-weapons-convention>. See generally Krass, *supra* note 90, at 306-09 (noting the increase in cooperative verification); James A. Schear, *Cooperative Measures of Verification: How Necessary? How Effective?* in *VERIFICATION AND ARMS CONTROL* 7-35 (William C. Potter ed., 1985).

⁹³ Amy F. Woolf, CONG. RESEARCH SERV., R41201, *MONITORING AND VERIFICATION IN ARMS CONTROL* 4, 10, 13 (2011) (describing the diversity of NTM programs, identifying NTM as providing the "bulk of the information" necessary

for effective and politically sustainable arms control—so NTM have become indispensable tools of the trade.⁹⁴

The appropriate types of NTM vary considerably from treaty to treaty, depending upon what objects and activities are regulated or banned by the agreement and are therefore subject to close monitoring by the parties. The 1996 Comprehensive Test Ban Treaty (CTBT),⁹⁵ for example, intends to prohibit nuclear weapon tests; to verify compliance with it, parties rely upon a vast array of 321 terrestrial seismometers, hydroacoustic sensors, infrasound detectors, and radionuclide samplers, as well as satellite-borne monitoring and communications capabilities.⁹⁶ The 2010 New

to monitor arms control treaties, and stating that both the United States and the Soviet Union/Russia “rely on NTM as the foundation of their verification regimes”); Krass, *supra* note 90, at 301-05 (describing the U.S. NTM); Christopher E. Paine, Thomas B. Cochran & Robert S. Norris, *Techniques and Procedures for Verifying Nuclear Weapons Elimination*, in CANBERRA COMMISSION ON THE ELIMINATION OF NUCLEAR WEAPONS, BACKGROUND PAPERS 167, 168-69 (1996) (on file with author) (identifying a variety of satellite-based and other NTM platforms); Thomas Graham, *International Law and the Military Uses of Space*, DISARMAMENT DIPLOMACY, no. 63, Mar.-Apr. 2002, available at <http://www.acronym.org.uk/dd/dd63/63op1.htm> (noting that without space-based NTM, effective verification of arms control treaties would be virtually impossible).

⁹⁴ Woolf, *supra* note 93; *Arms Control Verification*, DEF. THREAT REDUCTION AGENCY, <http://www.dtra.mil/missions/ArmsControlVerification/ArmsControlVerificationHome.aspx> (last visited Oct. 30, 2013) (describing the role of verification in arms control); *Verification of Nuclear Arms Control and Disarmament Treaties*, NUCLEAR FILES.ORG, <http://www.nuclearfiles.org/menu/key-issues/nuclear-weapons/issues/arms-control-disarmament/verification/index.htm> (last visited Oct. 30, 2013) (analyzing verification and its importance).

⁹⁵ CTBT, *supra* note 92.

⁹⁶ Regarding the four designated CTBT verification technologies, see *Verification Regime*, PREPARATORY COMM’N FOR THE COMPREHENSIVE NUCLEAR-TEST BAN TREATY ORG., <http://www.ctbto.org/verification-regime/> (last visited Oct. 31, 2013) [hereinafter CBTO Verification Regime]; regarding the satellite communications mechanisms—operating through a network of six satellites in geosynchronous orbits and three alternative satellites to serve particularly remote locations—designed to feed data from the worldwide detection stations to the International Data Center in Vienna, and from there to each of the treaty parties, see *Verification Regime*, GLOBAL COMM. INFRASTRUCTURE, <http://www.ctbto.org/verification-regime/the-global-communications-infrastructure/> (last visited Oct. 31, 2013). See generally COMM. ON REVIEWING & UPDATING TECHNICAL ISSUES RELATED TO THE COMPREHENSIVE NUCLEAR TEST BAN TREATY, NAT’L RESEARCH COUNCIL, THE COMPREHENSIVE NUCLEAR TEST BAN TREATY – TECHNICAL ISSUES FOR THE UNITED STATES (2012) [hereinafter NRC, CTBT TECHNICAL ISSUES]; OLA DAHLMAN, JENIFER MACKBY, SVEIN MYKKELTVEIT & HEIN HAAK, DETECT AND DETER: CAN COUNTRIES VERIFY THE NUCLEAR TEST BAN (2011); Bhupendra Jasani, *Verification of a Comprehensive Test Ban Treaty from Space: A Preliminary Study* (U.N.

START Treaty,⁹⁷ in partial contrast, imposes limits on U.S. and Russian long-range nuclear weapons; photoreconnaissance satellites are a primary means for identifying and counting inter-continental ballistic missiles (ICBMs), nuclear submarines and other accountable objects.⁹⁸

Satellites form a critical component of NTM, performing two primary kinds of functions: monitoring and communications. Monitoring includes diverse operations such as imagery observation of the visual spectrum, the infrared, and other frequencies;⁹⁹ "signals intelligence" (SIGINT), which entails interception of electronic communications and other emanations;¹⁰⁰

Inst. for Disarmament Research, Research Paper No. 32, 1994). See also Jihye Park et. al., *Ionospheric Detection of the 25 May 2009 North Korean Underground Nuclear Test*, 38 GEOPHYSICAL RES. LETTERS, L22802, 2011, at 1 (describing how sensors on satellites detect evidence of previously clandestine nuclear explosion).

⁹⁷ Treaty Between the United States of America and the Russian Federation on Measures for the Further Reduction and Limitation of Strategic Offensive Arms, Apr. 8, 2010 [hereinafter New START Treaty]; Les Aspin, *The Verification of the SALT II Agreement*, 240 SCI. AM. 38 (1979) (describing the verification methods of the SALT II Treaty).

⁹⁸ See New START Treaty, *supra* note 97, at art. II (establishing numerical limits on each party's deployed and non-deployed ICBMs, SLBMs, and heavy bombers, and associated warheads); Bureau of Arms Control, Verification, & Compliance, *New START Treaty: Resolution of Advice and Consent to Ratification*, U.S. DEPT. OF STATE (Dec. 22, 2012), <http://www.state.gov/t/avc/rls/153910.htm> (referring to condition 2, which requires annual presidential certification that U.S. NTM and other verification mechanisms "are sufficient to ensure effective monitoring of Russian compliance" with the treaty); Bureau of Verification, Compliance, & Implementation, *Fact Sheet: Verification*, U.S. DEP'T. OF STATE (April 8, 2010), <http://www.state.gov/t/avc/rls/139906.htm> (noting measures of verification); *The Value of New START Verification*, 1 ARMS CONTROL ASSOC., no. 9, July 21, 2010, <http://www.armscontrol.org/issuebriefs/STARTVerification> (discussing the verification provisions of the New START Treaty).

⁹⁹ DAHLMAN ET. AL., *supra* note 96, at 75-77 (providing information on satellite-based monitoring); Harris, *supra* note 66, at 48-57; Shaïda Johnston, *Technical Introduction to Satellite EO*, in EVIDENCE FROM EARTH OBSERVATION SATELLITES, *supra* note 2, at 17-36; Krass, *supra* note 90, at 304-05 (explaining infrared monitoring devices); LYALL & LARSEN, *supra* note 2, at 411-14; David Hafemeister, *Science and Society Test IX: Technical Means of Verification*, 54 Am. J. Physics 693 (1986), available at http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1018&context=phy_fac (detailing different methods and means of monitoring).

¹⁰⁰ RICHELSON, *supra* note 24, at 203-39 (stating that SIGINT includes interception of communications and detection of electronic emanations from foreign military equipment; sequential generations of satellites - operating in low earth orbits, geosynchronous orbits, and highly elliptical orbits - are critical components for collecting this data).

and the use of other types of sensors such as advanced synthetic aperture radars and “bhangmeters” that collect the electromagnetic radiation released by an atmospheric or outer space nuclear weapon detonation.¹⁰¹ Satellite NTM communications operations include the swift, reliable conveyance of reams of authenticated data. For example, under the CTBT, disparate technical information streams from the treaty’s worldwide array of sensors are reported in near real time to a centralized data analysis headquarters in Vienna, Austria. The organization then conveys that data, again via satellites, to interested parties.¹⁰²

The United States is by far the global leader in NTM satellites of heterogeneous sorts, having deployed increasingly sophisticated generations of orbiting platforms,¹⁰³ but other countries now also engage in an increasing array of space-enabled data collection and dissemination operations.

Some states are understandably reluctant to rely upon an exclusively made-in-America treaty verification capability, and have accordingly invested in independent sources of compliance data.¹⁰⁴

¹⁰¹ DAHLMAN ET. AL., *supra* note 96, at 108-10 (detailing the development and improvement of nuclear explosions monitoring equipment over time); RICHELSON, *supra* note 24, at 241-47; William C. Priedhorsky, *Eyes in Space: Sensors for Treaty Verification and Basic Research*, 28 LOS ALAMOS SCI. 152, 153 (2003) (describing U.S. space-based systems for detecting nuclear detonations); Jasani, *supra* note 96, at 6 (suggesting that Russia may have deployed similar sensors on its satellites).

¹⁰² CBTO Verification Regime, *supra* note 96.

¹⁰³ Jasani, *supra* note 46, at 21, 29-31; Krass, *supra* note 90, at 305 (discussing how numerous countries have or are developing satellite imaging capability).

¹⁰⁴ GALLAGHER & STEINBRUNER, *supra* note 6, at 23, n.59 (reporting that France and Israel recently deployed independent reconnaissance satellites “in large part because they could not count on receiving imagery from the United States and felt that access to information had been used to manipulate their security policies.”); Jasani, *supra* note 46, at 21, 24; W.E. STONEY, ASPRS GUIDE TO LAND IMAGING SATELLITES (2008), available at http://www.asprs.org/a/news/satellites/ASPRS_DATABASE_021208.pdf (providing a roster of optical and radar satellites, by country, swath, and best resolution); Jana Honkova, *The Russian Federation’s Approach to Military Space and Its Military Space Capabilities*, GEORGE C. MARSHALL INST. POL’Y OUTLOOK, Nov. 2013, at 1, available at <http://marshall.org/wp-content/uploads/2013/11/Russian-Space-Nov-13.pdf>; George Jahn, *UN Nuke Agency’s Iran Probe Driven by US-Led Intel*, WORLD POST, May 24, 2013, http://www.huffingtonpost.com/2013/05/24/un-nuke-agency-iran_n_3331090.html (reporting resistance from many countries to the International Atomic Energy Agency’s heavy reliance upon U.S. intelligence, noting that “[m]uch of the world looks at U.S. intelligence on weapons development with a suspicious eye”); *Russia to Launch New Spy Satellite in June*, SPACE WAR, June 4, 2013,

Promoting this dissemination of reconnaissance assets is the fact that for some purposes, even less than state-of-the-art capabilities may be useful. That is, even relatively inexact images or imprecise data can contribute to treaty monitoring, by providing a state a basis for challenging or complementing another treaty party's claims or intelligence assessments, and perhaps triggering additional verification functions.¹⁰⁵

Moreover, the technology in this area both advances and spreads rapidly. By one count, in 2008, there were thirty-five separate commercial imaging satellite systems in orbit from seventeen countries, and many more were anticipated.¹⁰⁶ Another tally recorded 130 earth observation satellites operated by thirty-three countries in 2009.¹⁰⁷ The level of ground resolution capability attained by satellite photoreconnaissance (a measure of how small an object on the surface of the earth can be discerned from space) has dramatically improved.¹⁰⁸ Details that could have been detected only by top-secret U.S. government assets only a few years ago are now accessible to satellites from many more

http://www.spacewar.com/reports/Russia_to_Launch_New_Spy_Satellite_in_June_999.html (reporting that Russia operates a network of 60-70 military reconnaissance satellites, using updated imaging technology and electro-optical systems). See also Kueter & Sheldon, *supra* note 76, at 16 (noting how national security space systems are used for earth imaging or communications by several countries, and how other countries are likely to pursue similar programs); Cerise (Satellite), WIKIPEDIA, [http://en.wikipedia.org/wiki/Cerise_\(satellite\)](http://en.wikipedia.org/wiki/Cerise_(satellite)) (last updated Jan. 15, 2014) (listing reconnaissance satellites of nine countries).

¹⁰⁵ For example, under the CTBT, *supra* note 92, evidence from NTM may be used to support a request for on-site inspection and to assist in assessing a party's compliance. CTBT, *supra* note 92, at art. IV.D.37. See also Mort Canty et al., *Treaty Monitoring*, in REMOTE SENSING FROM SPACE: SUPPORTING INTERNATIONAL PEACE AND SECURITY 167, 185 (Bhupendra Jasani, Martino Pesaresi, Stefan Schneiderbauer & Gunter Zeug eds., 2009).

¹⁰⁶ Pabian, *supra* note 7, at 226. See also STONEY, *supra* note 104 (listing optical and radar satellites and their best resolutions); Space Security Index 2012, *supra* note 2, at 122-25 (surveying remote sensing capabilities of several countries).

¹⁰⁷ Hitchens, *Saving Space*, *supra* note 12, at 6.

¹⁰⁸ CANTY ET AL., *supra* note 105, at 167-88; DAHLMAN ET AL., *supra* note 96, at 196-97; EUR. SPACE POLICY INST., *supra* note 2, at 6 (charting "the state of the art in earth observation"); Hays, *supra* note 2, at 180-84; Jasani, *supra* note 46, at 21, 31; LYALL & LARSEN, *supra* note 2, at 413-14; Irmgard Niemeyer, *Perspectives of Satellite Imagery Analysis for Verifying the Nuclear Non-Proliferation Treaty*, in INTERNATIONAL SAFEGUARDS AND SATELLITE IMAGERY, *supra* note 46, at 35, 36-39; Pabian, *supra* note 7, at 225-26; RICHELSON, *supra* note 24, at 169-87; WRIGHT, GREGO & GRONLUND, *supra* note 16, at 169-71.

countries, and to commercial operators, as well.¹⁰⁹ According to published reports, early images from the U.S. Landsat system could discern objects only at the level of thirty to seventy-nine meters; today, the GeoEye sensor can collect data as small as 0.41 meters.¹¹⁰ Chinese satellites, too, may soon be capable of sub-meter ground resolution capabilities.¹¹¹

It is therefore easy to predict that reliance upon multiple NTM satellite platforms will increase in the future—more countries will orbit more satellites to perform more verification functions pursuant to more arms control and national security treaties. In addition, at least as a cost-sharing measure, multinational consortia are likely to grow, empowering additional joint participation.¹¹²

¹⁰⁹ CANTY ET AL., *supra* note 105, at 167-88; EVIDENCE FROM EARTH OBSERVATION SATELLITES, *supra* note 2, at xxx (observing that “commercialization and privatization extended to the entire remote sensing operation, from building and launching satellites to marketing and selling the data”); JASANI, *supra* note 46, at 21, 31; BHUPENDRA JASANI, INTERNATIONAL SATELLITE MONITORING AGENCY – HAS THE TIME COME FOR ITS ESTABLISHMENT? 4-5 (2003), *available at* http://esarda2.jrc.it/db_proceeding/mfile/P_2003_Como_2-10-jasani-040130.pdf (listing resolution capabilities of optical satellites from several countries, some of which are commercially available); NIEMEYER, *supra* note 108, at 36-39; PABIAN, *supra* note 7, at 227; JEFFREY T. RICHELSON, COMMERCIAL SATELLITE IMAGERY AND NATIONAL SECURITY (2012), *available at* <http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB404/>; STONEY, *supra* note 104; WRIGHT, GREGO & GRONLUND, *supra* note 16, at 169-71; U.S. ARMS CONTROL & DISARMAMENT AGENCY, INTELLIGENCE NOTE, HIGH-RESOLUTION IMAGERY AND OPEN-SOURCE INFORMATION: IMPLICATIONS FOR ARMS CONTROL (1996), *available at* <http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB404/docs/13.pdf> (anticipating the advent of widely-available high-resolution satellite imagery, which might affect verification of arms control agreements); DAVID SAMUELS, *The Watchers*, WIRED (June 19, 2013), <http://www.wired.com/wiredscience/2013/06/startup-skybox>.

¹¹⁰ Harris, *supra* note 66, at 50; PABIAN, *supra* note 7, at 225-26 (listing high resolution commercial satellites from several countries); *Satellite Tasking*, DIGITAL GLOBE, <http://www.digitalglobe.com/products/data/select-tasking#features-benefits> (last visited Oct. 30, 2013). *See also* Peter B. de Selding, *Satellite Imagery Firms in U.S. and Europe Pushing for Permission to Sell Sharper Imagery*, SPACE NEWS (Sept. 16, 2013), <http://www.spacenews.com/article/military-space/37204satellite-imagery-firms-in-us-and-europe-pushing-for-permission-to-sell> (noting that private geospatial imagery providers are seeking authorization to offer products revealing even better ground resolution).

¹¹¹ Peter B. de Selding, *China's Satellite Imagery Capabilities Coming into Sharper Focus*, SPACE NEWS (Sept. 16, 2013), <http://www.spacenews.com/article/civil-space/37220china%E2%80%99s-satellite-imagery-capabilities-coming-into-sharper-focus>.

¹¹² Eur. Comm'n, *Towards a More Competitive and Efficient Defence and Security Sector: A New Deal for European Defence*, § 6.3, COM (2013) 542 final (July 24, 2013), *available at* <http://ec.europa.eu/enterprise/sectors/defence/files/>

The concept of an International Satellite Monitoring Agency¹¹³—a hardy perennial in the disarmament literature—may be revived, offering the potential for further collaboration in space verification operations, via MTM (multilateral technical means), as well as individual states' NTM.

An important associated recent development has been an increased reliance upon multi-function and privately-owned satellites for monitoring purposes, expanding the concept of NTM satellites in two ways. First, many defense-related satellites perform multiple types of operations simultaneously. GPS

communication_defence_en.pdf (calling for new forms of collaboration among Member States to build an EU satellite high resolution capability); DoD Directive 3100.10, *supra* note 8, § 4f (stating that U.S. Department of Defense "will seek to expand space-related cooperation with international partners"); AL-EKABI, *supra* note 3, at 61 (noting collaboration between five European countries on commercial satellite services to support European Defense Agency); RICHELSON, *supra* note 24, at 347-72 (describing U.S. intelligence cooperation with foreign services, including use of space assets); Media Note, U.S.-Japan, Joint Statement from the First Meeting of the Japan-U.S. Comprehensive Dialogue on Space (Mar. 11, 2013), available at http://www.state.gov/r/pa/prs/ps/2013/03/205939.htm?keepThis=true&TB_iframe=true&height=600&width=960&caption=U.S.+Department+of+State+-+Highlights (noting cooperation in space situational awareness and in transparency and confidence-building measures between United States and Japan); Media Note, U.S.-India, U.S.-India Joint Fact Sheet: Cooperation in Space (June 24, 2013), available at <http://www.state.gov/r/pa/prs/ps/2013/06/211029.htm> (noting cooperation in earth observation and other fields); SPACE SECURITY INDEX 69-71 (2011) [hereinafter Space Security Index 2011], available at <http://www.spacesecurity.org/space.security.2011.revised.pdf> (noting increasing formalized cooperation in space among African states); Dean Cheng, *China's Military Role in Space*, STRATEGIC STUD. Q., Spring 2012, at 55, 63 (noting cooperation between China and Brazil in satellite imaging system); Peter B. de Selding, Chinese, *French Space Agencies Talk Collaboration*, SPACE NEWS (July 19, 2013), <http://www.spacenews.com/article/civil-space/36363chinese-french-space-agencies-talk-collaboration>; *French Seek Lock on Persian Gulf Satellite Deals*, UPI (Oct. 14, 2013), http://www.upi.com/Business_News/Security-Industry/2013/10/14/French-seek-lock-on-Persian-Gulf-satellite-deals/UPI-88361381767739/ (detailing the cooperation between France and Saudi Arabia, United Arab Emirates, and others); Tom Kington, *Italy to Market Satellite Data to Other Countries*, DEF. NEWS (Oct. 19, 2013), <http://www.defensenews.com/article/20131019/DEFREG/310190004/Italy-Market-Satellite-Data-Other-Countries> (reporting that Italy purchased a reconnaissance satellite from Israel and will sell imagery on the open market); Miles, *supra* note 5; Shelton, *supra* note 8 (reporting that U.S. Air Force Space Command leader warns that U.S. reliance upon satellites carries great advantages, but also vulnerabilities).

¹¹³ Dep't for Disarmament Affairs, *The Implications of Establishing an International Satellite Monitoring Agency: Report of the Secretary-General*, A/AC.206/14 (1983); CANTY ET AL., *supra* note 105, at 168; Jasani, *supra* note 46.

satellites, for example, not only provide reliable, precise location information to the plethora of military and civilian receivers, they also contribute to arms control verification by hosting sensors that measure the visible light, radio waves, x-rays and radiation emitted from a nuclear explosion.¹¹⁴ Likewise, other earth monitoring orbiters can simultaneously or episodically contribute data that are relevant both to the detection, identification, and enumeration of other states' military resources (fulfilling an NTM function) and to the civilian tasks of forecasting weather, facilitating commercial communications, assessing crop yields, mapping highways, and responding to natural disasters.¹¹⁵

Second, commercially-owned and -operated satellites can be hired or commandeered for security purposes, including as NTM, as the occasion demands.¹¹⁶ For example, early in the fighting of the Afghanistan war in 2001, the U.S. military entered the international commercial marketplace to purchase all the available satellite imagery of the theater of battle from all public sources –

¹¹⁴ AARON J. BELL, AIR FORCE INST. OF TECH., ANALYSIS OF GPS SATELLITE ALLOCATION FOR THE UNITED STATES NUCLEAR DETONATION DETECTION SYSTEM 9-14 (2002); DAHLMAN ET AL., *supra* note 96, at 108-09; Jasani, *supra* note 96, at 7; Shaida Johnston, *Technical Introduction to Satellite EO*, in EVIDENCE FROM EARTH OBSERVATION SATELLITES, *supra* note 2, at 11-13 (noting that "Many satellite systems have multiple sensors on the same satellite platform" and citing the example of the French SPOT system); RICHELSON, *supra* note 24, at 245; Paul R. Higbie & Norman K. Blocker, *The Nuclear Detonation Detection System on the GPS Satellites*, LOS ALAMOS NAT'L LAB. (Sept. 7, 1993), <http://www.osti.gov/bridge/servlets/purl/10185731-Uwbga3/10185731.pdf>.

¹¹⁵ AFRICAN OUTER SPACE ACTIVITIES, *supra* note 7, at 3 (discussing dual-use satellites for Africa); DAHLMAN ET AL., *supra* note 96, at 108-10; Jasani, *supra* note 96, at 7; Cheng, *supra* note 112, at 64 (describing Chinese satellites used for both civilian and military purposes); *India to Tap Satellites as Missile Sensors*, GLOBAL SEC. NEWswire (May 21, 2013) (stating that India will use geosynchronous satellites both to monitor other countries' missile developments, and to assist with meteorology and communications).

¹¹⁶ DEFENSE GROUP INC., INDEPENDENT STUDY OF THE ROLES OF COMMERCIAL REMOTE SENSING IN THE FUTURE NATIONAL SYSTEM FOR GEOSPATIAL-INTELLIGENCE (NSG): FINAL REPORT (2007) [hereinafter INDEPENDENT STUDY], *available at* <http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB404/docs/22.pdf>; U.S. Army, Concept Capability Plan: Space Operations 2015-2024, TRADOC Pamphlet 525-7-4, 54 (Nov. 15, 2006) (listing several commercial communications satellites as "enablers" of Army combat operations); Watts, *supra* note 5, at 5-6 (noting that during the heaviest fighting in Iraq in 2003, eighty-four percent of U.S. military communications were conveyed by commercial satellites); Hitchens, *Saving Space*, *supra* note 12, at 7 (noting that several states are building dual-use satellites to perform both civil and military functions).

partially to obtain products that would supplement the output of the U.S. government's own satellites, and partly to deny access to the enemy.¹¹⁷ As noted above, the emphatic policy of the U.S. government is to increase its exploitation of private satellites for the full array of public functions including security operations.¹¹⁸ Other states are also likely to realize the economic efficiency of turning to the private sector for the performance of intermittent or regular public missions – what some call “the Poor Man’s NTM.”¹¹⁹ This trend is evidenced by the fact that satellite remote sensing has grown to a \$1 billion per year business.¹²⁰

Therefore, there can be no definitive roster listing all NTM satellites; there is no requirement or state practice of officially designating a particular orbiter as performing a national security monitoring function.¹²¹ Many platforms, launched by a wide array

¹¹⁷ Hays, *supra* note 2, at 167, 183-84 (describing the practice of “checkbook shutter control”); Niemeyer, *supra* note 108, at 39-40; Duncan Campbell, *US Buys Up All Satellite War Images*, GUARDIAN (Oct. 17, 2001) <http://www.guardian.co.uk/world/2001/oct/17/physicalsciences.afghanistan>.

¹¹⁸ *Supra* text accompanying note 8 (reporting the official policy of the U.S. government to rely as much as possible upon private providers of satellite functions).

¹¹⁹ Eur. Comm’n, *supra* note 112, at 19 (identifying commercial satellites as the “most affordable and flexible solution” for the growing need for military satellite communications); INDEPENDENT STUDY, *supra* note 116, at 54-55 (listing several countries where governmental and commercial sponsors collaborate in development of reconnaissance satellites); Pabian, *supra* note 7, at 221, 233-35 (recounting use of commercial satellite imagery in the detection of a covert nuclear facility in Algeria, and other instances of application of private satellites for security and arms control purposes); Kueter & Sheldon, *supra* note 76, at 15-16 (describing use of public-private satellite partnerships in other countries to save costs and serve multiple functions); Sandra I. Erwin, *Satellite Shortages May Choke Off Military Drone Expansion*, NAT’L DEF. MAG., Apr. 2013, <http://www.nationaldefensemagazine.org/archive/2013/April/Pages/SatelliteShortagesMayChokeOffMilitaryDroneExpansion.aspx> (illustrating how Australia has achieved significant savings by pursuing commercial-military cooperation in space).

¹²⁰ SATELLITE INDUSTRY ASSOC., STATE OF THE SATELLITE INDUSTRY REPORT 12 (2012), available at <http://www.sia.org/wp-content/uploads/2012/06/Final-2012-State-of-Satellite-Industry-Report.pdf> (reporting ten percent growth in satellite remote sensing imagery revenues to \$1.1 billion in 2011).

¹²¹ See HARRISON, *supra* note 67, at 9 (explaining that during the cold war era, neither the United States nor the Soviet Union wanted to specify which satellites were engaged in verifying compliance with arms control treaties and “both extended the general ban on non-interference to the entire national security space constellation of the other”); Harrison, Shackelford & Jackson, *supra* note 7, at 19 (“Both the Russians and the United States have extended the ‘non-interference’ ban to the entire military space constellation of the other.”).

of actors ostensibly to fulfill a variety of purposes, can be adapted to support arms control treaty monitoring as the occasion demands. Google Earth¹²² and other types of widely distributed satellite-based systems may in the future represent the face of NTM almost as much as highly classified government-owned orbiters now do.

Before moving on, it is instructive to note that NTM and other satellites can transit a variety of orbital paths through space.¹²³ Regarding altitude, three rough zones have been differentiated: Low earth orbit (LEO) (closer to earth than about 1000-2000 kilometers) is the favored posture for high-resolution photoreconnaissance satellites such as the now obsolete U.S. Keyhole system.¹²⁴ Medium earth orbit (MEO) (out to about 30,000 kilometers) is the environment for GPS satellites (and the corresponding navigation constellations created by other countries¹²⁵) and the NTM sensors they host.¹²⁶ Geosynchronous earth orbit (GEO) (at 35,800 kilometers altitude, where the speed of the satellite precisely matches the speed of the earth's rotation so the satellite appears to "hover" over a particular location on the equator) offers special advantages for communications and broadcasting satellites and for NTM satellites, such as elements of the U.S. Space-Based Infrared System (SBIRS), which monitor

¹²² Pabian, *supra* note 7, at 238-44 (presenting a case study of using Google Earth and commercial satellite imagery to observe a challenged clandestine nuclear facility in Iran); GOOGLE EARTH, <http://www.google.com/earth/index.html> (last visited Feb. 25, 2014) (offering "hundreds of maps covering all corners of the globe, from historical imagery to the latest high-resolution underwater terrain").

¹²³ See generally Jasani, *supra* note 46, at 20-29; Johnston, *supra* note 114, at 13-16; WRIGHT, GREGO & GRONLUND, *supra* note 16, at 29-46.

¹²⁴ WRIGHT, GREGO & GRONLUND, *supra* note 16, at 40-42.

¹²⁵ Other space actors have developed their own versions of the U.S. GPS system to provide independent location and timing information, such as Russia's GLONASS system, the European Galileo constellation, and China's Beidou. See LYALL & LARSEN, *supra* note 2, at 394-99; Honkova, *supra* note 104, at 19-25; *Pakistan Adopts Chinese Rival GPS Satellite System*, PHYS.ORG (May 18, 2013), <http://phys.org/news/2013-05-pakistan-chinese-rival-gps-satellite.html> (stating that Pakistan is set to adopt China's GPS satellite system); *Russia Launches Latest Satellite in Its Global Positioning System*, GPS DAILY (Apr. 26, 2013), http://www.gpsdaily.com/reports/Russia_launches_latest_satellite_in_its_global_positioning_system_999.html (describing the satellite launch); Space Security Index 2013, *supra* note 1, at 41-42.

¹²⁶ WRIGHT, GREGO & GRONLUND, *supra* note 16, at 42.

foreign missile launches and support U.S. missile defense programs.¹²⁷

These orbits may be structured as roughly circular, somewhat elliptical, or highly elliptical, each of which confers particular operational advantages.¹²⁸ In addition to its orbital altitude, a satellite is characterized by the degree to which its path overflies the equator, overflies the poles, or is inclined at some selected angle between those extremes.¹²⁹ Due to a variety of anomalies (e.g., magnetic fields, the effects of which are not evenly distributed), not all regions of space, and not all orbital pathways, are equally valuable. Instead, satellites tend to cluster into the most advantageous operating sub-environments for the optimal performance of their specified monitoring, communications and other functions.

Finally, it is important to stress how the NTM functions demand rigorous precision and reliability in the satellite operations. For example, the characteristic dual-peak flash of light from an atmospheric nuclear explosion, necessary to confidently detect it and identify its location and nature, lasts barely one second.¹³⁰ If the appropriate NTM satellite is not on station twenty-four hours a day, seven days a week, it may simply miss this telltale signature of an important treaty violation. Likewise, when a satellite is programmed to overfly a particular site of interest on earth at the same time each day, if that service is disrupted—as when the satellite is not in the optimal position to perform its assigned tasks—valuable comparative intelligence data may be irretrievably lost.¹³¹ Often, the characterization of an event (such as a nuclear explosion) requires the concerted efforts of multiple satellites (such as calculating the location, time, and size of a detonation, based upon the varying length of time required for the

¹²⁷ LYALL & LARSEN, *supra* note 2, at 248–50; RICHELSON, *supra* note 24, at 245; WRIGHT, GREGO & GRONLUND, *supra* note 16, at 43; Cheryl Pellerin, Am. Forces Press Service, *Despite Smaller Budget, Air Force Seeks to Protect Satellites*, DEP'T OF DEF. (Jan. 22, 2013), <http://www.defense.gov/news/newsarticle.aspx?id=119075> (noting that the SBIRS system employs satellites that are in geosynchronous orbits as well as those in highly elliptical orbits).

¹²⁸ WRIGHT, GREGO & GRONLUND, *supra* note 16, at 24–25, 42–43; Space Security Index 2013, *supra* note 1, at 31–32, 113.

¹²⁹ WRIGHT, GREGO & GRONLUND, *supra* note 16, at 23–24.

¹³⁰ See DAHLMAN ET AL., *supra* note 96, at 108–09.

¹³¹ Jasani, *supra* note 46, at 22–23.

impulses to reach four or more satellites); if one element of the necessary constellation is disrupted, the entire system may falter.¹³²

NTM satellites, like all others, have only a limited capacity for conducting maneuvers in outer space. All long-lived satellites must have some ability to make adjustments (called “station-keeping”) in order to maintain the desired orbital parameters in the face of episodic disruptions from solar winds, interaction with the upper atmosphere, irregularities in gravitational fields, etc., and they are equipped with small thrusters for this purpose.¹³³ But the fuel available to undertake these corrections is limited, and the weight and volume of the propellant must compete with other items necessary for performance of the satellite’s primary mission. Large, repeated maneuvers are therefore expensive and shorten a satellite’s useful lifetime.¹³⁴

3. THE LAW OF INTERFERENCE

The international law prohibiting interference with NTM is longstanding and fundamental to the practice of arms control treaty verification, but is still markedly incomplete. The concept—or at least the vocabulary—of NTM, and the creation of an obligation to refrain from interference,¹³⁵ originated in the SALT I

¹³² See Higbie & Blocker, *supra* note 114 (describing the need for “four or more satellites” to record the arrival time of x-rays from a nuclear detonation, in order to determine its location); Pellerin, *supra* note 127 (quoting Gen. William L. Shelton, the leader of the U.S. Air Force’s Space Command, stressing the importance of a complete space program, saying “You can’t say, ‘Well, I’ll just have one less GPS satellite or one less advanced [extremely high frequency] satellite or one less [space-based radar] satellite’... You can’t create holes in the constellation and still have global capability.”).

¹³³ See WRIGHT, GREGO & GRONLUND, *supra* note 16, at 50 tbl. 6.1, 60–61; *Station-Keeping*, ENCYCLOPEDIA OF SCI., <http://www.daviddarling.info/encyclopedia/S/station-keeping.html> (last visited Oct. 30, 2013).

¹³⁴ WRIGHT, GREGO & GRONLUND, *supra* note 16, at 14, 49–61, 69–74. See also GALLAGHER & STEINBRUNER, *supra* note 6, at 3; JOHNSON-FREESE, HEAVENLY AMBITIONS, *supra* note 15, at 70–71; NATIONAL ACADEMY, *supra* note 29, at 92; Space Security Index 2013, *supra* note 1, at 79, 142 (reporting that the extra fuel required for evasive maneuvers to avoid an ASAT interceptor “might represent more than 10–20 percent of the satellite cost”).

¹³⁵ Article IX of the OST, *supra* note 50, which predates SALT I, creates a more general obligation to engage in consultations prior to undertaking a space activity that “would cause potentially harmful interference with the activities of other States Parties in the peaceful exploration and use of outer space.” *Id.* This aspect of Art. IX has never been implemented. Michael C. Mineiro, *FY-1C and USA-193 ASAT Intercepts: An Assessment of Legal Obligations Under Article IX of the Outer*

negotiations, 1969-1972.¹³⁶ Those talks produced two agreements: the Anti-Ballistic Missile (ABM) Treaty¹³⁷ and the Interim Agreement on Strategic Offensive Arms (Interim Agreement),¹³⁸ which inaugurated the stream of bilateral U.S.-U.S.S.R. nuclear arms limitations. Neither of those two path-breaking accords contained extensive provisions for "cooperative" verification of compliance; each party relied instead upon its own unilateral monitoring capabilities—notably, but not explicitly identified as, satellites.¹³⁹

Space Treaty, 34 J. SPACE L. 321, 344-45, 349 (2008). See also HARRISON, *supra* note 67, at 6 (reporting that the OST did not contain any explicit provisions on verification because the United States was confident its NTM could adequately verify compliance and it did not want to draw additional attention to those capabilities; in fact, the United States preferred to rely upon its unilateral assets instead of creating any cooperative international regime). Likewise, the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, which contains no express terms regarding verification, is tacitly verified by the parties' satellite NTM. Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, Aug. 5, 1963, 14 U.S.T. 1313, 480 U.N.T.S. 43 [hereinafter LTBT]. See Higbie & Blocker, *supra* note 114 ("[O]ne of the conditions [underlying the LTBT] was that each party to the treaty could monitor the ban on testing in the atmosphere or in space using its own technical means").

¹³⁶ NOTBURGA K. CALVO-GOLLER & MICHEL A. CALVO, *THE SALT AGREEMENTS: CONTENT, APPLICATION, VERIFICATION* 261-95 (1987); GRAHAM, *supra* note 88, at 37, 58-59; Krass, *supra* note 90, at 300; John B. Rhinelander, *The SALT I Agreements, in SALT: THE MOSCOW AGREEMENTS AND BEYOND* 139-40 (Mason Willrich & John B. Rhinelander eds., 1974); GERARD SMITH, *DOUBLE TALK: THE STORY OF SALT I* (1985); STROBE TALBOTT, *ENDGAME: THE INSIDE STORY OF SALT II* (1979). See generally VERIFICATION OF CURRENT DISARMAMENT AND ARMS LIMITATIONS AGREEMENTS: WAYS, MEANS AND PRACTICES (Serge Sur ed., 1991).

¹³⁷ Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missile Systems, U.S.-U.S.S.R., May 26, 1972, 23 U.S.T. 3435 (no longer in force) [hereinafter ABM Treaty]. The ABM Treaty significantly limited the two parties' missile defense systems. In particular, it confined them to two sites each (later reduced to one site each) and restricted the numbers and types of interceptor missiles and supporting radar installations.

¹³⁸ Interim Agreement Between the United States of America and the Union of Soviet Socialist Republics on Certain Measures with Respect to the Limitation of Strategic Offensive Arms, U.S.-U.S.S.R., May 26, 1972, 23 U.S.T. 3462 (no longer in force) [hereinafter Interim Agreement]. The Interim Agreement was a five-year "freeze" on the number of launchers for intercontinental ballistic missiles and submarine launched ballistic missiles. It was intended as a temporary holding action, pending the negotiation of a more ambitious accord to reduce the numbers of strategic weapons.

¹³⁹ At the time of the SALT I negotiations, political conditions did not permit intrusive onsite inspection of the territory of the United States or the U.S.S.R. The

Regarding verification, Article XII of the ABM Treaty provides:

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.
2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article.
3. Each Party undertakes not to use deliberate concealment measures which impede verification by national technical means of compliance with the provisions of this Treaty. This obligation shall not require changes in current construction, assembly, conversion, or overhaul practices.¹⁴⁰

Article V of the companion Interim Agreement on Strategic Offensive Arms is substantively identical.¹⁴¹

These accords and their associated “agreed statements,” “common understandings,” and “unilateral statements” provided no definition of NTM or the other novel associated vocabulary.¹⁴² Similarly, the U.S. Department of State’s official “article by article

agreements were structured to regulate or ban only items that were sufficiently large, fixed, and conspicuous (such as ICBM launchers and ABM radars), making remote monitoring via NTM sufficient. Subsequent nuclear arms control treaties between the United States and Russia, such as the START I and New START Treaties, discussed *infra*, text accompanying notes 155–156, did incorporate vigorous onsite inspection routines, but also retained the provisions for the use and protection of NTM. GRAHAM, *supra* note 88, at 58–59, 131–33; Krass, *supra* note 90, at 300, 306. See also STEINBERG, *supra* note 88, at 66 (reporting a famous comment from President Lyndon Johnson, at the time of the early SALT negotiations, that U.S. NTM satellites were worth ten times the money the nation had spent in space, because “I know how many missiles the enemy has”).

¹⁴⁰ ABM Treaty, *supra* note 137, at art. XII.

¹⁴¹ Interim Agreement, *supra* note 138, at art. V. The Interim Agreement deviates from the ABM Treaty text only by substituting “Interim Agreement” for “Treaty.”

¹⁴² ABM Treaty, *supra* note 137, at Agreed Statements, Common Understandings, & Unilateral Statements Regarding the Treaty between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Anti-Ballistic Missiles; Interim Agreement, *supra* note 138, at Agreed Statements, Common Understandings, & Unilateral Statements.

analysis" of the agreements¹⁴³ and the U.S. Senate's legislative record¹⁴⁴ were bereft of any expansive clarification of the intended meaning of these points. Other items on the contemporaneous public record, including the otherwise illuminating memoirs of the chief U.S. negotiator,¹⁴⁵ supplied no meaningful elaboration.

A general understanding emerged that "interference" (covered by paragraph 2 of the ABM Treaty text) referred to actions that might be undertaken against the NTM vehicle (e.g., attacking a photoreconnaissance satellite), while "concealment" (regulated by paragraph 3) related to actions that might be conducted on the ground, to obscure the subject of the sensing (e.g., erecting covers to hide the weapons being remotely observed).¹⁴⁶ But little reliable official clarification emerged.

¹⁴³ See *Treaty Compliance: ABM Treaty, Article by Article Review*, U.S. DEP'T OF DEF.: ACQWEB, http://www.acq.osd.mil/tc/treaties/abm/abm_art.htm (last visited Nov. 5, 2013) (the official Department of State explanation of the ABM Treaty notes that Article XII.2 "would, for example, prohibit interference with a satellite in orbit used for verification of the Treaty").

¹⁴⁴ See, e.g., *Strategic Arms Limitation Agreements: Hearings Before the Senate Committee on Foreign Relations*, 92d Congress, 2d Session 6, 340-41 (1972) (containing only a brief discussion of NTM and satellites, which are mentioned only in the testimony of Secretary of State Rogers and in colloquy between Phyllis Schlafly, National Association of Pro America, and Senator John Sparkman).

¹⁴⁵ See SMITH, *supra* note 136, at 30-31, 99-100, 534 (noting that satellite photoreconnaissance is a critical form of NTM); GRAHAM, *supra* note 88, at 82-83 (recounting that in SALT II negotiations neither the United States nor the Soviet Union wanted to define NTM).

¹⁴⁶ See CALVO-GOLLER & CALVO, *supra* note 136, at 263-68 (discussing concealment articles in the treaty); Stuart A. Cohen, *The Evolution of Soviet Views on SALT Verification: Implications for the Future*, in *VERIFICATION AND SALT: THE CHALLENGE OF STRATEGIC DECEPTION* 49, 60-65 (William C. Potter ed., 1980) (differentiating between "active interference" and "passive interference," the latter of which is "concealment"). See also Cohen, *supra*, at 56-60 (discussing evolving Soviet views of the legality of overhead reconnaissance under international law, as reflected in paragraph 1 of the ABM Treaty provisions on NTM); GUIDO DEN DEKKER, *THE LAW OF ARMS CONTROL: INTERNATIONAL SUPERVISION AND ENFORCEMENT* 118 (2001) (considering what limitations might be suggested by the treaty commitment to operate NTM "in a manner consistent with generally recognized principles of international law"); GRAHAM, *supra* note 88, at 59 (stating that the concept of "concealment" also applied to the encryption of signals sent from a test missile back to its ground controllers, a practice that interfered with the other side's assessment of the missile's compliance with arms control treaties); TALBOTT, *supra* note 136, at 196-97 (describing SALT II negotiations' treatment of telemetry encryption as deliberate concealment); WOOLF, *supra* note 93, at 11-15 (discussing importance of missile telemetry for arms control treaty verification).

Nonetheless, the reliance upon NTM—and usually the rote incorporation of virtually identical language—became standard “boilerplate” practice in subsequent arms control treaties, as the participants recognized that *detente* could not proceed in the absence of reliable protection for these vital verification assets. The 1979 SALT II Treaty,¹⁴⁷ for example, copied exactly the same text,¹⁴⁸ supplementing it with a series of annotations defining in some detail what “deliberate concealment” could mean in the context of missile testing, but not otherwise elaborating the meaning of NTM or of interference.¹⁴⁹

The 1987 Intermediate Nuclear Forces (INF) Treaty¹⁵⁰ specified the NTM obligations in slightly different wording:

¹⁴⁷ Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Strategic Offensive Arms, U.S.-U.S.S.R., June 18, 1979, 18 I.L.M. 1138 [hereinafter SALT II]. SALT II would have replaced the Interim Agreement with a comprehensive, long-term accord that provided numerical limits on various categories and sub-categories of strategic nuclear weapons; it never entered into force.

¹⁴⁸ *Id.* at art. XV.

¹⁴⁹ *Id.* at addenda to Article XV, First Agreed Statement (“Deliberate concealment measures, as referred to in paragraph 3 of Article XV of the Treaty, are measures carried out deliberately to hinder or deliberately to impede verification by national technical means of compliance with the provisions of the Treaty.”); *id.* at Second Agreed Statement (“The obligation not to use deliberate concealment measures, provided for in paragraph 3 of Article XV of the Treaty, does not preclude the testing of anti-missile defense penetration aids.”); *id.* at First Common Understanding (“The provisions of paragraph 3 of Article XV of the Treaty and the First Agreed Statement thereto apply to all provisions of the Treaty, including provisions associated with testing. In this connection, the obligation not to use deliberate concealment measures associated with testing, including those measures aimed at concealing the association between ICBMs and launchers during testing.”); *id.* at Second Common Understanding (“Each Party is free to use various methods of transmitting telemetric information during testing, including its encryption, except that, in accordance with the provisions of paragraph 3 of Article XV of the Treaty, neither Party shall engage in deliberate denial of telemetric information, such as through the use of telemetry encryption, whenever such denial impedes verification of compliance with the provisions of the Treaty.”); *id.* at Third Common Understanding (“In addition to the obligations provided for in paragraph 3 of Article XV of the Treaty, no shelters which impede verification by national technical means of compliance with the provisions of the Treaty shall be used over ICBM silo launchers.”)

¹⁵⁰ Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles, U.S.-U.S.S.R., Dec. 8, 1987, S. Treaty Doc. No. 100-11 [hereinafter INF Treaty]. The INF Treaty supplemented the SALT process by addressing nuclear weapons of shorter ranges; it required the destruction of ground-launched

1. For the purpose of ensuring verification of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.

2. Neither Party shall:

- (a) interfere with national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article; or
- (b) use concealment measures which impede verification of compliance with the provisions of this Treaty by national technical means of verification carried out in accordance with paragraph 1 of this Article. This obligation does not apply to cover or concealment practices, within a deployment area, associated with normal training, maintenance and operations, including the use of environmental shelters to protect missiles and launchers.¹⁵¹

For purposes of this analysis, the substantive content of the INF Treaty provision on NTM is identical to that of the ABM Treaty and its progeny, with one conspicuous exception, discussed further *infra*:¹⁵² the INF Treaty omits the word "deliberate" from the restriction upon the use of "concealment" measures.

A host of other bilateral U.S.-U.S.S.R. agreements regarding nuclear weapons mimicked these NTM provisions, not always with cookie-cutter exactitude, but without any explanation of any possible nuances of intended differences in the meanings of the slightly varying formulations. The relevant provisions from the 1974 Threshold Test Ban Treaty,¹⁵³ the 1976 Peaceful Nuclear

ballistic and cruise missiles capable of ranges between 500 and 5500 kilometers. *Id.*

¹⁵¹ *Id.* at art. XII.

¹⁵² See *infra* text accompanying notes 223-225.

¹⁵³ Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Underground Nuclear Weapon Tests, U.S.-U.S.S.R., July 3, 1974, 1714 U.N.T.S. 123, 218 [hereinafter TTBT]. The TTBT limited the size of nuclear weapons test explosions to 150 kilotons yield; it constitutes a partial step toward the Comprehensive Test Ban Treaty. *Id.* Article II of the TTBT provides:

Explosions Treaty,¹⁵⁴ the 1991 START 1 Treaty,¹⁵⁵ and the 2010 New START Treaty¹⁵⁶ are set out in the margin, with notations about the minimal wording differences.

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with the generally recognized principles of international law. 2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article. 3. To promote the objectives and implementation of the provisions of this Treaty the Parties shall, as necessary, consult with each other, make inquiries and furnish information in response to such inquiries.

Id. at 218. This article is substantively identical with the corresponding language in the ABM Treaty except that the TTBT eliminates the ABM Treaty's third paragraph, which prohibits "deliberate concealment measures." ABM Treaty, *supra* note 137, at 3444.

¹⁵⁴ Treaty Between the United States of America and the Union of Soviet Socialist Republics on Underground Nuclear Explosions for Peaceful Purposes, U.S.-U.S.S.R., May 28, 1976, 1714 U.N.T.S. 387, 435 [hereinafter PNET]. The PNET regulates nuclear explosions conducted for "peaceful purposes" (e.g., for civil engineering, such as to deepen a river channel or to create an underground storage chamber, rather than for weapons development); it complements the TTBT because there is no essential or externally observable difference between the technologies of a "peaceful" and a "weapon" explosion, so similar limitations should apply to both. TTBT, *supra* note 153. Article IV of the PNET provides:

1. For the purpose of providing assurance of compliance with the provisions of this Treaty, each Party shall: (a) use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law; and (b) provide to the other Party information and access to sites of explosions and furnish assistance in accordance with the provisions set forth in the Protocol to this Treaty.

2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1(a) of this article, or with the implementation of the provisions of paragraph 1(b) of this article.

Id. at 435. The PNET paragraph regarding interference with NTM is substantially identical to the corresponding provisions of the ABM Treaty; the PNET (like the TTBT) does not contain the ABM Treaty's passage regarding "deliberate concealment measures." ABM Treaty, *supra* note 137, at 3444.

¹⁵⁵ Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms, U.S.-U.S.S.R. July 31, 1991, S. Treaty Doc. No. 102-20 [hereinafter START I]. START I continued the SALT process, but provided for actual reductions, rather than merely ceilings, on the parties' holdings of nuclear weapons, and established legally binding cuts in several categories of arms. *Id.* Article IX of START I provides:

In addition, a number of multilateral treaties have noteworthy provisions regarding NTM. For example, Article XV of the 1990 Treaty on Conventional Forces in Europe (CFE Treaty),¹⁵⁷ provides:

1. For the purpose of ensuring verification of compliance with the provisions of this Treaty, each Party shall use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law. 2. Each Party undertakes not to interfere with the national technical means of verification of the other Party operating in accordance with paragraph 1 of this Article. 3. Each Party undertakes not to use concealment measures that impede verification, by national technical means of verification, of compliance with the provisions of this Treaty. In this connection, the obligation not to use concealment measures includes the obligation not to use them at test ranges, including measures that result in the concealment of ICBMs, SLBMs, mobile launchers of ICBMs, or the association between ICBMs or SLBMs and their launchers during testing. The obligation not to use concealment measures shall not apply to cover or concealment practices at ICBM bases and deployment areas, or to the use of environmental shelters for strategic offensive arms.

Id. at 33. START I is essentially identical with the ABM Treaty model, *supra* note 137, at 3444, regarding non-interference with NTM; like the INF Treaty, *supra* note 150, START I omits the word "deliberate" from the restriction on "concealment measures."

¹⁵⁶ Article X of New START Treaty, *supra* note 97, provides:

For the purpose of ensuring verification of compliance with the provisions of this Treaty, each Party undertakes:

1. (a) to use national technical means of verification at its disposal in a manner consistent with generally recognized principles of international law; (b) not to interfere with the national technical means of verification of the other Party operating in accordance with this Article; and (c) not to use concealment measures that impede verification, by national technical means of verification, of compliance with the provisions of this Treaty.

2. The obligation not to use concealment measures includes the obligation not to use them at test ranges, including measures that result in the concealment of ICBMs, SLBMs, ICBM launchers, or the association between ICBMs or SLBMs and their launchers during testing. The obligation not to use concealment measures shall not apply to cover or concealment practices at ICBM bases or to the use of environmental shelters for strategic offensive arms.

New START Treaty, *supra* note 97, at 13. The New START Treaty NTM provisions are somewhat streamlined compared to the ABM Treaty model, *supra* note 137, but substantively identical.

¹⁵⁷ Treaty on Conventional Armed Forces in Europe art. XV, Nov. 19, 1990, S. Treaty No. 102-8 (1991), 2441 U.N.T.S. 285, 309 [hereinafter CFE Treaty]. The CFE Treaty limits five major categories of conventional military equipment in the region between the Atlantic Ocean and the Ural Mountains, and creates various subzone limits. *Id.*

1. For the purpose of ensuring verification of compliance with the provisions of this Treaty, a State Party shall have the right to use, in addition to the procedures referred to in Article XIV, national or multinational technical means of verification at its disposal in a manner consistent with generally recognized principles of international law.
2. A State Party shall not interfere with national or multinational technical means of verification of another State Party operating in accordance with paragraph 1 of this Article.
3. A State Party shall not use concealment measures that impede verification of compliance with the provisions of this Treaty by national or multinational technical means of verification of another State Party operating in accordance with paragraph 1 of this Article. This obligation does not apply to cover or concealment practices associated with normal personnel training, maintenance or operations involving conventional armaments and equipment limited by the Treaty.¹⁵⁸

The CFE text is not word-for-word identical to the ABM Treaty model, but it is substantively the same, with the notable addition of explicit recognition of “multinational” as well as “national” technical means of verification.

The 1996 CTBT,¹⁵⁹ in contrast, uses a different formulation of the NTM obligations (without discussing whether any variation in the meaning is intended). In Article IV., Section A, the CTBT provides:

5. For the purposes of this Treaty, no State Party shall be precluded from using information obtained by national technical means of verification in a manner consistent with generally recognized principles of international law, including that of respect for the sovereignty of States.
6. Without prejudice to the right of States Parties to protect sensitive installations, activities or locations not related to this Treaty, States Parties shall not interfere with elements

¹⁵⁸ *Id.* at art. XV.

¹⁵⁹ CTBT, *supra* note 92.

of the verification regime of this Treaty or with national technical means of verification operating in accordance with paragraph 5.¹⁶⁰

In Article IV., Section D, there is an additional specification:

37. The on-site inspection request shall be based on information collected by the International Monitoring System, on any relevant technical information obtained by national technical means of verification in a manner consistent with generally recognized principles of international law, or on a combination thereof. The request shall contain information pursuant to Part II, paragraph 41 of the Protocol.¹⁶¹

The CTBT text is thus a departure from the traditional NTM formula originally expressed in the ABM Treaty, but for purposes of this analysis, the language accomplishes the same two

¹⁶⁰ *Id.*, at art. IV, sec. A.

¹⁶¹ *Id.* Note that the CTBT's multilateral International Monitoring System incorporates four collectively operated technologies relying upon ground- and sea-based sensors; in addition, each party may employ its own NTM, which will (at least in the case of the United States) depend heavily upon satellite monitoring. See generally NRC, CTBT TECHNICAL ISSUES, *supra* note 96 (providing findings from the committee on reviewing and updating technical issues related to the comprehensive nuclear test ban treaty). See DAHLMAN ET AL., *supra* note 96, at 107-10, 126-27 ("In addition to using generally available data outside the [International Monitoring System], a state may use different national assets as part of its NTMs. This might include normal intelligence tools such as information from human sources and from monitoring communications of different kinds."); See also Conference on Disarmament, Report of the Ad Hoc Committee on a Nuclear Test Ban to the Conference on Disarmament 22, CD/1425 (Aug. 16, 1996), available at <http://documents-dds-ny.un.org/doc/UNDOC/GEN/G96/636/15/pdf/G9663615.pdf?OpenElement> (statement of China, objecting to the idea of treating NTM and the international monitoring system "as equals"); *id.* at 25 (providing the statement of Cuba); *id.* at 28 (providing the statement of Iran); *id.* at 32 (providing the statement of Pakistan); DEN DEKKER, *supra* note 146, at 317-18 (reporting that during CTBT negotiations, Russia strongly supported including language endorsing use of NTM, as a cost-efficient mechanism for verification; China, Pakistan and others opposed such a provision, on the basis that NTM were more available to the wealthy countries); Hays, *Sino-American*, *supra* note 3, at 20 (discussing Chinese resistance to allowing NTM to be used as a basis for CTBT verification operations); Rebecca Johnson, *Comprehensive Test Ban Treaty: Now or Never*, ACRONYM Rep. No. 8, in A REPORT OF THE 1995 CONFERENCE ON DISARMAMENT NEGOTIATIONS (1995), available at <http://www.acronym.org.uk/acrorep/a08comp.htm>.

objectives: (1) an authorization to use NTM and; (2) a prohibition against interference with it.

Surprisingly, the 1993 Chemical Weapons Convention,¹⁶² whose fulsome provisions on verification represent the “state of the art” in arms control data reporting and inspection, does not include any explicit reference to NTM. The provisions of the 1971 Seabed Arms Control Treaty,¹⁶³ the 1986 Stockholm Document on Confidence- and Security-Building Measures and Disarmament in Europe,¹⁶⁴ and the partially applicable language of the OST¹⁶⁵ are

¹⁶² CWC, *supra* note 92.

¹⁶³ Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof, Feb. 11, 1971, 23 U.S.T. 701, T.I.A.S. No. 7337. This treaty establishes the ocean floor as a zone free of nuclear weapons. Article III of this treaty provides:

5. Verification pursuant to this article may be undertaken by any State Party using its own means, or with the full or partial assistance of any other State Party, or through appropriate international procedures within the framework of the United Nations and in accordance with its Charter.

6. Verification activities pursuant to this Treaty shall not interfere with activities of other States Parties and shall be conducted with due regard for rights recognized under international law, including the freedoms of the high seas and the rights of coastal States with respect to the exploration and exploitation of their continental shelves.

Id. at art. III. This treaty pre-dated the ABM Treaty, and therefore it does not fully adopt the same vocabulary or structure. For instance, it does not use the term “NTM,” and it specifies that verification activities shall not interfere with the activities of the parties, rather than vice-versa. *Id.*

¹⁶⁴ Document of the Stockholm Conference on Confidence- and Security-Building Measures and Disarmament in Europe Convened in Accordance with the Relevant Provisions of the Concluding Document of the Madrid Meeting of the Conference on Security and Cooperation in Europe (CSBMs), Sept. 19, 1986, available at <http://www.state.gov/t/isn/4725.htm>. This document is a non-legally-binding agreement regarding enhanced security arrangements in Europe. With regards to compliance and verification, the agreement declares: “The participating States recognize that national technical means can play a role in monitoring compliance with agreed confidence- and security-building measures.” *Id.* ¶ 64.

¹⁶⁵ OST, *supra* note 50. Article IX provides:

In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and 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. States Parties to the Treaty shall pursue studies of

set out in the margin. In addition, there are several other arms control regimes for which the parties do, as a practical matter, rely upon NTM for the performance of treaty verification functions, although the relevant treaty does not specify that procedure and does not provide any explicit protection to NTM assets.¹⁶⁶

Note that some of the above-cited instruments – most importantly, the ABM Treaty, the SALT I Interim Agreement, and

outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If 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. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment.

Id. The OST, which pre-dated the ABM Treaty, does not employ the term “NTM” and does not directly prohibit “interference,” as the ABM Treaty model does. Instead, the OST requires consultation prior to undertaking potentially interfering activities. *Id.*

¹⁶⁶ See generally INTERNATIONAL SAFEGUARDS AND SATELLITE IMAGERY, *supra* note 46 (describing states’ extensive reliance upon satellites to monitor compliance with the 1968 Nuclear Non-Proliferation Treaty – which does not mention NTM – and associated additional protocols, which are agreements that enhance the ability of the International Atomic Energy Agency (IAEA) to verify compliance with nuclear non-proliferation obligations); Pabian, *supra* note 7 (analyzing how commercial satellites have played a role in non-proliferation verification); REMOTE SENSING FROM SPACE, *supra* note 105, at 169; Friedhorsky, *supra* note 101, at 152 (stating that the LTBT, which contains no express terms regarding verification, is tacitly verified by parties’ satellite NTM); Higbie & Blocker, *supra* note 114 (“[O]ne of the conditions [underlying the 1963 treaty] was that each party to the treaty could monitor the ban on testing in the atmosphere or in space using its own technical means.”); George Jahn, Associated Press, *UN Nuke Agency’s Iran Probe Driven by US-Led Intel*, HUFFINGTON POST (May 24, 2013, 8:27 AM), http://www.huffingtonpost.com/2013/05/24/un-nuke-agency-iran_n_3331090.html (discussing IAEA’s use of intelligence information, including that derived from satellite monitoring, provided by the United States).

START I—are no longer in force (and SALT II was never legally operative), and the CTBT has not yet entered into force.¹⁶⁷

Finally, just as these treaties deliberately fail to provide any definition of “national technical means,” they are likewise bereft of any specification regarding the meaning of “interference.” Nowhere in the texts of the instruments or in the public records supporting their ratification and entry into force did the treaty makers spell out the content of the concept of prohibited interference in any meaningful detail.¹⁶⁸ Nor has there been any overt “case law” to flesh out the meaning of the key terms since no party has ever publicly claimed that its NTM satellites have been subject to actionable interference.

Surely, the notion of interference under these treaties would have to embrace actions that would destroy, significantly damage, or capture another state’s monitoring or communications satellite.¹⁶⁹ It should be equally obvious that less catastrophic

¹⁶⁷ The implications of the lapse of these treaties are addressed further, *infra*, section 5.2.

¹⁶⁸ See SAMUEL BLACK, HENRY L. STIMSON CTR., NO HARMFUL INTERFERENCE WITH SPACE OBJECTS: THE KEY TO CONFIDENCE-BUILDING 5-8 (2008), *available at* http://www.stimson.org/images/uploads/research-pdfs/NHI_Final.pdf (discussing “Methods of Interference”); Mineiro, *supra* note 135, at 337 (defining three types of harmful interference in space: observational interference, radio frequency interference, and physical interference).

¹⁶⁹ See AM. ENTER. INST., SALT HAND BOOK: KEY DOCUMENTS AND ISSUES 1972-1979 45 (Roger P. Labrie ed., 1979) (quoting Henry Kissinger explaining that SALT I does not prohibit the testing of an anti-satellite weapon, but would prohibit using an ASAT to interfere with NTM); *id.* at 513 (quoting Paul Warnke as saying that use of an ASAT would be both “interference” with NTM and “concealment”). A standard dictionary definition of “interference” is an act of “hindering, obstructing, or impeding” or a “hindrance or obstruction that prevents a natural or desired outcome.” *Interference*, THE FREE DICTIONARY <http://www.thefreedictionary.com/interference> (last visited Nov. 5, 2013); *Definition of Interference*, BING DICTIONARY, <http://www.bing.com/> (search “definition of interference”). Black’s Law Dictionary defines interference as “the wrongful act of a person in preventing or disturbing the activities of another,” BLACK’S LAW DICTIONARY (2d ed. 1910), *available at* <http://thelawdictionary.org/letter/i/page/54/> (scroll down page to find “interference” definition). For comparison, the definition of “harmful interference” under the 1992 Convention of the International Telecommunication Union is: “Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunication service operating in accordance with the Radio Regulations.” Convention of the International Telecommunication Union, Annex 2, December 22, 1992, 1825 U.N.T.S. § 1003 (emphasis added).

actions, such as inflicting only temporary or limited disruptions upon a satellite's function—including dazzling or partially blinding its sensors or fiddling with its internal circuitry to disable it or divert it from its intended tasks—would also be prohibited. Jamming the communications to and from a satellite (the uplinks and downlinks) would also count as interference.

The argument here is that compelling a satellite to maneuver away from its intended orbital pathway can also amount to prohibited interference. Such unplanned deviations are impermissively disruptive for two reasons. First, they can cause a satellite to be “off station”—in the sense of being absent from its preferred, programmed location—at least to some degree, for some period of time. The displacement may be small and temporary, or it may be more significant and sustained. Second, obliging the satellite to fire its thrusters in order to alter its orbit—and later to do so a second time, to return to its wonted pathway—requires an unbudgeted expenditure of fuel, often the most scarce element limiting a satellite's useful lifetime and its ability to sustain its service to its owner.

4. ASATs

The specter of anti-satellite weapons has been around almost as long as satellites themselves—indeed, the first U.S. exploration of ASAT concepts was drawn up within weeks of the U.S.S.R.'s first orbit of Sputnik in 1957.¹⁷⁰ In subsequent years, the United States, Russia, and now China have pursued and experimented in space with diverse ASAT systems; multiple other states also now have significant capacities for and rising interests in similar technologies.¹⁷¹

¹⁷⁰ STARES, *supra* note 67, at 49 (reporting that first U.S. Army study of the feasibility of satellite interceptors was commissioned in June 1957 (shortly before the Soviet launch of Sputnik) and produced program recommendations by November 1957); LEITENBERG, *supra* note 67, at 4-8 (describing genesis of U.S. ASAT programs).

¹⁷¹ See GREGO, *supra* note 70 (providing brief examples of countries that have pursued ASAT and similar technologies). See also BURROWS, *supra* note 88, at 142-48, 276-83; LYALL & LARSEN, *supra* note 2 at 525-30; STEINBERG, *supra* note 88, at 32-35, 76-87; WRIGHT, GREGO & GRUNLUND, *supra* note 16, at 16-17, 117-39, 151-71. See generally Brian Weeden, *Through a Glass, Darkly: Chinese, American and Russian Anti-satellite Testing in Space*, SECURE WORLD FOUNDATION (2014), available at swfound.org/media/167224/Through_a_Glass_Darkly_March2014.pdf; MAX M. MUTSCHLER, ARMS CONTROL IN SPACE: EXPLORING CONDITIONS FOR PREVENTIVE ARMS

There are two basic physical concepts for ASATs—kinetic energy (KE) interceptors and directed energy (DE) systems. KE interceptors rely upon a mechanism for sending into space a physical mass, which maneuvers close to the target and either rams into it at fatal speed or detonates an explosion that destroys both objects.¹⁷² Alternatively, directed energy ASATs would exploit high-energy lasers, microwaves, cyber attacks, or beams of sub-atomic particles to burn a hole in a targeted satellite, blind or temporarily “dazzle” its sensors, jam or spoof its communications, or scramble its internal electronics.¹⁷³

CONTROL (2013); STIMSON CTR., *ANTI-SATELLITE WEAPONS, DETERRENCE AND SINO-AMERICAN SPACE RELATIONS* (Michael Krepon & Julia Thompson eds., 2013) [hereinafter *ANTI-SATELLITE WEAPONS, DETERRENCE AND SINO-AMERICAN SPACE RELATIONS*].

¹⁷² WRIGHT, GREGO & GRUNLUND, *supra* note 16, at 135–39 (defining KE attacks as, “[a]ttacks that attempt to damage or destroy a satellite through high-speed collisions with another object” and providing further details of KE types and mechanisms). See Grego, *supra* note 70, at 4–5. See also OTA, *supra* note 19, at 55–66 (providing a general overview of U.S. ASAT capabilities and giving the Air Force’s plans during the 1980s); WILSON, *supra* note 13, at 13–16 (noting that “[k]inetic and chemical interceptors, conventional guns, and low power lasers are the least sophisticated” ASATs); Ashton B. Carter, *Satellites and Anti-Satellites*, 10 INT’L SECURITY 4, 46 (1986); Jameson W. Crockett, *Space Warfare in the Here and Now: The Rules of Engagement for U.S. Weaponized Satellites in the Current Legal Space Regime*, 77 J. AIR L. & COM. 671, 677–79 (2012); Bruce M. DeBlois, Richard L. Garwin, R. Scott Kemp & Jeremy C. Marwell, *Space Weapons: Crossing the U.S. Rubicon*, 29 INT’L SECURITY 2, 50 (2004); Robert H. Zielinski et al., *Star Trek – Exploiting the Final Frontier: Counterspace Operations in 2025* (U.S. Air Force, Research Paper for Air Force 2025, 1996), available at <http://dtic.mil/cgi-bin/GetTRDoc?AD=ADA392588>. See also Brian Weeden, *Anti-satellite Tests in Space: The Case of China*, SECURE WORLD FOUND., Aug. 29, 2013, at 1, available at http://swfound.org/media/115643/China_ASAT_Testing_Fact_Sheet_Aug2013.pdf [hereinafter Weeden, *Tests in Space*] (differentiating between kinetic ASAT systems that rely upon a “direct ascent” mechanism (where the interceptor attacks the target shortly after the interceptor is launched; it does not achieve its own orbit) vs. “co-orbital” systems (which do place the interceptor in orbit, where it may loiter for a sustained time before attacking a target). Notably, some early U.S. and Soviet ASAT interceptor mechanisms relied upon nuclear explosives, but in modern practice, with greater accuracy in homing in on the target, conventional explosives are used (or no explosives at all—the system relies upon a direct collision).

¹⁷³ Grego, *supra* note 70, at 9, 15–16 (describing ground-based lasers and the mechanisms whereby these lasers can “dazzle” and “partially blind” satellite sensors). See OTA, *supra* note 19, at 66–75; HARRISON, *supra* note 3, at 10–14; WILSON, *supra* note 13, at 17–20; WRIGHT, GREGO & GRUNLUND, *supra* note 16, at 118–35 (providing a detailed scientific description of the underlying mechanisms for dazzling and partial blinding); Crockett, *supra* note 172, at 680–83 (discussing radio frequency ASATs, which can jam signals, particle beam ASATs, which can

In principle, either type of system could be based on the surface of the earth, on an aircraft, or on a satellite; in practice, the difficulty of sufficiently miniaturizing the power source, to date, has required that any DE mechanism be ground-based.¹⁷⁴ A KE system could be "direct ascent," meaning that the interceptor suddenly soars from the earth to attack its target, or "co-orbital," meaning that the killer satellite circles ominously in space for some extended duration, before being instructed to home in on and attack a selected target.¹⁷⁵

For purposes of this analysis, a major distinction between KE and DE mechanisms concerns the creation of debris. Successful use of a DE system could disable a target satellite, rendering it "debris," but at least it could be a single, large, and readily-observable hazard in space. The nature of a KE system, on the other hand, is to fracture the target (as well as the ASAT vehicle itself), creating immensely more shards of debris, which are also more difficult to detect and to navigate around. This distinction is not absolute – a laser ASAT, for example, might (deliberately or accidentally) hit a target's fuel supply, causing it to explode, while a hypothetical KE mechanism might be designed to capture or

generate "[e]nough energy to overload the satellite's internal electronics," and microsat and nanosat ASATs, which can disrupt satellites); DeBlois et al., *supra* note 172; *Focus: Tackling Satellite Interference*, MILSAT MAG., Dec. 2011, at 26, available at http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=289599074; Jan Kallberg, *Designer Satellite Collisions from Covert Cyber War*, STRATEGIC STUDIES Q., Spring 2012, at 124, 124, available at <http://www.au.af.mil/au/ssq/2012/spring/kallberg.pdf> (arguing how "cyber warfare" may offer "[a]dversarial actors the opportunity to directly or indirectly destroy US space assets with minimal risk due to limited attribution and traceability"); Oppenheim, *supra* note 13, at 780-84. See generally U.S. DEP'T OF DEF., DEFENSE SCIENCE BOARD TASK FORCE ON DIRECTED ENERGY WEAPONS: FINAL REPORT (2007), available at <http://www.acq.osd.mil/dsb/reports/ADA476320.pdf>.

¹⁷⁴ See WRIGHT, GREGO & GRUNLUND, *supra* note 16, at 125 (noting that "ASAT laser systems can be based on the ground, at sea, in the air, or in space," and providing examples of how ASATs could function in each location); Grego, *supra* note 70, at 11, 16 (recognizing that, currently, the technology requires "large power supplies, cooling, and, in some cases, exhaust systems").

¹⁷⁵ WRIGHT, GREGO & GRUNLUND, *supra* note 16, at 135-38 (defining and describing direct ascent and co-orbital systems). See Grego, *supra* note 70, at 4-5. See also WILSON, *supra* note 13, at 13-14.

confine a target, while minimizing debris¹⁷⁶ – but it is generally applicable.

4.1. *United States*

The United States conducted thirty-one kinetic ASAT tests in space between 1959 and 1970, employing a variety of kill mechanisms.¹⁷⁷ Three more tests in the 1980s used another approach, built upon a direct-ascent, non-explosive, hit-to-kill Miniature Homing Vehicle (MHV), launched from an F-15 jet.¹⁷⁸ On September 13, 1985, the MHV was directed against an obsolete U.S. Solwind solar observation satellite at 555 kilometers altitude, colliding at 24,000 kilometers per hour.¹⁷⁹ The impact obliterated both spacecraft, generating over 250 pieces of traceable debris, some of which required at least seventeen years to precipitate out of orbit, and part of which spun dangerously within one mile of the International Space Station.¹⁸⁰ The MHV program was terminated in 1987, but work continued fitfully on a next-generation kinetic ASAT through 2005.¹⁸¹

¹⁷⁶ See Crockett, *supra* note 172, at 677; David Wright, *Space Debris*, 60 PHYSICS TODAY 35, 36 (2007). See also Vladimir Dvorkin, *Space Weapons Programs*, in OUTER SPACE: WEAPONS, DIPLOMACY, AND SECURITY, *supra* note 3, at 30, 35 (describing U.S. concept for an “environmentally clean” KE ASAT).

¹⁷⁷ See STARES, *supra* note 67, at 106–34, 261 (describing several early U.S. ASAT programs, operated by Army, Navy, and Air Force, including both DE and KE systems, including some using nuclear explosives); Pike & Stambler, *supra* note 67, at 992–93. See also Desmond Ball, *Assessing China’s ASAT Programs*, APSNET SPECIAL REP. (June 14, 2007), <http://nautilus.org/apsnet/assessing-chinas-asat-program/#n2>; Weeden, *supra* note 171 at 21–30.

¹⁷⁸ See Grego, *supra* note 70, at 4. See also STARES, *supra* note 67, at 206–09. See generally WHITE HOUSE, THE U.S. ANTI-SATELLITE (ASAT) PROGRAM: A KEY ELEMENT IN THE NATIONAL STRATEGY OF DETERRENCE, (1987), available at <http://www.fas.org/spp/military/program/asat/reag87.html>.

¹⁷⁹ See KLINKRAD, *supra* note 20, at 20; Grego, *supra* note 70, at 5.

¹⁸⁰ See Grego, *supra* note 70, at 5. See also KLINKRAD, *supra* note 20, at 20; Imburgia, *supra* note 25, at 605.

¹⁸¹ See Pike & Stambler, *supra* note 67, at 993–94 (describing the history of the program); Space Security Index 2012, *supra* note 2, at 140 (describing U.S. research into ASATs throughout the 1990s and 2000s); Kerry Gildea, *Possible Funding Boost in FY’04 Budget Could Lead to KE-ASAT Flight Test*, DEF. DAILY (Dec. 17, 2002); Grego, *supra* note 70, at 5, 7 (reporting that the Air Force ended the ALMV program amid political opposition; also, providing instances where work on kinetic ASAT continued during the 2000’s); Emily Hsu, *Program Officials Trying to Rebuild Support for Army KE-ASAT System*, INSIDE MISSILE DEF. (Mar. 5, 2003).

In addition, it must be noted that there is (for Russia and China, as well as for the United States) considerable technical and bureaucratic overlap between ASAT programs and the corresponding national anti-ballistic missile (ABM) efforts aimed at developing systems for intercepting incoming ballistic warheads. Therefore, equipment, know-how, hardware, and flight tests nominally dedicated to either an ASAT function or an ABM function can have considerable application to the other program, too. Many missile defense systems are designed to operate at relatively low altitudes, so the space debris resulting from an intercept would not be persistent, but the similarity between the two types of enterprises obscures any effort to state with clarity whether a particular country is currently engaging in ASAT, ABM, or both types of activities.¹⁸²

A vivid illustration of this crossover was provided on February 20, 2008, when the U.S. Navy shot down the flailing USA-193 satellite by quickly adapting a standard ship-borne ballistic missile

¹⁸² JOHNSON-FREESE, *HEAVENLY AMBITIONS*, *supra* note 15; Michael Krepon & Sonya Schoenberger, *A Comparison of Nuclear and Anti-satellite Testing, 1945-2013*, in *ANTI-SATELLITE WEAPONS, DETERRENCE AND SINO-AMERICAN SPACE RELATIONS*, *supra* note 171, at 131-32 (discussing an emerging competition in ASAT capacities among America, China and Russia); Mirmina, *supra* note 26, at 294, 299 (discussing possible overlap between ABM and ASAT testing, noting that missile defense testing might generate space debris); David Wright & Laura Grego, *Anti-Satellite Capabilities of Planned US Missile Defence Systems*, 68 *DISARMAMENT DIPLOMACY* (2003) (analyzing the ASAT capabilities of three missile defense systems: Ground-based Midcourse Defense (GMD), the ship-based Aegis-LEAP system, and the Air-Borne Laser (ABL)); Am. Forces Press Service, *Missile Defense System Completes Successful Intercept Test*, DEP'T OF DEF. (May 16, 2013), <http://www.defense.gov/News/NewsArticle.aspx?ID=120059> (noting successful missile defense test using the same type of missile and the same ship firing platform that were used in the shoot-down of USA-193); Grego, *supra* note 70, at 2, 11-12 (noting that the ASAT mission is technically simpler than missile defense, so capabilities that will suffice against incoming missiles would be relatively easy to adapt for applications against satellites); Pellerin, *supra* note 127 (quoting U.S. military official as stating "I think it's safe to say that the Chinese didn't conduct the 2007 test and just quit. . . . They conducted another test in 2009 that, even though it was called an antiballistic missile test, certainly had [anti-satellite]-like ramifications. So I think it's safe to say that they continue in their efforts."); Victoria Samson, *Shooting down USA-193: A \$100 million shot to be followed by even greater political costs*, CENTER FOR DEF. INFO. (Feb. 26, 2008); *Overview of the development of AEGIS by Lockheed Martin and United States Military*, LOCKHEED-MARTIN <http://www.lockheedmartin.com/us/100years/stories/aegis.html> (quoting program director as asserting that "AEGIS is not a one-trick pony" and is capable of missile defense and other missions) (last updated Feb. 7, 2013).

interceptor to the task.¹⁸³ The United States declined to characterize this event as an ASAT test, but the capability is unmistakable. Fortunately, this encounter occurred at low altitude (approximately 250 kilometers) so the debris was short-lived.¹⁸⁴

On the directed energy side, the most vivid demonstration of U.S. ASAT prowess came in October 1997, with the test of the MIRACL laser (Mid-Infrared Chemical Laser) in New Mexico. The system targeted a MSTI-3 satellite at 420 kilometers altitude. Detailed results of the event have not been released, but it appears that although MIRACL basically failed, a companion lower-power laser, intended merely to monitor the proceedings, demonstrated a capacity to temporarily blind the target's sensors.¹⁸⁵

In recent years, the United States has expressed a vigorous preference for DE, instead of KE, ASAT mechanisms, in order to avoid the creation of unnecessary debris.¹⁸⁶ The U.S. Air Force has

¹⁸³ JOHNSON-FREESE, *HEAVENLY AMBITIONS*, *supra* note 15, at 108-16; *U.S. Missile Hits Spy Satellite*, NEW SCIENTIST (Feb. 21, 2008), <http://www.newscientist.com/article/dn13359-us-missile-hits-spy-satellite.html>; Press Release, Dep't of Defense, DoD Succeeds in Intercepting Non-Functioning Satellite (Feb. 20, 2008), available at <http://www.defense.gov/releases/release.aspx?releaseid=11704>; Am. Forces Press Service, *Officials Declare Satellite Mission Successful*, DEP'T OF DEF. (Feb. 25, 2008), <http://www.defense.gov/news/newsarticle.aspx?id=49066>.

¹⁸⁴ Imburgia, *supra* note 25, at 604-05 (detailing that most of the debris from this event de-orbited within an hour, and all the remaining debris fell soon thereafter); Fred W. Baker III, Am. Forces Press Service, *Gates Pleased by Mission's Success*, DEP'T OF DEF. (Feb. 21, 2008), <http://www.defense.gov/news/newsarticle.aspx?id=49025>; Marc Kaufman & Walter Pincus, *Effort to Shoot Down Satellite Could Inform Military Strategy*, WASH. POST (Feb. 20, 2008), http://articles.washingtonpost.com/2008-02-20/news/36805991_1_anti-satellite-spy-satellite-joint-space-operations-center; Jim Wolf, *U.S. Official Minimizes Debris From Satellite Shoot*, REUTERS (Mar. 19, 2008, 6:48 PM), <http://www.reuters.com/article/2008/03/19/us-satellite-intercept-usa-idUSN1932521820080319>; Samson, *supra* note 182.

¹⁸⁵ Dvorkin, *supra* note 176, at 36-37; Grego, *supra* note 70, at 6-8; *U.S. Test-Fires 'MIRACL' at Satellite Reigniting ASAT Weapons Debate*, ARMS CONTROL TODAY, Oct. 1997, http://www.armscontrol.org/act/1997_10/miraclot; STARES, *supra* note 67, at 213-15 (describing early US DE ASAT programs); Hitchens, *Saving Space*, *supra* note 12, at 8 (describing continued U.S. military interest in high-powered lasers, which could have implications for ASAT development).

¹⁸⁶ U.S. DEP'T OF DEF., *BUDGET JUSTIFICATION: SPACE CONTROL TECHNOLOGY, FISCAL YEAR 2004/2005* (2004), available at <http://www.dtic.mil/descriptivesum/Y2005/AirForce/0603438F.pdf> (stating that U.S. military policy is to "focus only on negation technologies which have temporary, localized, and reversible effects."); *Seven Questions: Space Weapons, Part II*, FOREIGN POLICY (Aug. 1, 2005), http://www.foreignpolicy.com/articles/2005/07/31/seven_questions_space_we

accordingly pursued a variety of advanced non-destructive "space denial" mechanisms that would enable it to inflict disruptions upon an enemy's space systems that would be only localized, temporary, partial, and reversible.¹⁸⁷ Other states, too, are coming to appreciate the importance of avoiding kinetic ASAT tests and the unnecessary, dangerous space debris they create.¹⁸⁸

The American fascination with the anti-satellite mission in general has hardly abated. In his January 2013 confirmation hearings, Secretary of Defense Chuck Hagel reiterated the standing U.S. policy "to develop capabilities, plans and options to deter, defend against, and, if necessary, defeat efforts to interfere with or attack U.S. or allied space systems."¹⁸⁹ On May 7, 2013, Deputy Secretary of Defense Ashton Carter revealed that the U.S. military had undertaken a "long overdue" program to develop mechanisms for countering the space capabilities of potential adversaries, including both resistance to another state's ASAT activities, and pursuit of "our own capability to deny the use of space against our forces in a conflict."¹⁹⁰

4.2. Russia

apons_part_ii (providing an interview with Daniel P. Leaf, vice commander of U.S. Air Force Space Command, who states, "[o]ur priority is on temporary and reversible means, not destruction").

¹⁸⁷ Kasku-Jackson & Waldrop, *supra* note 49, at 74-75; Jeffrey Lewis, *Counter Satellite Communications System Deployed*, ARMS CONTROL WONK (Oct. 2, 2004), <http://lewis.armscontrolwonk.com/archive/25/countersatellitecommunications-system-deployed> (describing offensive counterspace program to enable U.S. Air Force "to disrupt adversary space systems with temporary and reversible effects").

¹⁸⁸ Group of Governmental Experts, *supra* note 15, at 17 (reaching a consensus among an international group of governmental experts on outer space, including representatives from China, Russia, and the United States on the judgment that "[i]ntentional destruction of any on-orbit spacecraft or launch vehicle orbital stages or other harmful activities that generate long-life debris should be avoided").

¹⁸⁹ Bill Gertz, *Hagel Responds, Hagel: Pentagon developing space weapons in response to Chinese ASAT weapons*, THE WASH. FREE BEACON (Jan. 31, 2013), <http://freebeacon.com/hagel-responds/>.

¹⁹⁰ Andrea Shalal-Esa, *Pentagon Cites New Drive to Develop Anti-Satellite Weapons*, REUTERS (May 17, 2013), <http://www.reuters.com/article/2013/05/07/us-pentagon-satellites-idUSBRE94614E20130507>. But see Victoria Samson, *Space Control in the Air Force's 2014 Budget Request*, THE SPACE REVIEW (July 22, 2013), <http://www.thespacereview.com/article/2335/1> (concluding that Carter's remarks did not signal any major new anti-satellite weapons program).

During the cold war, the Soviet Union was as early and as vigorous as the United States in investigating multiple ASAT instruments. The U.S.S.R. tested its primary mechanism (relying upon 300 kilograms of high explosives) in space approximately twenty times between 1968 and 1982. (Most of the tests were “fly-by” demonstration events, not producing any collisions or debris.) The system reached altitudes between 150 and 1600 kilometers, and was regarded by the United States as an “operational” capability.¹⁹¹ The program was decommissioned in 1993 and has been quiescent for years, but Russian interest in the ASAT concept has not dissipated. In 2009, responding to the continuing ASAT developments in the United States and China, Russia’s Deputy Minister of Defense, Valentin Popovkin, cautioned, “[w]e can’t sit back and quietly watch others doing that; such work is being conducted in Russia.”¹⁹²

Moscow’s efforts on DE ASATs are harder to assess. A site in Sary Shagan in Kazakhstan had long been suspected as the home of advanced high-energy laser research, with possible ASAT activities, or at least implications. However, an inspection of the facility in 1989 revealed little cause for concern, and its current status and activities are unknown.¹⁹³

¹⁹¹ OTA, *supra* note 19, at 50-55; Dvorkin, *supra* note 176, at 32-33; Pike & Stambler, *supra* note 67, at 994; Weeden, *supra* note 171, at 30-34; LEITENBERG, *supra* note 67, at 27-34 (describing early Soviet ASAT programs); STARES, *supra* note 67, at 135-56, 262; Asa Bates, Jr., *National Technical Means of Verification*, 123 ROYAL UNITED SERVICES INST. J., no. 2, June 1978, at 64; *Chinese Anti-satellite Test Creates Most Severe Orbital Debris Cloud in History*, ORBITAL DEBRIS Q. NEWS, Apr. 2007, at 2, 3, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv11i2.pdf> (noting that Soviet ASAT testing from 1968 to 1982 had generated more than 700 catalogued items of space debris, 301 of which are still in orbit); Johnson, *supra* note 25, at 3; Ball, *supra* note 177, at 3; Grego, *supra* note 70, at 3-4; Anatoly Zak, *The Hidden History of the Soviet Satellite-Killer*, POPULAR MECHANICS (Nov. 1, 2013), <http://www.popularmechanics.com/technology/military/satellites/the-hidden-history-of-the-soviet-satellite-killer-16108970>; Anatoly Zak, *Spacecraft: Military: IS Anti-satellite System*, RUSSIAN SPACE WEB, <http://www.russianspaceweb.com/is.html> (last updated Nov. 1, 2013).

¹⁹² Honkova, *supra* note 104, at 34-40; *Russia Building Anti-satellite Weapons*, THE INDEPENDENT (UK), Mar. 5, 2009, <http://www.independent.co.uk/news/world/europe/russia-building-antisatellite-weapons-1638270.html>; *Russia Pursuing Antisatellite Capability*, GLOBAL SEC. NEWSWIRE, Mar. 6, 2009, <http://www.nti.org/gsn/article/russia-pursuing-antisatellite-capability/>.

¹⁹³ STARES, *supra* note 16, at 145-46 (describing early Soviet DE ASAT programs); Ball, *supra* note 177; Grego, *supra* note 70, at 6, 8. See *Space Operations Discussion Board, Real Space Wars*, STRATEGY PAGE (Sept. 25, 2004),

4.3. China

China entered the ASAT game late, but with a bang.¹⁹⁴ China tested its KE mechanism—an interceptor launched from a mobile two-stage ballistic missile—in space three times in 2005-07. The first two demonstrations did not involve any impacts or explosions or create any orbital debris.¹⁹⁵ Then, on January 11, 2007, China deployed the system to strike an aging Fengyun-1C weather satellite at 860 kilometers altitude.¹⁹⁶ The resulting collision produced three thousand of pieces of trackable debris, totaling approximately seventeen percent of all the human-caused rubble then in orbit. This percussion is widely considered to be the worst space debris-generating event in history, because the altitude of impact will cause the debris cloud to remain in orbit for decades or centuries, obscuring the possibilities for safe space travel and operations in an unpredictable, ever-widening swath. Fully two-

<http://www.strategypage.com/militaryforums/21-158.aspx#startofcomments> (discussing alleged Soviet use of lasers against U.S. reconnaissance satellites in 1970s through 1980s); see also *Russian Strategic Nuclear Forces: Is Russia Reviving an Old Laser ASAT Project*, RUSS. STRATEGIC NUCLEAR FORCES, May 27, 2011, http://russianforces.org/blog/2011/05/is_russia_reviving_an_old_lase.shtml. (regarding a possible renewal of Russian interest in laser ASAT systems).

¹⁹⁴ China orbited its first satellite in 1970; its activities in space have accelerated greatly in recent years. ANTI-SATELLITE WEAPONS, DETERRENCE AND SINO-AMERICAN SPACE RELATIONS, *supra* note 171, *passim*; Cheng, *supra* note 59, at 55; Weeden, *Tests in Space*, *supra* note 172; Phillip Saunders, Jing-dong Yuan, Stephanie Lieggi & Angela Deters, *China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons*, CENTER FOR NAT'L SEC., JAMES MARTIN CENTER FOR NONPROLIFERATION STUDIES (July 22, 2002), <http://cns.miis.edu/stories/020722.htm>; Joan Johnson-Freese, *China's Space Ambitions*, IFRI SECURITY STUDIES CENTER PROLIFERATION PAPERS, Summer 2007, at 5, available at http://www.ifri.org/files/Securite_defense/China_Space_Johnson_Freese.pdf; John Hickman, *China Is Winning the Space Race*, FOREIGN POLICY (Aug. 2, 2013), http://www.foreignpolicy.com/articles/2013/08/02/china_is_winning_the_space_race.

¹⁹⁵ Michael R. Gordon & David S. Cloud, *U.S. Knew of China's Missile Test, But Kept Silent*, N.Y. TIMES, Apr. 23, 2007, <http://www.nytimes.com/2007/04/23/washington/23satellite.html?pagewanted=all&r=0>; Weeden, *Tests in Space*, *supra* note 172, at 2.

¹⁹⁶ Shirley Kan, *China's Anti-Satellite Weapon Test*, CONG. RESEARCH SERV., RS22652 (2007); *Special Report: Chinese Anti-Satellite Weapon Test: The Shot Heard 'Round the World*, 13 WMD INSIGHTS, Mar. 2007, at 2, available at http://cns.miis.edu/wmd_insights/WMDInsights_2007_03.pdf; Gregory Kulacki & Jeffrey G. Lewis, *Understanding China's Antisatellite Test*, 15 NONPROLIFERATION REV. 2, 335 (2008); Mineiro, *supra* note 135; Gordon & Cloud, *supra* note 195.

thirds of the payloads now in orbit will have to pass through the hazard zone.¹⁹⁷

In January 2010 and January 2013, China again test-fired rockets – without generating any orbital debris – labeling these as missile defense tests, rather than ASAT events, but the technological cross-over is undeniable.¹⁹⁸ In August 2010, two small Chinese satellites maneuvered into close proximity and apparently “bumped” each other at low speed, in another possible ASAT experiment.¹⁹⁹ More dramatically, in May 2013, China fired a DN-2 rocket into space – again, with no explosion or collision – in

¹⁹⁷ MATTHEW DUNCAN & DAVID K. RAND, CLOSE APPROACH PREDICTION ANALYSIS OF THE EARTH SCIENCE CONSTELLATION WITH THE FENGYUN-1C DEBRIS (2008), available at <http://www.ai-solutions.com/Portals/0/AI%20Docs/Technical%20Paper%20Library%20pdf/2008/7.pdf>; T.S. KELSO, ANALYSIS OF THE 2007 CHINESE ASAT TEST AND THE IMPACT OF ITS DEBRIS ON THE SPACE ENVIRONMENT (2007), <http://celestrak.com/publications/AMOS/2007/AMOS-2007.pdf>; NASA, ORBITAL DEBRIS PROGRAM OFFICE, HISTORY OF ON-ORBIT SATELLITE FRAGMENTATIONS 1 (14th ed. June 2008), available at <http://orbitaldebris.jsc.nasa.gov/library/SatelliteFragHistory/TM-2008-214779.pdf>; *An Update of the FY-1C, Iridium 33, and Cosmos 2251 Fragments*, ORBITAL DEBRIS Q. NEWS, Jan. 2013, at 1, 4-5, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV17i1.pdf> (reporting that of the 3378 items of cataloged debris from the 2007 ASAT test, 302 had decayed, leaving 3076 still in orbit, and projecting that some of the debris will remain in space beyond 2105); Imburgia, *supra* note 25, at 600 (explaining that because the debris from the Chinese 2007 test was driven by the collision into different directions at high speeds, it has spread to completely surround the earth); Mineiro, *supra* note 135; *Most Severe Orbital Debris Cloud*, *supra* note 191; *Top Ten Satellite Breakups*, ORBITAL DEBRIS Q. NEWS, July 2010, at 2, 3, available at <http://orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNV14i3.pdf> (reporting that the 2007 event was “By far the source of the greatest amount of orbital debris,” accounting for eighteen percent of the entire catalog of human-made debris in space); Brian Weeden, *2007 Chinese Anti-Satellite Test Fact Sheet*, SECURE WORLD FOUND., Nov. 23, 2010, at 1, available at http://swfound.org/media/9550/2007_chinese_asat_test_factsheet.pdf; Miles, *supra* note 10; Weeden, *Tests in Space*, *supra* note 172, at 2; Schulte, *supra* note 1, at 5.

¹⁹⁸ Li Bin, *What China's Missile Intercept Test Means*, CARNEGIE ENDOWMENT FOR INT'L PEACE (Feb. 4, 2013), <http://carnegieendowment.org/2013/02/04/what-china-s-missile-intercept-test-means/fa45>; *China: Missile Defense System Test Successful*, USA TODAY (Nov. 11, 2010, 8:08 PM), http://usatoday30.usatoday.com/news/world/2010-01-11-china-missile-defense_N.htm?csp=34; Bill Gertz, *Going on Defense*, WASH. FREE BEACON (Jan. 27, 2013, 5:02 PM), <http://freebeacon.com/national-security/going-on-defense/>; Brian Weeden, *Time for Obama to Go Public on China's ASAT Program*, DEF. NEWS (June 2, 2013, 4:05 PM), <http://www.defensenews.com/article/20130602/DEFREG/306020009/Time-Obama-Go-Public-China-s-ASAT-Program>.

¹⁹⁹ Cheng, *supra* note 59, at 64; Weeden, *supra* note 36; William Matthews, *Chinese Puzzle*, DEFENSENEWS.COM (Sept. 6, 2010), <http://www.defensenews.com/article/20100906/DEFFEAT01/9060317/Chinese-Puzzle>.

an exercise widely interpreted as a first test of another new ASAT system, one purportedly capable of jeopardizing even satellites at high altitudes.²⁰⁰

Chinese authorities have gone on record as pursuing space denial capabilities, saying, "[i]t is necessary for China to have the ability to strike US satellites. This deterrent can provide strategic protection to Chinese satellites and the whole country's national security."²⁰¹

²⁰⁰ CRAIG MURRAY, U.S.-CHINA ECON. & SEC. REVIEW COMM'N, CHINA MISSILE LAUNCH MAY HAVE TESTED PART OF A NEW ANTI-SATELLITE CAPABILITY (2013), available at http://origin.www.uscc.gov/sites/default/files/Research/China%20Missile%20Launch%20May%20Have%20Tested%20Part%20of%20a%20New%20Anti-Satellite%20Capability_05.22.13.pdf; Bill Gertz, *China Conducts Test of New Anti-Satellite Missile*, WASH. FREE BEACON (May 14, 2013, 1:46 PM), <http://freebeacon.com/national-security/china-conducts-test-of-new-anti-satellite-missile>; Bill Gertz, *China's Latest Space Warfare is not 'A Big Step for Mankind' . . . Satellite Catches and Doesn't Release*, SATNEWS DAILY, Oct. 4, 2013, <http://www.satnews.com/story.php?number=1243651026>; Johnson-Freese, *Learning*, *supra* note 77; Weeden, *supra* note 171, at 4-20; Tom Phillips, *US Fears After Chinese Missile Test*, THE TELEGRAPH (U.K.) (May 17, 2013, 9:57 AM), <http://www.telegraph.co.uk/news/worldnews/asia/china/10063455/US-fears-after-Chinese-missile-test.html>; Andrea Shalal-Esa, *U.S. Sees China Launch as Test of Anti-Satellite Muscle: Source*, REUTERS (May 15, 2013, 6:43 PM), <http://www.reuters.com/article/2013/05/15/us-china-launch-idUSBRE94E07D20130515>; Weeden, *Tests in Space*, *supra* note 172, at 2. See also Bill Gertz, *China Launches Three ASAT Satellites*, WASH. FREE BEACON (Aug. 26, 2013, 5:00 AM), <http://freebeacon.com/national-security/china-launches-three-asat-satellites> (assessing that three small satellites launched in July 2013 are also intended for testing anti-satellite functions).

²⁰¹ Ashley Tellis, *Punching the U.S. Military's "Soft Ribs": China's Antisatellite Weapon Test in Strategic Perspective*, 51 POLICY BRIEF (Carnegie Endowment for International Peace), Jun. 2007, at 1, available at http://carnegieendowment.org/files/pb_51_tellis_final.pdf. *Russian Satellite Hit by 'Space Junk' from Destroyed Chinese Spacecraft*, RT (Mar. 9, 2013), <http://rt.com/news/russian-satellite-collide-chinese-044/> (quoting a January 2013 editorial in the state-run Global Times China). See also LARRY M. WORTZEL, AM. ENTERPRISE INST., *THE CHINESE PEOPLE'S LIBERATION ARMY AND SPACE WARFARE* (2007), available at http://www.aei.org/files/2007/10/17/20071017_SpaceWarfare.pdf (analyzing Chinese military strategists' discussions and writings); Cheng, *supra* note 112, at 65-69 (surveying Chinese writings on military space operations); Wilson, *supra* note 13, at 5 (quoting a Chinese news agency as noting, "For countries that could never win a war by using the method of tanks and planes, attacking the U.S. space system may be an irresistible and most tempting choice"). But see Kulacki & Lewis, *supra* note 196 (postulating that the U.S. perception of China's intentions overestimates "the importance of the United States as a driver in China's decision to develop the technology and conduct the test"); Paul Oh, *Assessing Chinese Intentions for the Military Use of the Space Domain*, 64 JOINT FORCE Q., 1st quarter, 2012, at 91 (suggesting that the government of China may be divided concerning militarization of space).

The U.S. military has taken Beijing's actions and statements of intention seriously. The growing concern is reflected in the most recent authoritative U.S. annual report on Chinese military developments, which highlighted the fact that China "is acquiring a range of technologies to improve China's space and counter-space capabilities," citing both kinetic and directed energy programs that could "blind and deafen the enemy."²⁰²

Regarding the DE ASAT systems, there have been uncorroborated reports about what could be quite provocative Chinese activity, allegedly illuminating and disrupting or damaging U.S. satellites with high-powered lasers. Whether these 2006 events were tests of a laser dazzler or simply a mechanism to detect and track orbiters overflying China remains unknown.²⁰³ Still, Chinese defense reports continue to assert that "the ability to wage cyber war in space is vital for China's military modernization."²⁰⁴

4.4. Other Countries

Distressingly, the capability for undertaking at least crude ASAT activities may already have proliferated broadly. The

²⁰² U.S. DEP'T OF DEFENSE, ANNUAL REPORT TO CONGRESS: MILITARY AND SECURITY DEVELOPMENTS INVOLVING THE PEOPLE'S REPUBLIC OF CHINA 2013, at 33 (2013), available at http://www.defense.gov/pubs/2013_China_Report_FINAL.pdf; Ball, *supra* note 177; Andrea Shalal-Esa, *Space Plays a Growing Role in U.S.-China Security Talks: Official*, REUTERS (Apr. 11, 2013, 9:26 PM), <http://www.reuters.com/article/2013/04/12/us-usa-china-space-idUSBRE93B01W20130412> (quoting Department of State official saying "The United States continues to have concerns about the development of China's anti-satellite program . . ."); News Briefing, U.S. Dep't of Defense, DOD News Briefing with Deputy Secretary William Lynn and Assistant Secretary of Defense Gregory Schulte (Feb. 4, 2011), available at <http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4765> (expressing concern about a wide range of developing Chinese military counter-space capabilities).

²⁰³ TELLIS, *supra* note 201, at 4-5; Ball, *supra* note 177; Yousaf Butt, *Effects of Chinese Laser Ranging on Imaging Satellites*, 17 SCIENCE AND GLOBAL SECURITY 20 (2009); Grego, *supra* note 70, at 11; Francis Harris, *Beijing Secretly Fires Lasers to Disable US Satellites*, THE TELEGRAPH (U.K.), Sept. 26, 2006, <http://www.telegraph.co.uk/news/worldnews/1529864/Beijing-secretly-fires-lasers-to-disable-US-satellites.html>; Vago Muradian, *China Attempted to Blind U.S. Satellites with Laser*, DEF. NEWS, Sept. 21, 2006, <http://sci.tech-archive.net/pdf/Archive/sci.space.policy/2006-09/msg00666.pdf>.

²⁰⁴ Bill Gertz, *China's Military Preparing for 'People's War' in Cyberspace, Space*, WASH. FREE BEACON (July 30, 2013, 5:00 AM), <http://freebeacon.com/national-security/china-military-preparing-for-peoples-war-in-cyberspace-space>.

overlap between long-range missile technology and space-launch technology means that many countries already possess, or could soon develop, the competence for hostile space operations. Even a low-tech concept, such as inserting a quantity of gravel or nails into the oncoming path of a target satellite could constitute a crude KE capability (at least for a country that was not overly concerned about preserving its own ability to undertake peaceful space operations in the future, uninhibited by persistent junk).²⁰⁵

India, in particular, has been publicly energized to pursue autonomous ASAT capabilities. Spurred by China's 2007 ASAT test, India has hastened to enhance its military space activities, focusing on a kinetic energy mechanism adapted from its missile defense program.²⁰⁶

²⁰⁵ Jeffrey Lewis, "Hit-to-Kill" and the Threat to Space Assets, in *CELEBRATING THE SPACE AGE*, *supra* note 17, at 147, 149 (highlighting kinetic energy ASAT development work in Israel, Japan, and European countries); Robert McDougall & Phillip J. Baines, *Military Approaches to Space Vulnerabilities: Seven Questions*, in MONTEREY INST. CTR. FOR NONPROLIFERATION STUDIES, *FUTURE SECURITY IN SPACE: COMMERCIAL, MILITARY, AND ARMS CONTROL TRADE-OFFS* 11, 13 (James Clay Moltz ed., 2002) (asking "Who has the capability to create such threats?"); WRIGHT, GREGO & GRONLUND, *supra* note 16, at 136-37, 157-65; Space Security Index 2013, *supra* note 1, at 83; Space Security Index 2011, *supra* note 112, at 152; Wilson, *supra* note 13, at 11-13; Burak Ege Bekdil, *Turkey's Sat-Launcher Plans Raise Concerns*, DEF. NEWS (July 28, 2013, 3:45 AM), <http://www.defensenews.com/article/20130728/DEFREG04/307280004/Turkey-s-Sat-Launcher-Plans-Raise-Concerns> (noting technological overlap between satellite launch and missile capabilities); Ball, *supra* note 177; Grego, *supra* note 70, at 9-10; *Why It's So Hard for North Korea (or Anyone) to Build an ICBM*, DVICE (May 9, 2013, 12:04 PM), <http://www.dvice.com/2013-5-9/why-its-so-hard-north-korea-or-anyone-build-icbm> (citing North Korea technological progress as an example of the difficulty in building an accurate ICBM).

²⁰⁶ Lewis, *supra* note 205, at 149; Arvind K. John, *India and the ASAT Weapon*, ORF ISSUE BRIEF 41 (Aug. 2012), available at http://www.observerindia.com/cms/sites/orfonline/modules/issuebrief/attachments/ORF_Ib_41_1346129414917.pdf; Kallberg, *supra* note 173, at 128-30; Space Security Index 2013, *supra* note 1, at 86; Space Security Index 2011, *supra* note 112, at 156; Peter B. de Selding, *India Developing Anti-Satellite Spacecraft*, SPACE.COM (Jan. 11, 2010, 3:42 PM), <http://www.space.com/7764-india-developing-anti-satellite-spacecraft.html>; Grego, *supra* note 70, at 13; *India Contemplates Anti-Satellite Vehicle Integration with Agni-III Ballistic Missile*, DEFENCENOW.COM, <http://www.defencenow.com/news/343/india-contemplates-anti-satellite-vehicle-integration-with-agni-iii-ballistic-missile.html> (last updated Oct. 2013); Vivek Raghuvanshi, *China's ASAT Galvanizes Indian Efforts*, ACCESS WORLD NEWS (Apr. 9, 2007, 3:45 AM), <http://www.defensenews.com/article/20120225/DEFPEAT06/120202001/SPECIAL-REPORT-Vivek-Raghuvanshi-India's-Tech-Roadmap-Points-to-Small-Sats-Space-Weapons>, DEF. NEWS (Sept. 10, 2013, 9:45 AM), <http://www.defensenews.com/article/20130910/DEFREG03/309100007/India-s-Tech-Roadmap-Points-Small->

DE mechanisms, including devices to interrupt normal satellite services at least temporarily, may be even more widely disseminated. Commercial-off-the-shelf lasers may almost suffice to jeopardize many satellites, and one expert group concluded in 2006 that “[a]s many as 30 states may already have the capability to use low-power lasers to degrade unhardened satellite sensors.”²⁰⁷

Electronic jamming or other radio frequency interference is an even more present threat, with persistent complaints about annoying and costly disruptions.²⁰⁸ Even non-spacefaring states and non-state actors can get into this insidious game, with various genres of hackers demonstrating the power to degrade, jam, or even preempt satellite broadcasts.²⁰⁹

5. THE THESIS

This section assembles the material presented above to propound the thesis that a test or use in space of a debris-creating ASAT would already be illegal under existing international law, even in the absence of any new, hard-to-negotiate treaty on point, because such an intercept would create a dangerous, persistent

Sats-Space-Weapons; Victoria Samson, *Intel: India's Missile Defense/Anti-Satellite Nexus*, MILSATMAGAZINE.COM (Sept. 2010), http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=1588860555.

²⁰⁷ SPACESECURITY.ORG, SPACE SECURITY 2006, at 23 (2006), available at <http://www.spacesecurity.org/SSI2006.pdf>. See also WRIGHT, GREGO & GRUNLUND, *supra* note 16, at 119, 125-30, 140-42 (noting that simple mechanisms for jamming satellite communications are inexpensive to make or buy); Grego, *supra* note 70, at 10, 16 (reporting that dazzling of a satellite “can be achieved with low-power lasers that are widely available commercially”); DOD News Briefing, *supra* note 202, at 5 (noting that countries including China, Iran, and Ethiopia have used their counterspace capabilities and jammed commercial satellites); Schulte, *supra* note 1, at 5.

²⁰⁸ Space Security Index 2013, *supra* note 1, at 84-85; *France's Eutelsat Jams Iran Press TV Channel*, PRESSTV (May 31, 2013), <http://www.presstv.com/detail/2013/05/31/306383/press-tv-signals-jammed-on-nilesat/>; Press Release, Eutelsat, Eutelsat Condemns Jamming of Broadcasts from Iran and Renews Appeals for Decisive Action to International Regulators (Oct. 4, 2012), available at <http://www.eutelsat.com/home/news/communiqués-de-presse/archives/2012/press-list-container/eutelsat-condemns-jamming-of-bro.html>.

²⁰⁹ WRIGHT, GREGO & GRUNLUND, *supra* note 16, at 122 (noting jamming of Chinese television broadcasts by Falun Gong); William J. Lynn, III, *A Military Strategy for the New Space Environment*, 34 WASH. Q. 7, 11 (2011); Nina-Louisa Remuss, *The Need to Counter Space Terrorism - A European Perspective*, EURO. SPACE POL'Y INST. PERSP., no. 17, Jan. 2009, at 3; Grego, *supra* note 70, at 9.

debris stream that would, at some point, impermissibly interfere with the operation of treaty-protected NTM satellites.

The discussion first presents the thesis and suggests its implications. Then it considers three significant "counterpoints" or potential limitations upon its validity and power.

This argument seeks to combine something old, something new, and something surprising. The old part is the commitment to use and protect NTM as an essential element in the global security apparatus; international respect for this critical element of the arms control infrastructure is longstanding and profound.²¹⁰ The new part is the increasing awareness of the hazards of orbital debris; the spacefaring community is uniting as never before in its rejection of the shortsighted fouling of the exo-atmospheric environment and its appreciation of the imperative of avoiding further harm.²¹¹ The surprising part is that existing international law—understood in a novel way—can already contribute a partial solution, even in the absence of any new laboriously-negotiated and politically-contentious treaty that would explicitly ban ASAT activity.²¹²

The emerging reality is that space debris imposes an increasing, unacceptable cost to safe and efficient satellite operations, and any future kinetic energy ASAT events in space would likely generate expansive debris plumes that would impermissibly interfere with NTM operations over a very long time frame. This interference

²¹⁰ See *supra* text accompanying notes 135-165 (discussing treaty provisions protecting NTM).

²¹¹ See *supra* section 1.2 (discussing increasing global concern about space debris). See also Barry Kellman, *Space: The Fouled Frontier: Adjudicating Space Debris as an International Environmental Nuisance* (forthcoming); Hitchens, *supra* note 61. Arguably, the relatively recent growth in the recognition of the seriousness of the problem of space debris could provide a basis for differentiating, in terms of legal liability, between early and contemporary ASAT debris creation. That is, the U.S. and Soviet ASAT tests of the 1960s through 1980s might not be viewed as such egregious violations of the NTM-protecting provisions of the SALT I agreements, because there was only a low probability that the resulting debris would, in fact, disrupt the operation of the relatively few photoreconnaissance satellites then operational. Today, however, the vastly greater population of objects in space has created a much more serious debris problem, including a much greater danger of disruption of NTM vehicles, and all spacefaring actors must be well aware of the risks. See JAMES CLAY MOLTZ, *THE POLITICS OF SPACE SECURITY: STRATEGIC RESTRAINT AND THE PURSUIT OF NATIONAL INTERESTS* 203 (2d ed. 2011) (noting the U.S. Department of Defense's official acknowledgement in the 1980s of the problem of space debris and its pledge to mitigate creation of new debris).

²¹² See *supra* text accompanying notes 69-87 (discussing political difficulty in attempting to negotiate new arms control measures for outer space).

comes in three forms. First, wayward debris from an ASAT event could directly impact an NTM satellite.²¹³ Depending upon the size of the fragment, the feature of the satellite it happened to hit, the speed and angle of the collision, and other factors, the consequences could range from minor to catastrophic; the NTM functions could be temporarily disabled or permanently terminated.²¹⁴ Some ASAT fragments are large enough to be effectively tracked and some verification satellites retain a sufficient capability for maneuvering—but most debris is too small to monitor reliably and satellites are essentially “sitting ducks,” permanently vulnerable to abrupt destruction by invisible, indiscriminate oncoming traffic.²¹⁵

Second, when a country does have sufficient “space situational awareness” about the presence of a debris plume, it can adjust the space transiting orbits of its NTM satellites to steer them clear of the hazard zone. But this, too, constitutes a form of prohibited interference because it compels the verification assets to linger in locations or trajectories other than those that would optimally be selected for the performance of their particular treaty functions. Any time an artificial, arbitrary “keep-out zone” is established by an ASAT debris swarm, the treaty-protected NTM function is partially compromised. Again, there is considerable variation: the size of the debris stream could be large or small (but probably growing over time²¹⁶), and the enforced deviation from the preferred NTM path could be minor and intermittent, or large and (depending upon the altitude of the debris) persisting for decades or even centuries.²¹⁷

²¹³ This analysis could also embrace “indirect” interference, such as when an ASAT test generates fragments that collide in space with other debris, triggering a chain reaction in which resulting remnants later impact another state’s NTM satellite. See *supra* text accompanying note 33 (describing the Kessler Syndrome of cascading collisions).

²¹⁴ See *supra* text accompanying notes 26, 28 (including citations comparing the power of high-speed outer space collisions to more familiar terrestrial events, such as dynamite explosions or truck collisions).

²¹⁵ Butt, *supra* note 19.

²¹⁶ See Weeden, *supra* note 197 (noting that within three years after the 2007 Chinese ASAT test, the resulting debris cloud had spread so widely as to essentially encircle the earth from 175 to 3600 kilometers altitude).

²¹⁷ See *supra* text accompanying notes 23, 33 (including the notion of the Kessler Syndrome through which collisions between items of space debris lead to

Third, where an NTM satellite does have the ability and the advance notice to maneuver effectively, it can attempt to dodge the ASAT shards (at least those that are large enough to be detected). But this forced adaptation is itself a form of interference, because it consumes scarce fuel, reducing the satellite's ability to perform other necessary maneuvers and thereby potentially shortening its lifespan. NTM satellites are so expensive that countries do not deploy multiple "spare" or redundant systems; if even one is out of place or prematurely incapacitated, the treaty monitoring function may be degraded.

Advancing this thesis, admittedly, puts advocates in a somewhat unusual posture. In complaining about a debris-creating ASAT activity, we cannot specify which particular NTM satellite will be subjected to interference; similarly, we cannot predict when or where the disruption will occur. But the relevant arms control treaties do not require that level of courtroom evidentiary precision—we do know, with statistical certainty, that under the current debris-laden circumstances of outer space, impermissible interference will occur. Today's ill-advised action will surely result in tomorrow's bad results; the treaty violation is present.²¹⁸

As of this writing, this thesis remains, fortunately, hypothetical. The world has not yet witnessed a clear, confirmed, publicly-known instance of an NTM satellite being damaged or destroyed by, or being compelled to maneuver in order to avoid impact with, a leftover fragment from a kinetic ASAT test. Something ominously similar to that scenario may have played out in January 2013, when a functional Russian nanosatellite denominated BLITS (Ball Lens In The Space), used for laser ranging experiments, was apparently struck by debris from the Chinese 2007 ASAT test. BLITS was knocked off its trajectory and its spin velocity and altitude were compromised; it is still unclear whether the satellite

the creation of additional fragments, which could generate a "chain reaction" of expanding generations of impacts and debris).

²¹⁸ Conversely, advocates will often face a difficult attribution problem: With today's limited space surveillance capabilities, it can be hard to identify the reason for a particular satellite malfunction; even if it is determined that the problem was due to an impact, it can be problematic to tie it to human-caused, rather than natural, sources; and even if spacecraft debris is identified as the cause, it is not always possible to identify the specific space vehicle that originally generated the particular piece of debris.

has been rendered totally nonfunctional.²¹⁹ We do know that numerous other satellites have been compelled to maneuver in order to dodge fragments from the Chinese 2007 ASAT event;²²⁰ it seems very likely that NTM satellites, too, will be struck or forced into similar fuel-consuming evasive operations, if they have not already done so.

5.1. Counter-argument 1: Deliberateness

The first important point of resistance to this thesis arises from the suggestion that the ban on “interference” contained in the several relevant arms control treaties is best understood as a prohibition only on “intentional” or “deliberate” interference with NTM, not applicable to accidental or unplanned consequences, even if they are “foreseeable.” That is, it could be argued that the treaty makers indeed intended to bind themselves not to disrupt each other’s NTM via any premeditated, purposeful campaign, but they did not agree to measures that would simultaneously outlaw unhappy bad luck.²²¹

²¹⁹ At this point, there is considerable uncertainty about whether the BLITS satellite was struck by a tracked piece of debris from the 2007 Chinese ASAT test (or by a smaller untracked piece) or whether something else caused the observed disruption in its behavior. See Butler, *supra* note 46; Warren Ferster, *Pentagon: Russian Satellite Not Hit by ASAT Test Debris*, SPACE NEWS (Mar. 21, 2013), <http://www.spacenews.com/pentagon-russian-satellite-not-hit-by-asat-test-debris>; *Russian Satellite Hit by Remnants of Destroyed Chinese Spacecraft*, SPACE DAILY (Mar. 12, 2013), http://www.spacedaily.com/reports/Russian_satellite_hit_by_remnants_of_destroyed_Chinese_spacecraft_999.html; *Russian Satellite Hit by “Space Junk” from Destroyed Chinese Spacecraft*, RT (Mar. 9, 2013), <http://rt.com/news/russian-satellite-collide-chinese-044/>; Bruce Totolos, *Reports Confirm Collision between Chinese and Russian Satellite*, FRENCH TRIB. (Mar. 9, 2013), available at <http://frenchtribune.com/teneur/1316598-reports-confirm-collision-between-chinese-and-russian-satellite>; Mike Wall, *Legal Action against China Unlikely in Orbital Debris Collision*, SPACE NEWS (Mar. 13, 2013), available at <http://www.spacenews.com/legal-action-against-china-unlikely-in-orbital-debris-collision>.

²²⁰ U.S. Satellites Dodge Chinese Missile Debris, WASH. TIMES, Jan. 11, 2008, <http://www.washingtontimes.com/news/2008/jan/11/us-satellites-dodge-chinese-missile-debris/?page=all> (explaining how a commercial satellite Orbcomm FM 36 and a NASA earth observation satellite Terra were each forced to maneuver in order to avoid debris from the 2007 Chinese ASAT test).

²²¹ See Jeffrey C. Chu, *Intel: Satellite Interference: The Good, the Bad and the Ugly*, MILSAT MAG., April 2012), at 78, available at http://www.milsatmagazine.com/cgi-bin/display_article.cgi?number=1062654025 (differentiating between intentional and unintentional electronic interference with satellites). The sequential U.S. government statements of space policy sometimes specify that

That could, indeed, have been a plausible approach to crafting an arms control instrument, but it is simply not the choice that the parties made in these particular treaties. First, the plain language of the NTM provisions—from the original use in the ABM Treaty through all its successors—does not include the qualifier “deliberate” or “intentional” in the relevant passages.²²² If the drafters had intended to restrict coverage that way, they could readily have accomplished that goal by writing, “Each Party undertakes not to deliberately interfere with the national technical means of verification of the other Party.”

Even more importantly, the SALT I negotiators did display a fine eye for nuance in this area, as revealed in the contrast between paragraphs 2 and 3 of the NTM article of the ABM Treaty.²²³ That is, in paragraph 2, each party undertakes “not to interfere” with NTM; in the immediately following paragraph, each undertakes a complementary commitment “not to use deliberate concealment measures which impede verification by [NTM]” (emphasis added). This juxtaposition—the insertion of the word “deliberate” in one place, coupled with its omission in the other—makes clear that what is banned is “deliberate” concealment, versus “any” interference.²²⁴

“purposeful interference” with space systems will be regarded as an infringement of national rights (implying a lower concern for what might be regarded as “accidental” interference). See also DOD DIRECTIVE NO. 3100.10, *supra* note 8, §4.b; U.S. DEP’T OF DEF., DIRECTIVE NO. 3100.10, SPACE POLICY §4.2.1 (July 9, 1999); 2010 *National Space Policy*, *supra* note 47, at 3; 2006 *National Space Policy*, *supra* note 47 (referring to the fourth listed “Principle”).

²²² See *supra* text accompanying notes 140-41 (indicating that under the ABM Treaty, each party “undertakes not to interfere with the national technical means of verification of the other Party,” without qualification).

²²³ See *supra* text accompanying notes 140 (stating that in the ABM Treaty, the obligation under Article XII, paragraph 2 is “not to interfere”; under Article XII, paragraph 3, the commitment is “not to use deliberate concealment measures”) (emphasis added). See Rhinelander, *supra* note 136, at 139-40) (addressing the scope of the word “deliberate”).

²²⁴ See *Hamdan v. Rumsfeld*, 548 U.S. 557, 578 (2006) (“[A] negative inference may be drawn from the exclusion of language from one statutory provision that is included in other provisions of the same statute.”); *Russello v. United States*, 464 U.S. 16, 23 (1983) (“[W]here Congress includes particular language in one section of a statute but omits it in another section of the same Act, it is generally presumed that Congress acts intentionally and purposely in the disparate inclusion or exclusion.”).

Further confirmation of this interpretation arises from analysis of subsequent arms control documents, such as the INF Treaty, which omit the word “deliberate” from the paragraph about “concealment,” too.²²⁵ This must be read as reflecting the parties’ determination, at that point, to extend the coverage even to non-purposeful concealment activities as well as to accidental interference.

Undoubtedly, deliberate or willful interference (and concealment) were principally on the negotiators’ minds in all these instances—that sort of calculated disruption of another party’s NTM functions would pose the most severe challenge to the treaty verification regime. Certainly, a deliberate campaign of attacks on another state’s early warning, surveillance, communications, and other satellites—the “eyes and ears” of the intelligence network—would constitute a grave threat to international peace and security.²²⁶ But just as clearly, the negotiators of the arms control treaties determined to cast the agreements’ protections in wider, more ambitious terms, consciously omitting the word “deliberate” from the non-

²²⁵ See *supra* text accompanying note 150-52 (providing that in the INF Treaty, “Neither Party shall . . . use concealment measures which impede verification of compliance”). The conscious nature of the omission of the word “deliberate” in the INF Treaty’s NTM provision is confirmed by the Department of State’s authoritative “article by article analysis” of the treaty, which accompanied the INF Treaty when it was transmitted to the Senate for its advice and consent. See *INF Treaty: Article-by-Article Analysis, Article XII: National Technical Means of Verification*, UNDER SEC’Y OF DEF. FOR ACQUISITION, TECH. & LOGISTICS, TREATY COMPLIANCE, http://www.acq.osd.mil/tc/treaties/inf/inf_art.htm#top (last visited Apr. 12, 2014) (“In subparagraph (b) of paragraph 2, the Parties are prohibited from using any concealment measures that impede verification by national technical means of compliance with the Treaty. This provision is broader than similar provisions in earlier U.S.-Soviet arms control agreements, which merely prohibited deliberate concealment measures.”). See also GEORGE L. RUECKERT, *GLOBAL DOUBLE ZERO: THE INF TREATY FROM ITS ORIGINS TO IMPLEMENTATION* 92 (1993) (stressing that the INF Treaty prohibits “the use of any concealment measure specifically designed to impede NTM. The formulations in the INF Treaty are broader in this regard than those in earlier treaties which only prohibited deliberate concealment measures” (emphasis in original)).

²²⁶ See *Space Security Index 2011*, *supra* note 112, at 72 (“Russia has repeatedly expressed concern that attacks on its early warning and space surveillance systems would represent a direct threat to its security.”).

interference provisions, and thereby judiciously forbidding even accidental, unintended interference.²²⁷

In a similar vein, a temporal objection might be heard, arguing that the treaties would be concerned only with immediate, or near-contemporaneous, interference, not with harms that might be inflicted on NTM functions long after the ASAT test. Again, the treaty drafters hypothetically could have incorporated such a limitation in their texts; again, however, they chose not to do so. Especially here, where the hazards of kinetic ASAT tests or uses are so well-known, where the resulting debris (depending upon altitude and other factors) can be expected to persist for such an extended period of time, and where the jeopardy to NTM satellites approaches a statistical certainty, there is no reason to impute a "timing" factor into the text of the treaties, as if reading in a "proximity" requirement that the drafters did not enact.

We therefore reach the conclusion that the ban on interference with NTM is comprehensive, embracing both deliberate and accidental, and immediate and long-term, disruptions with arms control verification. To be sure, the interference must rise to some level of "significance," under the principle of *de minimis non curat*

²²⁷ See also ABM Treaty, *supra* note 137, at art. XIII.1(c) (authorizing the Standing Consultative Commission (SCC)—the dispute resolution mechanism established to promote the objectives and implementation of the SALT I agreements—to "consider questions involving unintended interference with national technical means of verification"). Insertion of the word "unintended" into Article XIII, coupled with its absence in Article XII, confirms that the Article XII prohibition on "interference" encompasses both deliberate and unintended actions. On the other hand, any implication that the SCC would not also be competent to address questions of "intended interference" with NTM would be unwarranted. Two additional points of comparison to the Outer Space Treaty are illuminating here. First, OST Article IX requires consultation prior to undertaking any space activity that "would cause potentially harmful interference" with the space activities of another party. See OST, *supra* note 50, at art. IX. However the NTM requirements of arms control treaties are much stronger; they prohibit the interference, not simply requiring prior consultation about it. Second, OST Article VII (and the Liability Convention, Article III, see *supra* text accompanying notes 57) create a tort liability system, including liability for fault for damage inflicted upon another party's space assets. Again, the NTM provisions of arms control treaties are stronger; they prohibit such damage, not simply provide compensation for it. Whether the knowing, but unintentional, creation of a space debris cloud could be construed as liability for fault has not been tested. LYALL & LARSEN, *supra* note 2, at 103-14; Mirmina, *supra* note 26, at 303; Wall, *supra* note 219; Luke Punnakanta, *Space Torts: Applying Nuisance and Negligence to Orbital Debris*, 86 S. CAL. L. REV. 163 (2012).

lex.²²⁸ But the types of interference under scrutiny here are far from trivialities. The best reading of the NTM passages in the several arms control treaties, therefore, overrules this first counter-argument.

5.2. Counter-argument 2: Treaty Proliferation

A second type of objection to the thesis raises a very different type of concern. That is, even if the main thrust of the analysis is correct, it could be argued to be of only minor significance because, at present, there are too few treaties in force that contain the relevant non-interference provision—and China, in particular, is not party to any of those legal commitments.

This counter-argument, admittedly, has legs. Unfortunately, there are simply not enough treaties containing the explicit NTM provisions to create a truly comprehensive, global restriction on ASAT activities. In particular, at this writing, the only agreements legally in force with the operative language are bilateral U.S.-Russia treaties (especially New START, the INF Treaty, and specialized test ban accords) or geographically limited (i.e., the CFE Treaty, confined to North America and Europe). China, one of only three countries to have tested a kinetic energy ASAT interceptor in space, is not party to any such instrument, nor are Japan, India, Iran, North Korea, and other highly relevant players.

Nonetheless, the glass remains partially full. The United States and Russia—traditionally the powers undertaking the lion's share of space activities—are fully enmeshed in this web of international law. Many other countries, including the European nations most active in outer space, are parties to the CFE Treaty and its embedded commitment to respect NTM.²²⁹ Notably, the INF Treaty, the CFE Treaty, and the CTBT are all of unlimited (i.e., permanent) duration.²³⁰

²²⁸ The law does not notice trivialities. BLACK'S LAW DICTIONARY 219 (4th Pocket ed. 2011).

²²⁹ The continuance of CFE Treaty is in jeopardy, as a result of persistent Russian non-compliance (under the guise of a unilateral "suspension") and the eventual United States response; there is considerable danger that the regime may collapse. Tom Z. Collina, *CFE Treaty Talks Stall*, ARMS CONTROL TODAY, Sept. 2011, http://www.armscontrol.org/2011_09/CFE_Treaty_Talks_Stall.

²³⁰ INF Treaty, *supra* note 150, at art. XV(1); CFE Treaty, *supra* note 157, at art. XIX(1); CTBT, *supra* note 92, at art. IX.

Still, the primary rebuttal to this second counter-argument must be forward-looking in several respects. First, additional arms control treaties are likely to come along, sooner or later, and it is very likely that they will incorporate some version of the now-standard NTM provision as routine "boilerplate" language. The CTBT, in particular, would provide the most significant extension of the current legal regime, embracing a truly global constituency. As noted above, CTBT contains a "non-standardized" provision regarding NTM, but it is fully protective of their activities and prohibits interference with them.²³¹ The treaty cannot enter into force until forty-four specified countries ratify it; currently thirty-six of those have done so (the United States and China are two of the prominent holdouts) and 125 other states have also ratified the accord.²³² The prospects for early effectuation of the CTBT are not bright,²³³ but when it occurs, not only will the ban on nuclear weapons testing overnight assume very widespread force, but the protection of NTM will be globally distributed, too.

Moreover, even the current interim CTBT status provides some indirect refuge for NTM. This limited protection arises because the signatory states established a "Preparatory Commission" to pave the way toward entry into force of the treaty, including a mandate for constructing the elaborate verification apparatus. The relevant text charges the Preparatory Commission with responsibility for ensuring prompt and effective operationalization of the network of multiple sensors and the overarching International Data Center.²³⁴ This system is already substantially in place, with the vast bulk of

²³¹ *Supra* text accompanying notes 159-161 (discussing that CTBT has a variant of the standard non-interference language (art. IV.5, 6, 37) and states also pledge cooperation with the verification program (art. IV.3, 11)).

²³² CTBT, *supra* note 92, at art. XIV(1), Annex 2 (providing the entry into force provisions); *Status of Signature and Ratification*, COMPREHENSIVE TEST BAN TREATY ORG., <http://www.ctbto.org/the-treaty/status-of-signature-and-ratification/> (last visited Nov. 13, 2013).

²³³ See DAHLMAN et al, *supra* note 96, at 13-20 (surveying prospects for ratification of the CTBT in the states whose membership is necessary for the treaty to enter into force); see generally JONATHAN MEDALIA, CONG. RESEARCH SERV., R41201, COMPREHENSIVE NUCLEAR-TEST-BAN TREATY: BACKGROUND AND CURRENT DEVELOPMENTS (2013).

²³⁴ See Resolution Establishing the Preparatory Commission for the Comprehensive Nuclear Test-Ban Treaty Organization, CTBT/MSS/RES/1, ¶¶ 13, 14, Annex (Oct. 17, 1996), available at http://www.ctbto.org/fileadmin/user_upload/public_information/2009/prepcom_resolution.pdf.

the planned configuration of 321 stations currently operational or under construction.²³⁵ The system utilizes satellite communications mechanisms to transmit the collected data to the headquarters in Vienna and from there to the participating states.²³⁶

In support of that structure, customary international law, as reflected in Article 18 of the Vienna Convention on the Law of Treaties, specifies that in the interval between signature of a treaty and its entry into force, a state has an obligation “to refrain from acts which would defeat the object and purpose” of the treaty.²³⁷ It is not too much of a legal stretch to suggest that CTBT signatories have thereby assumed some level of commitment not to interfere with national and multinational technical means of verification, including the communications links, even prior to the treaty’s entry into force.

Peering somewhat further into the future development of arms control, a rich agenda of ambitious possibilities looms. No one can anticipate the timetable on which this diverse series of bilateral, regional, and global initiatives may come to fruition, but it is easy to predict that verification provisions—in large part enabled by satellite NTM—will form a key aspect of any agreements, and that bans on interference will be prominent. These treaties may deal with topics such as: a cutoff in the production of fissile materials for use in nuclear weapons;²³⁸ a globalized expansion of the currently bilateral INF Treaty;²³⁹ pursuit of the complete abolition

²³⁵ *Station Profiles*, COMPREHENSIVE TEST BAN TREATY ORG., <http://www.ctbto.org/verification-regime/station-profiles/> (last visited Nov. 13, 2013).

²³⁶ *The Global Communications Infrastructure*, COMPREHENSIVE TEST BAN TREATY ORG., <http://www.ctbto.org/verification-regime/the-global-communications-infrastructure/> (last visited Nov. 13, 2013) (noting that the CTBT structure employs six geosynchronous satellites for communications to and from the International Data Center in Vienna, Austria).

²³⁷ Vienna Convention on the Law of Treaties art. 18, May 23, 1969, 1155 U.N.T.S. 331. The United States is not a party to this treaty, but accepts much of its content as customary international law. *Vienna Convention on the Law of Treaties*, U.S. DEP’T OF STATE, <http://www.state.gov/s/l/treaty/faqs/70139.htm> (last visited Nov. 13, 2013).

²³⁸ Daryl Kimball, *Fissile Material Cut-off Treaty (FMCT) at a Glance*, ARMS CONTROL ASSOC. (Aug. 2013), <http://www.armscontrol.org/factsheets/fmct>.

²³⁹ David A. Cooper, *Globalizing Reagan’s INF Treaty: Easier Done Than Said?* 20 NONPROLIFERATION REV. 1, 145 (2013); Catherine M. Kelleher & Scott L. Warren,

of nuclear weapons globally;²⁴⁰ and articulation of regional "nuclear weapons free zones."²⁴¹

The thesis advanced in this article, therefore, will only become stronger and more comprehensive in the years to come, as more arms control treaties are developed and extend the existing bans on interference with NTM; as more states become party to those obligations; as more countries, and an increasing array of international consortia, invest in satellite verification assets; as diverse types of NTM are placed in orbit to provide close, persistent monitoring of different types of terrestrial arms activities; and as more debris continues to accumulate in the most favored outer space lanes.

5.3. Counter-argument 3: Consent of the States

The third form of resistance to this thesis adopts a political perspective, arguing that it is "too clever by half" – it is implausible to suddenly spring a new form of legal obligation of this sort upon sovereign states. International law arises from the consent of states,²⁴² and unless the leading players voluntarily agree to accept a commitment restricting ASAT activities, it cannot be effective. This counter-argument contends that surprises—especially surprising interpretations of long-standing legal obligations—do not fit well into the structure of international law, and will not be honored.²⁴³

Getting to Zero Starts Here: Tactical Nuclear Weapons, ARMS CONTROL TODAY, Oct. 2009, http://www.armscontrol.org/act/2009_10/Kelleher.

²⁴⁰ See *The Global Zero Action Plan*, GLOBAL ZERO, <http://www.globalzero.org/get-the-facts/GZAP> (last visited Nov. 12, 2013).

²⁴¹ See, e.g., *WMD-Free Middle East Proposal at a Glance*, ARMS CONTROL ASSOC., <http://www.armscontrol.org/factsheets/mewmdfz> (last updated July 2013) (describing a proposed WMD-free zone in the Middle East).

²⁴² See *Legality of the Threat or Use of Nuclear Weapons*, Advisory Opinion, 1996 I.C.J. 226, 247, ¶ 52 (July 8) (affirming that international law is not generally structured to "authorize" states to use specified weapons; instead, the rules are cast as prohibitions); *S.S. Lotus (Fr. vs. Turk.)*, 1927 P.C.I.J. (ser. A) No. 10 (Sep. 7) (asserting the fundamental proposition that "Restrictions upon the independence of states cannot therefore be presumed"); RESTATEMENT, *supra* note 59, at § 102.1 ("A rule of international law is one that has been accepted as such by the international community of states.").

²⁴³ See *Rumsfeld Commission*, *supra* note 13, at 17 ("The U.S. must be cautious of agreements intended for one purpose that, when added to a larger web of treaties or regulations, may have the unintended consequences of restricting future activities in space.").

The response to this critique begins by acknowledging that a new treaty—or even a new non-legally-binding “code of conduct”—could be a preferable mechanism for insinuating into international law an effective curb on ASAT activities. Overt law-making of that sort carries the undoubted advantage of clarity regarding the precise content of the obligation and the roster of states upon whom it is binding.

But if the world is in the unfortunate situation in which the process of generating a new outer space treaty is unduly constipated, then other mechanisms can be brought into play. And here, after all, the proposed approach is to rely upon treaty law—to exercise, in fact, a series of provisions that leading states have repeatedly accepted in the most important international arms control agreements—but to apply those traditional passages with new rigor. The practice of international law—as with domestic law in all states—is replete with “surprises” of various sorts, as courts and other authorities sometimes construe existing legal obligations in ways that were unanticipated by the progenitors. The concept of “rule of law” sometimes demands respect for newly evolving, but legally sound, novel interpretations of old rules.

In another way, the scope of this article’s argument may be even more ambitious and surprising. That is, it is not only ASAT testing that generates the enormous hazards of space debris (although the Chinese 2007 collision stands apart as the single worst proliferator of the pernicious dangers). All space events can spawn debris, even those undertaken by actors sincerely committed to following the “best practices” articulated by the United Nations guidelines.²⁴⁴ Routine launches and operations are responsible for some degree of litter, and statistically foreseeable accidents and mishaps can be devastating for the space environment. Could the logic of this article be extended from opposing debris-creating ASAT tests to opposing all debris-creating space activities and labeling all of them as inconsistent with parties’ obligations under arms control treaties that protect NTM? If so, what would be the “limiting principle” for this extension? Surely, we would not leverage this analysis to prohibit any activity that generates any quantity of debris; that would effectively preclude all space operations (including even the launch

²⁴⁴ See *supra* text accompanying note 47 (regarding UN IADC guidelines).

of additional NTM!) This article simply notes that additional conundrum but does not explore it further.

6. CONCLUSION

Under pressure from the counter-arguments advanced above, the thesis of this article is modest. It would become appreciably more powerful when additional treaties—especially broad multilateral treaties (such as the CTBT) and, in particular, treaties that attract the participation of China—enter into force, and carry with them some variant of the standard boilerplate language prohibiting interference with NTM. Moreover, I readily concede that a comprehensive new space treaty, incorporating an overt, dedicated ASAT prohibition, could be a superior mechanism. Such an agreement could inspire widespread support, and resolve numerous tricky definitional and verification issues.²⁴⁵ Most importantly, this type of agreement would protect all satellites (regardless of function or national origin), and would address both the directed energy ASAT systems and the debris-creating kinetic energy systems principally considered here.²⁴⁶

In the alternative, perhaps it is not simply wishful thinking to suggest that a general, global agreement might be crafted specifically to protect NTM (and MTM, as well). Under such a hypothetical NTM Treaty, parties could agree to refrain from interference (and also promise not to undertake concealment measures) that would impair verification with any arms control treaty, regardless of their status as parties or non-parties to those other accords. Conceivably, all states could recognize that they share an interest in protecting the stability and mutual confidence that NTM promote. They would agree to refrain from acts, such as

²⁴⁵ See *supra* text accompanying note 77-78 (discussing complex definitional and verification issues in any effective ASAT treaty).

²⁴⁶ Cf. BLACK, *supra* note 168, at 5-8; GALLAGHER & STEINBRUNER, *supra* note 6, at 76-78; LYALL & LARSEN, *supra* note 2, at 307, 564-65 (advocating a formal, legally binding treaty on space debris as "the best way to achieve International Law in precision"); Rebecca Johnson, *NGO Approaches and Initiatives for Addressing Space Security*, in *FUTURE SECURITY IN SPACE*, *supra* note 205, at 61-69; KREPON & CLARY, *supra* note 7; Liemer & Chyba, *supra* note 77, at 154-57 (arguing for a limited ban on ASAT testing); Oppenheim, *supra* note 13 (proposing a treaty to ban KE ASAT tests). See also DoD Directive 3100.10, *supra* note 8, § 4.c (the official U.S. government policy statement, expressing objective of deterring and responding to attacks on allied space systems, as well as U.S. orbiters); 2010 *National Space Policy*, *supra* note 47, at 3.

unnecessary creation of significant space debris, which would jeopardize the treaty's goals.²⁴⁷

In yet another alternative, perhaps the leading spacefaring states could collude in the creation of a new norm of customary international law on point, to provide a degree of protection for NTM via avoidance of the generation of new ASAT-created space debris. Customary international law is a well-established source of authority arising from a longstanding, widespread and concordant practice undertaken by states out of a sense of legal obligation;²⁴⁸ it has been especially prominent as a source of space law.²⁴⁹ In the current environment, it could be argued that the "objective" half of that definition—the analysis of how states actually behave—is already met, because, in fact, nations do avoid interfering with each other's NTM (and all other satellites) with a high degree of regularity, and because debris-creating ASAT tests have been rare.²⁵⁰ On the other hand, the "subjective" or *opinio juris* element is lacking, because states have not yet confirmed that they exercise this pattern of self-restraint out of a sense that they are legally obligated (aside from the contents of any particular treaty that they have joined) to refrain from disrupting another state's NTM or from conducting ASAT tests.²⁵¹ If leading states were to change

²⁴⁷ See Arbatov, *supra* note 73, at 96-101 (offering a Russian perspective in favor of space arms control); Graham, *supra* note 93 (arguing for international legal protection of NTM). A partial analogy here would be to the 1992 Treaty on Open Skies, under which parties agree to allow frequent over-flights by other states' monitoring aircraft, outfitted with an array of sensors, as a confidence-building measure. Treaty on Open Skies, Mar. 24, 1992, S. TREATY DOC. NO. 102-37 (1992). This treaty does not entail any actual reductions or limitations upon participating states' weapons, but it can support the openness that can facilitate other arms control regimes. Daryl Kimball, *The Open Skies Treaty at a Glance*, ARMS CONTROL ASSOC. (Oct. 2012), <http://www.armscontrol.org/factsheets/openskies>.

²⁴⁸ RESTATEMENT, *supra* note 59, at § 102.2 (1986) (identifying customary international law as a primary source of international law); Statute of the International Court of Justice art. 38(1)(b), June 26, 1945, 59 Stat. 1031, 33 U.N.T.S. 993 (listing international custom as one of the kinds of law the court will apply); LYALL & LARSEN, *supra* note 2, at 42-43, 70-80 (discussing how elements of the OST have passed into customary international law).

²⁴⁹ Cheng, *supra* note 59, at 23.

²⁵⁰ RESTATEMENT, *supra* note 59, at § 102 at cmt. b, rep. n.2 (1986) (discussing how the 1962 United Nations General Assembly's Outer Space Resolution could have become customary international law, even in the absence of the OST).

²⁵¹ *Id.* § 102 at cmt. c; Int'l Law Assoc., Res. 16/2000, *Statement of Principles Applicable to the Formation of General Customary International Law*, in INT'L LAW ASSOC., REPORT OF THE SIXTY-NINTH CONFERENCE, LONDON 712, 719-21 (2000)

their tune, however, and affirm their belief that such a general obligation already exists, the magic of customary international law could soon make it so.²⁵²

But the world does not have the luxury of unlimited time to pursue these alternative law-making mechanisms. An unprecedented constellation of adverse factors demands a prompt solution: we face the exacerbating proliferation of space debris, combined with the incipient danger of an accelerating arms race in outer space, replete with additional development and testing of ASAT mechanisms.²⁵³ On the positive side, the world has finally awoken to the dangers of space debris and its threat to safe, efficient, and profitable exploitation of the myriad benefits of outer space. Despite the seemingly intractable resistance to new treaties, it may be possible to achieve progress through the sleight of hand suggested in this article.

Aside from any new international agreement, therefore, an additional political function of advancing this thesis could be to help rally the space community against the dangers of ASATs and to prompt concerted action in resistance to their re-emergence. The article provides a legal, as well as political, rationale for condemning debris-creating ASAT tests; it suggests a context for "naming and shaming" those states that violate the taboo and threaten to disrupt others' NTM satellite activities.

On the level of individual countries, perhaps this analysis can help inspire leadership toward unilateral action in opposition to

(arguing that the subjective element is not usually necessary for the establishment of a rule of customary international law); Peter Hulsroj, *Beyond Global: The International Imperative of Space*, 18 SPACE POL'Y 107 (2002). See Harrison, Shackelford & Jackson, *supra* note 7, at 19 (noting that the United States and the U.S.S.R./Russia have de facto extended the non-interference obligation contained in arms control treaties to cover "the entire military space constellation of the other," instead of confining it solely to NTM; there are no public statements in either country reflecting a commitment to this practice).

²⁵² But see DEN DEKKER, *supra* note 146, at 62-66 (concluding that states have been reluctant to create arms control rules via custom instead of treaty, and "In the field of arms control it is difficult to establish rules of customary international law").

²⁵³ Johnson-Freese, *Learning*, *supra* note 77 (arguing that U.S. diplomatic silence has been unsuccessful in persuading other countries to refrain from ASAT development); Hitchens, *Saving Space*, *supra* note 12, at 3, 5 (calling the 2007 Chinese ASAT test a "game-changer," and asserting that "the threats to safety and security in outer space today are arguably greater than even at the height of the Cold War").

ASAT developments. That is, reflecting upon the NTM provisions of arms control treaties may remind national decision-makers that they have sound, historically-tested reasons to protect satellites, not to march further down a pathway that exposes these vulnerable space assets to additional jeopardy. Self-restraint, of course, does not guarantee that other space actors will reciprocate, but the converse is surely true: if one state pioneers the next round of an ASAT development race, others will surely follow.

On the collective level, perhaps this argument can help prompt fresh action on a broader, more ambitious agenda of space governance. Paul B. Larsen has suggested the possible application to outer space of the principles that have so successfully facilitated international civil aviation—"rules of the road" for safe, secure, and profitable traffic management.²⁵⁴

Even if recognition of this thesis seems a stretch at the moment, events will propel it forward. In the years to come, more states will orbit more satellites to fulfill more functions, including NTM functions, pursuant to more treaties. Creative adoption of new technologies may soon amplify these trends as well. The U.S. Department of State has recently promoted the notion—including through sponsorship of a vigorous public innovation competition—that "societal monitoring," such as via new programs of social media, can play a role in verifying compliance with arms control treaties.²⁵⁵ Cellphone and tablet applications, for example, could empower ordinary citizens around the world to monitor and report about their country's behavior in newfound ways—not only by sending telltale photographs to international

²⁵⁴ Larsen, *supra* note 22.

²⁵⁵ See *Innovation in Arms Control Challenge: How Can the Crowd Support Arms Control Transparency Efforts?* INNOCENTIVE (Aug. 28, 2012), <https://www.innocentive.com/ar/challenge/9933144> (describing the innovation competition sponsored by U.S. Department of State to generate new ideas for transparency and social verification mechanisms utilizing widely accessible information technologies); Press Release, U.S. Dep't of State, *U.S. Department of State Launches the "Innovation in Arms Control Challenge"* (Aug. 28, 2012), available at <http://www.state.gov/r/pa/prs/ps/2012/08/196962.html> (announcing a contest in which the public is challenged to suggest how information technology advancements can help shape arms control verification); Rose Gottemoeller, Acting Under Sec'y for Arms Control & Int'l Sec, Remarks: Arms Control in the Information Age: Harnessing "Sisu," (Aug. 29, 2012), available at <http://translations.state.gov/st/english/texttrans/2012/08/20120831135358.html#axzz2XK9QXumb>.

authorities, but also by downloading onto ubiquitous personal electronics new capabilities such as for detecting small earth tremors that could substantiate doubts about clandestine nuclear weapons testing. If crowd sourced data of those sorts proliferated, could they someday be considered as a component of another state's NTM mechanism (or of an international organization's MTM), protected from interference and concealment?

In sum, the thesis advanced here is an attempt to leverage existing treaty law to effectuate some surprising limits on a dangerous outer space activity in a situation where the achievement of more direct restraints has proven problematic. The hope, of course, is that the concept will expand: that if a country is precluded from conducting debris-creating ASAT tests (or uses) that interfere with other parties' NTM, there will *de facto* be a prohibition on *all* kinetic ASAT events, and all satellites of all states—not solely NTM of participating states—will be indirect beneficiaries.²⁵⁶ As James Clay Moltz has observed, there is an important symbiotic relationship: wise measures of arms control can contribute to the stability of the outer space regime (by creating the conditions for peaceful interaction among leading players) and, conversely, stability in outer space can simultaneously promote arms control (by ensuring effective verification of compliance through reliable NTM monitoring).²⁵⁷

²⁵⁶ An important subsidiary question, not addressed in this article, concerns the application or suspension of the NTM-protecting provisions of arms control treaties during a time of armed conflict. None of the treaties discussed in this article explicitly contemplates this point, and it would be difficult to assess the unexpressed intentions of the drafters. It might seem implausible that belligerent states would be obligated generally to refrain from interfering with each other's earth observation and communications satellites, since the reconnaissance data and transmission links provided for arms control purposes could also be valuable for waging war. See OTA, *supra* note 19, at 39 (asserting that arms control treaties would be suspended during war); Arbatov, *supra* note 73, at 91-92 ("During times of war, however, prohibitions against interfering with [another nation's orbital support systems] . . . could hardly be expected to hold."). On the other hand, the NTM of neutral states should still be respected—and debris, such as that created by use of a kinetic energy ASAT, would jeopardize all states' NTM into the indefinite future. Regarding the author's perspective on the legality of the use of ASATs during wartime, see David A. Koplow, *ASAT-ification: Customary International Law and the Regulation of Anti-Satellite Weapons*, 30 MICH. J. INT'L L. 1187 (2009).

²⁵⁷ MOLTZ, *supra* note 211, at 45.

In the interim, a similar analysis might also suggest the possibility for a finding that other types of satellites are likewise serendipitously protected by cognate shreds of existing international law. For example, modern arms control treaties now frequently provide mechanisms for "on-site inspection," through which designated personnel dispatched by an international organization are privileged to conduct intrusive searches and other investigations inside the territories of member states to ensure that no illegal activities are being undertaken.²⁵⁸ Routinely, the relevant treaties provide that the inspectors shall have the right to unfettered communications with their home headquarters²⁵⁹ and that the inspected state shall not impede that function.²⁶⁰ If those communications (at the inspectors' discretion) occur via satellite-enabled means, does that imply that the inspected state has an obligation, in good faith, not to interfere with those satellites? And would the inspected state therefore be in breach of its duty if it conducted an ASAT test or use that generated a persistent debris cloud that impaired the normal functioning of that satellite network?

In similar fashion, perhaps other treaties, initially designed as bilateral confidence-building and crisis-defusing instruments, can support this broader function, too. For example, under the 1971 U.S.-U.S.S.R. Agreement to Improve the Direct Communications Link (the "hotline"), the parties agreed to "take all possible measures to assure the continuous and reliable operation of the

²⁵⁸ See, e.g., CWC, *supra* note 92, at art. IX Annex on Implementation and Verification, Part X (establishing a regime for challenge inspections); CTBT, *supra* note 92, at art. IV.D & Protocol, Part II.

²⁵⁹ See, e.g., CWC, *supra* note 92, at Verification Annex, Part II.E(44) ("Inspectors shall have the right throughout the in-country period to communicate with the Headquarters of the Technical Secretariat. For this purpose they may use their own, duly certified, approved equipment."); CTBT, *supra* note 92, at Protocol, Part II.E (62) ("The members of the inspection team shall have the right at all times during the on-site inspection to communicate with each other and with the Technical Secretariat. For this purpose they may use their own duly approved and certified equipment with the consent of the inspected State Party, to the extent that the inspected State Party does not provide them with access to other telecommunications.").

²⁶⁰ See, e.g., CTBT, *supra* note 92, at art. IV.D(57)(e) (stating that the inspected state has the obligation not to impede the ability of the inspection team to carry out inspection activities).

communications circuits.”²⁶¹ Likewise, under the 1971 Accidents Measures Agreement, each superpower undertook to notify the other immediately “in the event of signs of interference” with its missile warning systems or related communications facilities.²⁶² Since these mechanisms did, and still do, rely upon satellite services, maybe these early international instruments can now be spun into a broader commitment not to undertake debris-creating ASAT activities that would inhibit their vital communications capabilities.²⁶³

Even more broadly – well outside the specialized realm of arms control – the Vienna Convention on Diplomatic Relations enshrines a state’s obligation to “permit and protect free communication on the part of the mission for all official purposes”²⁶⁴ and empowers the diplomats to “employ all appropriate means”²⁶⁵ for communications, which would, of course, include satellite mechanisms. Can this provision, ostensibly established as part of a framework for diplomatic privileges and immunities, likewise be inflated into a covert constraint upon ASAT activities that produce

²⁶¹ Agreement Supplementing and Modifying the Agreement on Measures to Improve the U.S.A.-U.S.S.R. Direct Communications Link, U.S.-U.S.S.R., art. 2, Sept. 30, 1971, 806 U.N.T.S. 402.

²⁶² Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War, U.S.-U.S.S.R., art. 3, Sept. 30, 1971, 807 U.N.T.S. 57.

²⁶³ Grego, *supra* note 70, at 3-4. See also Agreement between the United States of America and the Union of Soviet Socialist Republics to Expand the U.S.-U.S.S.R. Direct Communications Link, U.S.-U.S.S.R., ¶ 6, Jul. 17, 1984, available at <http://www.state.gov/t/isn/4786.htm> (mandating that parties shall “[t]ake all possible measures to assure the continuous, secure and reliable operation” of “hot line” communications links); Agreement between the United States of America and the Union of Soviet Socialist Republics on the Establishment of Nuclear Risk Reduction Centers Protocol II, U.S.-U.S.S.R., art. 7, Sept. 15, 1987, available at <http://www.state.gov/t/isn/215573.htm>; Agreement Between the Government of the United States of America and the Government of the Union of Soviet Socialist Republics on the Prevention of Dangerous Military Activities, art. II(1)(b), June 12, 1989, 28 I.L.M. 887 (committing parties to prevent “[u]sing a laser in such a manner that its radiation could cause harm to personnel or damage to equipment of the armed forces of the other Party”); *id.* at art. II(1)(d) (preventing “[i]nterfering with the command and control networks in a manner which could cause harm to personnel or damage to equipment of the armed forces of the other Party”).

²⁶⁴ Vienna Convention on Diplomatic Relations art. 27(1), Apr. 18, 1961, 23 U.S.T. 3227, 500 U.N.T.S. 95. See also Vienna Convention on Consular Relations art. 35(1), Apr. 24, 1963, 21 U.S.T. 77, 596 U.N.T.S. 261 (providing freedom of communications for consular officers in terms similar to those for diplomats).

²⁶⁵ *Id.*

hordes of space debris that will eventually subvert the mandate to “permit and protect” communications? Today, 189 countries (including Russia and China, as well as the United States) are party to this agreement.²⁶⁶ Although it does not incorporate the express prohibition against “interference” with satellites that arms control treaties have included, perhaps the notion of “good faith” in treaty implementation²⁶⁷ drives to a similar result.²⁶⁸

It may, indeed, seem peculiar to use international law in this novel way – identifying malleable scraps of existing treaty law and bending them to purposes unforeseen by their originators. But this sort of new inferential legal understanding—even if it suddenly springs full-grown, instead of via the more traditional birthing process for international law—may have a salutary and essential impact in this urgent, under-developed area.

²⁶⁶ *Vienna Convention on Diplomatic Relations*, U.N. TREATY COLLECTION, http://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=III-3&chapter=3&lang=en#EndDec (last visited Nov. 13, 2013).

²⁶⁷ *Vienna Convention on the Law of Treaties*, *supra* note 237, at art. 26 (“Every treaty in force is binding upon the parties to it and must be performed by them in good faith.”).

²⁶⁸ Even more broadly, established principles of international environmental law might already constitute restrictions upon debris-creating ASAT events, independent of any new treaty. See LYALL & LARSEN, *supra* note 2, at 275-311; David A. Koplow, *ASAT-isfaction*, *supra* note 256, at 1187; Mirmina, *supra* note 26.

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