Deterrence as the MacGuffin: The Case for Arms Control in Outer Space

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INTRODUCTION

Legendary Hollywood directors Alfred Hitchcock and John Huston perfected the literary device of the "MacGuffin" in classic *film noir* thrillers such as "The 39 Steps" and "The Maltese Falcon." A MacGuffin is an object, goal, or other motivator, not always fully explained or justified, that drives the plot's action, by inspiring the protagonists to pursue it with ceaseless zeal, determination, and sacrifice. It doesn't matter all that much just what the MacGuffin really consists of – some pilfered secret government plans for a silent aircraft engine, an elusive ancient jewel-encrusted statuette of a bird, or in later incarnations, the Lost Ark of the Covenant or the rebels' vulnerability analysis for the Death Star – as long as the actors value it and devote themselves to seeking, acquiring, protecting, and exploiting it. They may voyage all over the world in suspenseful hot pursuit of the MacGuffin, never being sure just where the adventure will take them, how much it may cost, or what bodily harm they may have to endure in the quest.[1]

In like fashion, the concept of deterrence has long been the MacGuffin of modern U.S. defense strategy and doctrine. For decades, deterrence has been portrayed as the Holy Grail of strategic thought and action, to be stalked and husbanded relentlessly. Key actors and commentators perpetually extoll its virtues and underscore its importance, while the intricate plot lines of international relations bubble around it. Fervent writings parse the arcane sources and the diverse meanings of deterrence, scrutinize its many applications, and expound upon its extension to all manner of additional targets and sectors. We worry breathlessly about whether we have it, or does someone else have it, or have we suddenly lost it (deterrence is frequently said to be sacrificed when we are "lulled to sleep" by erstwhile favorable security developments that can nonetheless be exploited by cunning rogues). We certainly devote limitless time and treasure to the pursuit of deterrence, and we indefatigably inject military and diplomatic personnel into danger zones all around the globe to support and promote it.

This Article argues that deterrence is not enough; sound national security policy requires a more complicated, multi-pronged approach, pairing the leitmotif of deterrence with additional methods. In one regard, this contention is not at all surprising. Indeed, within the realm of nuclear weapons, the trophy of deterrence has always been tightly paired with the art and science of another distinct strategic concept: arms control and disarmament. Generations of SALT, START, test ban, and other nuclear agreements have long recognized that judicious diplomatic and legal measures can accomplish what the craft of deterrence alone cannot: arms control treaties can emplace direct reductions in the numbers, types, and capabilities of the deadly weapons that adversaries can field against us, and can help shape their deployment and use.

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1. *See* MICHAEL WALKER, HITCHCOCK'S MOTIFS 296-306 (2005); *MacGuffin*, WIKIPEDIA, https://en.wikipedia.org/wiki/MacGuffin (last updated Sept. 23, 2019); *What Is a MacGuffin?*, ELEMENTSOFCINEMA.COM, https://perma.cc/5Y8X-LF6Q; *Frequently-Asked Questions*, 'THE MACGUFFIN' WEB PAGES, https://perma.cc/LP29-M4ZM (last updated Mar. 22, 2016).

But, oddly, that insight from the nuclear realm of mating deterrence with arms control has not been applied to outer space. Regarding space, when the United States confronts, as it does today, a growing perception of a rising international threat, it is deterrence – and deterrence alone – that has been summoned. Concepts for arms control – even relatively modest initial and partial steps – are categorically ruled off the table, as U.S. security professionals confine their analyses, rhetoric, and deployment programs to a reinvigorated quest for heavily weaponized pure deterrence in all its manifestations. This single-minded vision of arms racing is particularly problematic today because, as this Article seeks to demonstrate, the prospects for effective deterrence are considerably weaker, and the opportunities for meaningful arms control are appreciably stronger, in space than in the nuclear sector. A return to a more balanced approach, drawing upon both concepts in pursuit of security in space, is therefore overdue and imperative.

The Article is organized to advance that thesis as follows. After this Introduction, Part I provides essential background regarding the patterns of exploitation of space by the United States and others, for a wide and growing array of both military and civilian applications. It also describes the modern elevated threat to the stability and security of satellite services, and it highlights the recent U.S. responses to those provocations – including via bellicose leadership rhetoric, organizational reforms, and muscular new operational programs.

Part II then describes the theory and practice of deterrence. In the classic formulation, there are two complementary types of deterrence, each of which comprises two alternative sub-types. First, there is deterrence by threat of retaliation: the communication to adversaries that if they undertake hostile action X, we will respond with counter-action Y, which they would find so unpleasant, damaging, or expensive that it would deprive them of any gains or advantages that X might initially have seemed to offer. The two sub-types arise because our threatened retaliatory action Y might be symmetric or asymmetric – that is, it might roughly correspond to X in terms of quality, venue, and nature, or it might occur in a rather different mode or theater of operations.

The second main type is deterrence by denial, an effort to persuade the adversaries not to undertake actions we dislike because those actions will not succeed; we have the capability to frustrate the accomplishment of the harmful goals they have in mind. The sub-types here are interceptive (interrupting enemy action while it is underway) and self-protective (sheltering ourselves and our assets to withstand the potential effects of their attack).

In all of this, it should be noted, the vocabulary and structure of the various types and sub-types of deterrence are not completely standardized, and the components of the 2x2 matrix are not always clean and pure – there may be qualifications, overlaps, and fuzzy edges. But the key concept is that deterrence is a heavily psychological ploy: it attempts to persuade the opponents not to act in ways we disfavor, by altering their own calculations of the expected probabilities and payoffs.

Part III then introduces the alternative concept of arms control, which, in contrast to deterrence, undertakes to directly reduce the adversaries' military prowess, shaving their physical capability for launching the disfavored attack. An effective arms control instrument imposes cuts or other significant restrictions on the arsenal that stands at an enemy's disposal, rendering the opponent less powerful and less able to inflict damage upon us, our allies, and our interests. Of course, it imposes symmetric restrictions on our own military structures and strengths, too.

Here, the Article juxtaposes the full flowering of this approach in the nuclear realm (where decades of bipartisan practice have repeatedly demonstrated the value of arms control) with the sterility of the current American approach to security in space (where under both Republican and Democratic administrations, diplomatic activities of this nature have perpetually been non-starters). Of course, arms control is not a panacea; it requires grappling with severe and sometimes insurmountable obstacles, and there are persistent controversies over verification, compliance, and enforcement. But in dealing with the most substantial security problems, arms control should play an essential role.

Part IV then presents the heart of the matter: the analysis of why each of the four variants of deterrence is systematically less applicable in space. It highlights the asymmetry between the United States and its chief rivals in the exploitation of, and dependence upon, space assets and services, and it identifies other salient features that combine to make standard principles of deterrence – as robust as they may be in the nuclear and other realms – less suitable for extraterrestrial application.

Part V performs a companion service, highlighting the under-appreciated factors that should make arms control in space even more feasible than the sporadic successes in the nuclear history might suggest. There can be, of course, no guaranties of success in space arms control, but there are concrete reasons for optimism, as well as profound incentives to try.

Part VI concludes the Article, offering the bottom-line recommendation that U.S. security policy should now intelligently draw upon both deterrence and arms control in both the nuclear and space realms. The current anomaly – the antipathy to diplomacy in a sector where it could provide the greatest benefits – should be promptly reversed, and there are multiple opportunities for doing so.

In likening deterrence to a MacGuffin, I do not mean to disparage this critical focus of strategic theory and practice. Deterrence is not just a cheap theatrical gimmick; unlike the meaning of "Rosebud" in "Citizen Kane," deterrence has inherent value, and is essential to pursue. Deterrence in all its manifestations continues to make vital contributions to stability and safety across weapon types and locations. Instead, the analogy is simply intended to convey the suggestion that we should not be overly dazzled by our coveting of deterrence and too single-minded in the search for it; we need to be able to look beyond deterrence, to consider more deeply the complementary path of also emphasizing prudent measures of arms control in space.

I. SECURITY IN SPACE

This section addresses three main elements: a) the current and emerging patterns in the large and growing use of space by the United States and others, for both military and civilian purposes; b) the surge in problematic, potentially offensive experiments, spending, rhetoric, and bureaucratic reorganizations feeding the rising perception of threat to peaceful space activities; and c) a quick primer on the various genres of anti-satellite (ASAT) or space control weapons that may challenge the security and stability of the space regime.

A. The Use of Space

Space and satellite services are now thoroughly integrated into virtually all aspects of U.S. military and civilian life, and the contemporary patterns of ubiquitous exploitation and reliance will only deepen and broaden in the future.[2]

On the military side, the American defense and intelligence communities have for decades depended upon space-borne sensors and links for the performance of indispensable strategic functions, such as collecting essential data about other states' weapons developments and deployments, monitoring compliance with arms control treaties, sounding the first alert about hostile missile launches, and transmitting launch authorizations to our own nuclear armada. In addition, today a plethora of more tactical missions is assigned to satellites, too, including communicating among headquarters and fielded forces, providing battlefield reconnaissance, and guiding missiles, aircraft, naval vessels, land vehicles accurately toward their targets.[3] As then-Deputy Secretary of Defense William J. Lynn III explained in 2011, "Space systems enable our modern way of war. . .Without them, many of our most important military advantages evaporate. . .Today we rely on space for almost everything we do."[4]

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2. *See generally* U.S. DEF. INTELLIGENCE AGENCY, CHALLENGES TO SECURITY IN SPACE 11 (Jan. 2019) [hereinafter DIA], https://perma.cc/SUJ3-GP7H (describing key areas in which space-enabled applications affect people's daily lives); FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 1-2 (2d ed. 2018); DIV. ON ENG'G AND PHYSICAL SCI., NAT'L ACAD. OF SCI., ENG'G, AND MED., NATIONAL SECURITY SPACE DEFENSE AND PROTECTION 10-24 (2016) [hereinafter NAS REPORT], https://perma.cc/C2Q5-TPVT (surveying wide and growing array of space-enabled capabilities); STEVE LAMBAKIS, NAT'L INST. FOR PUB. POL'Y, FOREIGN SPACE CAPABILITIES: IMPLICATIONS FOR U.S. NATIONAL SECURITY (Sept. 2017), https://perma.cc/NQ8X-3WRL; ELBRIDGE COLBY, CTR. FOR A NEW AM. SECURITY, FROM SANCTUARY TO BATTLEFIELD: A FRAMEWORK FOR A U.S. DEFENSE AND DETERRENCE STRATEGY FOR SPACE (Jan. 2016), https://perma.cc/NC5J-FWPM.

3. NAS Report, *supra* note 2, at 24-26 (describing national security uses of space); LAMBAKIS, *supra* note 2, at 1-11, 41; COLBY, *supra* note 2, at 4 (describing U.S. satellites as vital to American preeminence in defense and intelligence operations, and noting that this reliance is increasing); MAX M. MUTSCHLER, ARMS CONTROL IN SPACE: EXPLORING CONDITIONS FOR PREVENTIVE ARMS CONTROL 106–08 (2013).

4. William J. Lynn III, *A Military Strategy for the New Space Environment*, 34 WASH. Q., June 2011, at 7, 10 (adding that space systems "allow our warfighters to strike with precision, to navigate with accuracy, to communicate with certainty."). *See also* LAMBAKIS, *supra* note 2, at 2 (quoting then-Commander of U.S. Strategic Command, Gen. John Hyten, saying that "[s]pace is critical to everything that we do in the military."); *The Battle Above* (CBS News broadcast Apr. 26, 2015), https://perma.cc/HZK8-6U4P (also quoting Hyten about the military importance of space).

The U.S. civilian economy is similarly inextricably space-enabled. Many communications links (voice, email, television, and Internet) are routed via satellites, as are routine credit card purchases. The elaborate minuet of just-in-time business transactions and shipments is largely coordinated via space, as are the now-familiar GPS tracking and positioning. Satellites are vital for weather forecasting, for land use management monitoring, and for disaster relief coordination.[5] The Internet of Things will multiply the reliance upon satellites; space already amounts to a $345 billion per year sector of the global economy.[6]

Other countries hover a step or two behind the United States in the progression toward space, but many are advancing along a similar trajectory, with both military and civilian applications in mind.[7] Already eleven states or consortia have demonstrated a capability for launching objects into space, sixty or more own or operate their own satellites, and all benefit from satellite services.[8] The imminent

5. LAMBAKIS, *supra* note 2, at 1 (citing U.S. military leaders asserting that American prosperity depends upon access to space and that "space underpins our Nation's way of life in peacetime and provides critical warfighting capabilities during conflict."); SPACE SECURITY INDEX 54-60 (Jessica West ed., 15th ed. 2018), http://spacesecurityindex.org/ (summarizing diverse civilian uses of satellite services); LYALL & LARSEN, *supra* note 2, at 227-34 (describing future space tourism); NAS REPORT, *supra* note 2, at 12-14 (describing civil uses of space); UNION OF CONCERNED SCIENTISTS, *What Are Satellites Used For?*, (Jan. 15, 2015), https://perma.cc/5YFE-FDHE; Jeff Greenblatt & Al Anzaldua, *How Space Technology Benefits the Earth*, SPACE REV. (July 29, 2019), https://perma.cc/GW7Q-QNZH.

6. OFFICE OF COMMERCIAL SPACE TRANSP., FED. AVIATION ADMIN, THE ANNUAL COMPENDIUM OF COMMERCIAL SPACE TRANSPORTATION: 2018, at 9 (Jan. 2018), https://perma.cc/V2L7-PAMA; LYALL & LARSEN, *supra* note 2, at 413-45 (describing commercial space activities of several states); NAS REPORT, *supra* note 2, at 13-19 (noting that demand for space services is not just growing, it is accelerating); Kevin O'Connell, *Remarks on the Trillion Dollar Space Economy*, OFFICE OF SPACE COMMERCE (Nov. 27, 2018), https://perma.cc/ECY8-Q4ZH; *Satellites May Connect the Entire World to the Internet*, ECONOMIST (Dec. 8, 2018), https://perma.cc/NH8E-5UHU; MORGAN STANLEY, SPACE: INVESTMENT IMPLICATIONS OF THE FINAL FRONTIER 10 (Oct. 12, 2017), https://perma.cc/7P7B-D2HV (predicting the global space economy to grow to $1.1 trillion by 2040); ALAN C. O'CONNOR ET AL., RTI INTERNATIONAL, ECONOMIC BENEFITS OF THE GLOBAL POSITIONING SYSTEM (GPS) – FINAL REPORT (June 2019), https://perma.cc/NE45-FF7F (estimating that the loss of GPS service would have a $1 billion per day impact on the U.S. economy).

7. TODD HARRISON ET. AL., CTR. FOR STRATEGIC & INT'L STUDIES, SPACE THREAT ASSESSMENT 2019 (Apr. 2019), https://perma.cc/A8DW-ZU52; LAMBAKIS, *supra* note 2, at 12-13; *Benefits of Space for Humankind*, U.N. OFFICE FOR OUTER SPACE AFFAIRS, https://perma.cc/2CWQ-NQDB; Murielle Delaporte, *From Paris to Orbit: France's New Space Strategy*, BREAKING DEFENSE (Jan. 3, 2019), https://perma.cc/QE9H-8XVK (describing French plans to modernize space capabilities); Joseph Trevithick, *The French Have Plans for a Constellation of Laser-Armed Miniature Satellites*, THE DRIVE (July 26, 2019), https://perma.cc/6VDR-BBAT; DANIEL R. COATS, CYBER SECURITY & INFO. SYS. INFO. ANALYSIS CTR., WORLDWIDE THREAT ASSESSMENT OF THE US INTELLIGENCE COMMUNITY 16-17 (Jan. 29, 2019), https://perma.cc/D5VV-KJFN (U.S. intelligence community assesses that commercial uses of space by many countries will continue to expand); West, *supra* note 5, at 83-94 (assessing growth of commercial space industry); LYALL & LARSEN, *supra* note 2, at 447-81 (describing military use of space by many countries); JOAN JOHNSON-FREESE, SPACE WARFARE IN THE 21ST CENTURY: ARMING THE HEAVENS 33–39 (2017).

8. Lynn, *supra* note 4 at 7, 8 (reporting that eleven states now operate twenty-two launch sites, and more than sixty nations have a presence in space); West, *supra* note 5, at 65 (citing ten states with launch capability and sixty-two as owners/operators of satellites); LAMBAKIS, *supra* note 2, at 12; DANIEL PORRAS, U.N. INST. FOR DISARMAMENT RESEARCH, SHARED RISKS: AN EXAMINATION OF UNIVERSAL SPACE SECURITY CHALLENGES 6-7 (2019) https://perma.cc/2TU9-2TC5; FRANK A. ROSE, BROOKINGS INST., SAFEGUARDING THE HEAVENS: THE UNITED STATES AND THE FUTURE OF NORMS OF BEHAVIOR IN OUTER

dazzling "democratization of space" – featuring dramatically reduced launch costs, the proliferation of inexpensive miniature spacecraft, and the blossoming of private sector entrepreneurship – augurs unprecedented multilateral engagement with exoatmospheric assets.[9]

Still, the United States remains the planet's preeminent space power. There is no authoritative "box score" of space activity, but in terms of number of orbiters, national budgets devoted to space, and (more impressionistically) benefits derived from space, there is a substantial gap between the United States and others.[10] The next leading powers, China and Russia (in either order), are assiduously devoting themselves to space, as are other industrialized players (including Japan, Canada, several European states, and the European community collectively), as well as many emerging space participants (such as Argentina, Brazil, India, Iran, Israel, Mexico, North Korea, and South Korea).[11] It is hard to say overall whether the gap between the United States and the others (on either the

Space 1 (June 2018), https://perma.cc/U2GK-QNTW; NAT'L AIR & SPACE INTELLIGENCE CTR., PUB. AFFAIRS OFFICE, COMPETING IN SPACE 3-12 (Dec. 2018) [hereinafter NASIC], https://perma.cc/2SHJ-FTLQ; U.S. DEP'T OF DEF. & OFFICE OF THE DIRECTOR OF NAT'L INTELLIGENCE, NATIONAL SECURITY SPACE STRATEGY 2 (Jan. 2011) [hereinafter NATIONAL SECURITY SPACE STRATEGY], https://perma.cc/9CEV-Y3MD; *The Battle Above*, *supra* note 4; Helene Fouquet & Ania Nussbaum, *France Joins 21st Century Space Race Fearing Future Conflict*, BLOOMBERG (Sept. 7, 2018), https://www.bloomberg.com/news/articles/2018-09-07/france-suspects-russian-space-attack-targeted-military-satellite.

9. Dave Baiocchi & William Welser IV, *The Democratization of Space: New Actors Need New Rules*, FOREIGN AFF., May/June 2015, https://www.foreignaffairs.com/articles/space/2015-04-20/democratization-space; PORRAS, *supra* note 8, at 6-7 (discussing new trends in the growing national and private space activities); West, *supra* note 5, at 83-94 (reporting growth of global commercial space industry); STANLEY, *supra* note 6, at 20-24 (describing growth of private sector space activities); TODD HARRISON ET AL., ESCALATION AND DETERRENCE IN THE SECOND SPACE AGE 8 (2017) (describing space today as increasingly diverse, disrupted, disordered, and dangerous).

10. *Two Breakup Events Reported*, ORBITAL DEBRIS Q., Aug. 2019, at 14 (listing 1778 active and defunct U.S. satellites in orbit, compared to 1527 for Russia, 356 for China, 175 for Japan, 97 for India, 89 for Europe, and 943 other), https://perma.cc/3KNP-PUHA; *The Battle Above*, *supra* note 4 (citing a $25 billion U.S. military budget for space); West, *supra* note 5, at 101-04 (counting 128 dedicated U.S. military satellites, 59 for Russia, and 48 for China).

11. DIA, *supra* note 2, at 13-21, 23-29 (describing China's and Russia's space strategy, organizations, and capabilities); U.S. DEP'T OF DEF., ANNUAL REPORT TO CONGRESS: MILITARY AND SECURITY DEVELOPMENTS INVOLVING THE PEOPLE'S REPUBLIC OF CHINA 2019, at 49-55 (reporting that "China's space program continues to mature rapidly" and "China continues development of multiple counterspace capabilities"), https://perma.cc/76LF-HTAV; U.S.-CHINA ECON. & SECURITY REVIEW COMM'N, USCC 2018 ANNUAL REPORT TO CONGRESS 177 (Nov. 2018) (reporting that "China has made progress in important projects deemed crucial for Beijing's space ambitions"), https://perma.cc/H98A-RTWQ; ANATOLY ZAK, RUSSIAN MILITARY AND DUAL-PURPOSE SPACECRAFT: LATEST STATUS AND OPERATIONAL OVERVIEW 2 (June 2019) (describing restoration of Russia's space program after fifteen years of neglect), https://perma.cc/442T-YU6X; PAVEL PODVIG & HUI ZHANG, AM. ACAD. OF ARTS AND SCI., RUSSIAN AND CHINESE RESPONSES TO US MILITARY PLANS IN SPACE (Jan. 2008) (discussing Russian and Chinese military space activities), https://perma.cc/PJB7-PJ5Z; HARRISON ET AL., *supra* note 7, at 25-29, 30-34, 21-40 (respectively discussing Iran's, North Korea's and other countries and non-state actors' military space capabilities); LAMBAKIS, *supra* note 2, at 11-12, 18-19; *Satellites in Our Everyday Lives*, CAN. SPACE AGENCY, https://perma.cc/B6SU-Y2MV; Jens Stoltenberg, *Press Conference by NATO Secretary General Jens Stoltenberg Following the Meetings of NATO Defence Ministers*, NORTH ATLANTIC TREATY ORG. (June 27, 2019), https://perma.cc/5BYA-SYZU (describing approval of overall NATO space policy, based on assessment that "Space is essential to the Alliance's defence and deterrence.").

military or the civilian balance sheet) is widening or narrowing (or some combination of both), but the roster of space-active states is impressive and mushrooming.[12]

B. Threats to Space

There has never been armed conflict in space, but neither has space been a sanctuary, free from military competition, arms races, and threats. Indeed, throughout the Cold War, the United States and the Soviet Union routinely developed, tested, and deployed all manner of ASAT devices, and brandished them for effect. Bursts of activity toward militarization of space were interspersed with phases featuring superpower self-restraint or accommodation, but partisans on both sides perpetually kept a wary eye on each other's initiatives toward space dominance.[13]

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12. *See* LAMBAKIS, *supra* note 2, at 11 (asserting that the United States clearly remains the leading space power today, but the gap between the United States and others is closing); FORREST E. MORGAN, DETERRENCE AND FIRST-STRIKE STABILITY IN SPACE: A PRELIMINARY ASSESSMENT 3 (2010) (arguing that the United States derives so much benefit from space that the fundamental U.S. national security interest is stability in the regime); STANLEY, *supra* note 6, at 29 (projecting various countries' future spending on space); Jacqueline Feldscher & Liu Zhen, *Are the U.S. and China on a War Footing in Space?*, POLITICO (June 16, 2019) (discussing origins and relative future strength of U.S. and Chinese anti-satellite capabilities); BRUCE W. MACDONALD ET AL., CRISIS STABILITY IN SPACE: CHINA AND OTHER CHALLENGES FOREIGN POLICY INSTITUTE 7 (2016) (reporting that the United States outspends China on space activities by a margin of $40 billion to $10 billion annually), https://perma.cc/7JUU-BSVV.

13. LAURA GREGO, UNION OF CONCERNED SCIENTISTS, A HISTORY OF ANTI-SATELLITE PROGRAMS (Jan. 2012) (presenting the evolving history of U.S. and other ASAT programs); PAUL B. STARES, THE MILITARIZATION OF SPACE: U.S. POLICY, 1945-1984 (1985); West, *supra* note 5, at 123-25 (summarizing history of development of ASAT capabilities by United States and U.S.S.R); NANCY GALLAGHER & JOHN D. STEINBRUNNER, AM. ACAD. OF ARTS & SCI., RECONSIDERING THE RULES FOR SPACE SECURITY 7-25 (Apr. 2008) (discussing the historical legacy of U.S. pursuit of space superiority), https://perma.cc/WUM8-QAVC; HARRISON ET AL., *supra* note 7, at 1 (asserting that "space has been a contested warfighting domain from the beginning"); DIA, *supra* note 2, at 7 (reporting that Russia and China are seeking means to exploit the U.S. reliance upon space-based systems, and Iran and North Korea have also demonstrated counterspace capabilities); BONNIE L. TRIEZENBERG, DETERRING SPACE WAR: AN EXPLORATORY ANALYSIS INCORPORATING PROSPECT THEORY INTO A GAME THEORETIC MODEL OF SPACE WARFARE 8-16 (Sept. 2017), https://perma.cc/UL9Q-Q5Y7; S. CHANDRASHEKAR & N. RAMANI, INT'L STRATEGIC & SECURITY STUDIES PROGRAMME, CHINA'S SPACE POWER AND MILITARY STRATEGY – THE ROLE OF THE YAOGAN SATELLITES (July 2018) (describing growth of China's military space surveillance programs); Morgan, *supra* note 12, at 7-13; Sam Jones, *Satellite Wars*, FIN. TIMES (Nov. 20, 2015), https://perma.cc/7YSF-7ZYL; Brian Weeden, *Real Talk and Real Solutions to Real Space Threats*, SPACE NEWS (Nov. 12, 2018) (emphasizing that the existence of counterspace capabilities is not new; both the United States and the U.S.S.R. developed, tested, and deployed multiple destructive ASAT systems during the Cold War), https://perma.cc/3Z7K-WQGM; Lee Billings, *War in Space May Be Closer Than Ever*, SCI. AM. (Aug. 10, 2015), https://perma.cc/4Y9B-AWZ6; Nicholas D. Wright, *China and Escalation in the "Gray Zone-Entangled Space Age*, *in* OUTER SPACE; EARTHLY ESCALATION?: CHINESE PERSPECTIVES ON SPACE OPERATIONS AND ESCALATION 5 (Nicholas D. Wright ed., 2018), https://perma.cc/NE4Z-FYGG (identifying three sequential epochs of space conflict); PODVIG & ZHANG, *supra* note 11, at 22 (describing early Soviet ASAT activities); Alexey Arbatov, *Arms Control in Outer Space: The Russian Angle, and a Possible Way Forward*, 75 BULL. ATOMIC SCIENTISTS 151, 151-52 (2019).

The current surge in perceived danger[14] can be roughly traced to 2007, when China abruptly launched an interceptor missile that collided with and destroyed an aging Chinese weather satellite at 865 km altitude, shattering both objects and resulting in a cloud of 3000 pieces of trackable debris.[15] This "wake up call" was both preceded and followed by other Chinese ASAT tests (sometimes undertaken under the cover of missile defense testing), exploring a variety of technologies and conducted at diverse altitudes. These events deliberately did not result in additional collisions but nonetheless validated the efficacy of the tracking, steering, and related techniques.[16]

Russia, too, has initiated a variety of ambitious military space activities, attempting to reestablish some of the capabilities that dissipated in the immediate aftermath of the Cold War. These exercises have featured some secretive or ambiguous programs, including investigations of an airborne laser ASAT, revivified

14. Regarding the current threats to the stability of space, see BRIAN WEEDEN & VICTORIA SAMSON, GLOBAL COUNTERSPACE CAPABILITIES: AN OPEN SOURCE ASSESSMENT, SECURE WORLD FOUNDATION (Apr. 2019); HARRISON ET AL., *supra* note 7; LAMBAKIS, *supra* note 2; Paul Meyer, *Diplomacy: The Missing Ingredient in Space Security, Simons Papers in Security and Development*, SIMONS PAPERS SECURITY & DEV., Nov. 2018, at 6 (describing ASAT systems as "moth-balled" and the ASAT threat as "dormant" until China's 2007 test); COLBY, *supra* note 2, at 9 (describing the noticeably more alarmed tone in recent discussions about U.S. space security); Russ Read, *Pentagon Official: Threats to US Space Systems "At an All-Time High"*, WASH. EXAMINER (Apr. 26, 2019), https://perma.cc/8GFT-NWTS (quoting senior Pentagon officials asserting that Russian and Chinese military activities in space pose an existential threat to U.S. military advantages, and tracing the surge in concern to China's 2007 ASAT test); James Lewis, *"Bottom Line Thinking" about the "Commanding Heights"*, *in* OUTER SPACE; EARTHLY ESCALATION?: CHINESE PERSPECTIVES ON SPACE OPERATIONS AND ESCALATION 20 (Nicholas D. Wright ed., 2018), https://perma.cc/Y3DS-4J7F (assessing Chinese strategy for space conflict).

15. Brian Weeden, *Through a Glass, Darkly: Chinese, American, and Russian Anti-Satellite Testing in Space*, SPACE REV. (Mar. 17, 2014), https://perma.cc/MR57-YB89; WEEDEN & SAMSON, *supra* note 14, at 1.9-1.10; Michael C. Mineiro, *FY-1C and USA-193 ASAT Intercepts: An Assessment of Legal Obligations under Article IX of the Outer Space Treaty*, 34 J. SPACE L. 321, 321 (2008); LAMBAKIS, *supra* note 2, at 42 (describing a U.S. "counter-space awakening" in response to rising perceptions of threat from Russian and Chinese military space activities); DIA, *supra* note 2, at 14-17, 20-21 (describing China's counterspace capabilities).

16. Weeden, *supra* note 15 (describing the sequence of Chinese ASAT tests); WEEDEN & SAMSON, *supra* note 14, at 1.1-1.22; HARRISON ET AL., *supra* note 7, at 8-16, 11 (quoting then-Lt Gen. James Raymond stating that because of China's investment in ASAT weapons, "soon every satellite in every orbit will be able to be held at risk"), 14 (quoting U.S. government assessments about China's growing ability to blind or damage U.S. satellite sensors); LAMBAKIS, *supra* note 2, at 19-26; U.S. DEF. INTELLIGENCE AGENCY, CHINA MILITARY POWER: MODERNIZING A FORCE TO FIGHT AND WIN 40-46 (2019), https://perma.cc/TMT8-2FCN (discussing China's space and counterspace programs); NASIC, *supra* note 8, at 14-23; COATS, *supra* note 7, at 17 (U.S. intelligence community assesses that "China and Russia are training and equipping their military space forces and fielding new antisatellite (ASAT) weapons to hold US and allied space services at risk"); DAVID A. DEPTULA ET AL., MITCHELL INST. FOR AEROSPACE STUDIES & MITRE CORP., MODERNIZING U.S. NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS 25-26 (Feb. 2019), https://perma.cc/HY8E-88J6; Billings, *supra* note 13; *The Battle Above*, *supra* note 4; U.S. DEP'T OF DEF., 2019 MISSILE DEFENSE REVIEW 20-22 (2019) [hereinafter MISSILE DEFENSE REVIEW], https://perma.cc/QDC6-GXSE; Mutschler, *supra* note 3, at 133-36 (discussing China's rise in space); PODVIG & ZHANG, *supra* note 11, at 31; STEVE LAMBAKIS, A GUIDE FOR THINKING ABOUT SPACE DETERRENCE AND CHINA (July 2019) [hereinafter LAMBAKIS, GUIDE FOR THINKING], https://perma.cc/GKB4-VF23.

covert pursuit of "rendezvous and proximity operations" (RPO) maneuvering technology that could be a precursor for advanced ASAT capabilities, and multiple close approach inspections of U.S. and allied high-altitude satellites.[17]

For its part, the United States has also flexed its space control muscle,[18] shooting down a failing weather satellite in 2008's Operation Burnt Frost.[19] The Pentagon has also, with studied understatement, developed the mysterious X-37B spacecraft – a small, long-endurance, unmanned version of a space shuttle – as a reusable, maneuverable vehicle potentially for inspecting or for attacking satellites.[20] The United States has also redoubled its capacity for "space situational awareness" – the ability to discern with greater fidelity what satellites are in orbit, where each is headed, and what their missions and capabilities may be.[21]

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17. WEEDEN & SAMSON, *supra* note 14, at 2.1-2.24; ZAK, *supra* note 11, at 3-4, 28; HARRISON ET AL., *supra* note 7, at 17-24, 19 (asserting that Russia has repeatedly tested, and is now deploying, several counterspace weapons), 21 (describing noteworthy 2017-18 Russian RPO testing); LAMBAKIS, *supra* note 2, at 26-31, 27 (asserting that "Russia today is experiencing a counterspace revival."); DIA, *supra* note 2, at 23-29 (describing Russia's counterspace programs); Theresa Hitchens, *Shanahan: China Is Deploying Directed Energy Weapons*, BREAKING DEF. (Apr. 9, 2019), https://perma.cc/C3GH-YS9T (reporting that U.S. Acting Secretary of Defense assesses that both China and Russia are deploying directed energy systems, weaponizing space "with the intent to hold American space capabilities at risk."); Yleem Poblete, *Remarks on Recent Russian Space Activities of Concern*, U.S. DEP'T OF STATE (Aug. 14, 2018) [hereinafter Poblete, *August 2018 Remarks*], https://perma.cc/C9JP-JSW9; Amanda Macias & Michael Sheetz, *Russia Conducted Another Successful Test of an Anti-Satellite Missile, According to a Classified US Intelligence Report*, CNBC.COM (Jan. 18, 2019), https://perma.cc/AG5Q-XHZP; Bill Gertz, *U.S. Says Small Russian Satellite a Space Weapon*, WASH. FREE BEACON (Aug. 15, 2018), https://perma.cc/NH8T-N8GC; Theresa Hitchens, *The Stellar Dance: US, Russia Satellites Make Potentially Risky Close Approaches*, BREAKING DEF. (Apr. 10, 2019) [hereinafter Hitchens, *Stellar Dance*], https://perma.cc/CJR8-HEFM; *The Battle Above*, *supra* note 4; PODVIG & ZHANG, *supra* note 11, at 1; Arbatov, *Arms Control*, *supra* note 13, at 152.

18. LAMBAKIS, *supra* note 2, at 49-51; Hitchens, *Stellar Dance*, *supra* note 17 (noting similarities between U.S. and Russian RPO exercises); Weeden, *supra* note 15, part 2.

19. LAMBAKIS, *supra* note 2, at 50; Nicole Petrucci, *Reflections on Operation Burnt Frost*, AIR POWER STRATEGY (Mar. 5, 2017), https://perma.cc/6CMQ-JV2P; Weeden, *supra* note 15, part 2.

20. Mike Wall, *X-37B: The Air Force's Mysterious Space Plane*, SPACE.COM (June 2, 2017), https://www.space.com/25275-x37b-space-plane.html; LAMBAKIS, supra note 2, at 51; GREGO, *supra* note 13, at 11; Oriana Pawlyk, *The Former Air Force Secretary Explains How the US Military's Secret Space Plane Drives Enemies "Nuts"*, TASK & PURPOSE (July 24, 2019), https://perma.cc/3WBU-JT4G. *See* Tom O'Connor, *U.S. Blames Russia and China for Space "Arms Race," But Refuses Their Weapons Ban*, NEWSWEEK (Mar. 20, 2019), https://perma.cc/4KTT-YFFP (reporting that the United States criticizes Russian and Chinese military activities in space, and they reciprocally blame the United States for initiating an arms race in space and declining to pursue arms control opportunities); Yang Sheng, *US Making Space Arms Race: Expert*, GLOBAL TIMES (Dec. 19, 2018), https://perma.cc/WU36-2PDQ (arguing that the United States has initiated the space arms race, forcing China to follow); *The Battle Above*, *supra* note 4.

21. WEEDEN & SAMSON, *supra* note 14, at 3.1-3.19 (noting that the United States possesses "the best military space capabilities in the world" (p. 3.1) and describing ongoing programs); West, *supra* note 5, at 43-52 (surveying U.S., Russian, and other space situational awareness capabilities, noting that improvements are a priority for the United States); LAMBAKIS, *supra* note 2, at 45-47 (discussing space situational awareness); U.S. AIR FORCE DOCTRINE, ANNEX 3-14 - COUNTERSPACE OPERATIONS (Aug. 27, 2018), https://perma.cc/RS48-VKPH; Billings, *supra* note 13; THERESA HITCHENS & JOAN JOHNSON-FREESE, TOWARD A NEW NATIONAL SECURITY SPACE STRATEGY: TIME FOR A STRATEGIC REBALANCING 3 (2016) [hereinafter HITCHENS & JOHNSON-FREESE] (describing the "quiet panic" in the U.S. space community following China's 2007 ASAT test).

Most recently, India has vigorously and ostentatiously entered the ASAT race, shooting down a test satellite on March 27, 2019 via a relatively low-altitude interception.[22]

Each of these protagonists has reinforced its military space budgets – for example, the United States hurriedly threw an additional $5-8 billion at the space control mission in 2015, to counteract the activities of its rivals.[23]

Pointedly, the published military doctrine and the public statements of the national leaders have vividly ratcheted up the verbal battle. U.S. military leaders – now vigorously joined by Trump Administration civilian leadership – have heralded space as the "new high ground" for military competition, emphasizing that space is no longer a sanctuary, but should be conceptualized as simply another venue for armed competition and eventually armed conflict. They insist that just as all other realms have seen war, so inevitably will space, and the United States must be armed and positioned to prevail. Mirror-image rhetoric emanates from Moscow and Beijing.[24]

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22. Marco Langbroek, *Why India's ASAT Test Was Reckless*, THE DIPLOMAT (Apr. 30, 2019), https://perma.cc/ZV2P-HK3R; Ankit Panda, *India Can Blow Up Satellites Now. And a New Space Arms Race Could Be Starting*, WASH. POST, Apr. 1, 2019; Ajey Lele, *The Implications of India's ASAT Test*, SPACE REV. (Apr. 1, 2019), https://perma.cc/R6QK-73VQ; Ankit Panda, *Exclusive: India Conducted a Failed Anti-Satellite Test in February 2019*, THE DIPLOMAT (Mar. 30, 2019), https://perma.cc/L3AA-9EPJ; GOV'T OF INDIA, MINISTRY OF EXTERNAL AFFAIRS, FREQUENTLY ASKED QUESTIONS ON MISSION SHAKTI, INDIA'S ANTI-SATELLITE MISSILE TEST CONDUCTED ON 27 MARCH 2019 (describing the test, and asserting that "India has no intention of entering into an arms race in outer space. We have always maintained that space must be used only for peaceful purposes. We are against the weaponization of Outer Space."); WEEDEN & SAMSON, *supra* note 14, at 6.1-6.4 (describing India's ASAT test); *see also* 4.1-4.4 (describing Iran's counterspace capabilities and programs), 5.1-5.5 (North Korea); LAMBAKIS, *supra* note 2, at 31-35 (discussing military space programs of Iran and North Korea); Micah Zenko, *Dangerous Space Incidents*, COUNCIL ON FOREIGN RELATIONS, Apr. 2014 (surveying potentially dangerous space activities by China, North Korea, and Iran); NASIC, *supra* note 8, at 24-25.

23. COLBY, supra note 2, at 9; *The Battle Above*, *supra* note 4; Billings, supra note 13; JOHNSON-FREESE, *supra* note 7, at 13; Varun Kumar, *Top 10+ Space Research Organisations in the World, 2019 Edition*, RANKED RED (June 2, 2019), https://perma.cc/K6MV-D34T; Charlie Campbell, *From Satellites to the Moon and Mars, China Is Quickly Becoming a Space Superpower*, TIME (July 17, 2019), https://perma.cc/NM5W-BT3G. *See also* LAMBAKIS, *supra* note 2, at 27 (asserting that Russia is spending $5 billion annually on military space activities).

24. WEEDEN & SAMSON, *supra* note 14, at 2.21-2.22 (describing Russian space doctrine and views about space warfare), 1.20-1.22 (Chinese policy statements); LAMBAKIS, *supra* note 2, at 22 (quoting Chinese Air Force commander asserting that "militarization of space is a 'historic inevitability'"); OUTER SPACE; EARTHLY ESCALATION?: CHINESE PERSPECTIVES ON SPACE OPERATIONS AND ESCALATION (Nicholas Wright ed., Aug. 2018), https://perma.cc/T8EF-BWK2 (discussing Chinese views of civil and military operations in space); Feldscher and Zhen, *supra* note 12 (quoting Chinese general asserting "If the United States thinks it can also drag China into an arms race and take down China as it did with the Soviets. . .in the end, probably it would not be China who is down on the ground. "); Dean Cheng, *Space and Information Warfare: A Key Battleground for Information Dominance*, *in* Wright, *supra* note, at 25 (describing Chinese view of "space shock and awe strikes"). The strident rhetoric about impending space conflict is not entirely new. *See, e.g.*, the 2001 report of the Space Commission, chaired by Donald Rumsfeld, which concluded that space warfare is a "virtual certainty." REPORT OF THE COMMISSION TO ASSESS UNITED STATES NATIONAL SECURITY SPACE MANAGEMENT AND ORGANIZATION EXECUTIVE SUMMARY 10 (Rumsfeld Commission) (Jan. 11, 2001), http://www.dod.gov/pubs/spaceintro.pdf; *President Donald J. Trump Is Establishing America's Space Force*, THE WHITE HOUSE (Feb. 19, 2019), https://perma.cc/HL6Q-FSNK (emphasizing steps toward "guaranteeing

The final component of this revised, more truculent alignment of power is the proposed or accomplished reorganization of the national bureaucratic elements responsible for propounding the military exploitation of space. Most sensational in this regard is the Trump Administration proposal to create a new U.S. Space Force, to lead the march toward space weaponization, domination, and combat. At this writing, it is not yet clear what the final composition of the proposed new institutions will be, but the motivation – to anticipate and to lead international military space competition – is manifest.[25] Proponents stress that China and Russia have already undertaken their own corresponding reconfigurations of their

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American space dominance" and the need to "Strengthen America's ability to compete, deter, and win in an increasingly contested domain," and asserting that "America will always seek peace through strength" and "space is now a warfighting domain just like the air, land and sea"); *Remarks by Vice President Pence at the Fourth Meeting of the National Space Council*, THE WHITE HOUSE (Oct. 23, 2018), https://perma.cc/P78K-W7HV (emphasizing that space is a warfighting domain and "America will be as dominant there as we are here on Earth" and the need "to deter and defeat a new generation of adversaries on that new horizon."); Theresa Hitchens, *Experts Warn Space Force Rhetoric Risks Backfiring*, BREAKING DEF. (May 28, 2019), https://perma.cc/39PC-T99T (citing experts who critique the Trump administration statements emphasizing offensive operations in space); GALLAGHER AND STEINBRUNNER, *supra* note 13, at 22-32; Valerie Insinna, *Air Force Leaders on Space Deterrence: 'At Some Point, We've Got to Hit Back,'* DEF. NEWS (Apr. 16, 2019), https://perma.cc/N7VM-GJX5 (reporting that "Deterrence was the watchword among U.S. Air Force leadership" at a space symposium, and Air Force Chief of Staff Gen. Dave Goldfein said "It's not enough to step into the ring and just bob and weave, block and parry, and absorb punches. At some point, we've got to hit back."); Joel Achenbach, *Trump and Pence Push "America First" Agenda to the Moon and Outer Space*, WASH. POST (Apr. 26, 2019), https://perma.cc/NM9D-XY5R (quoting prepared Senate testimony from Acting Secretary of Defense Patrick Shanahan and Chair of the Joint Chiefs of Staff Joseph F. Dunford Jr, "Having carefully observed our dependencies on space, China and Russia have developed new technologies, strategies, tactics, and asymmetric capabilities specifically intended to deny our freedom of operation in space. While we would prefer space remain free from conflict, they have made space a war-fighting domain."); Weeden, *supra* note 13 (emphasizing that the tangible change in current U.S. space policy is less important than the change in how overtly the United States publicly addresses space threats; "the United States has traditionally refrained from talking about space as a warfighting domain in public statements, because the geopolitical repercussions outweighed the rhetorical gains."); Patrick M. Shanahan, *Remarks by Acting Secretary of Defense Shanahan at the Center for Strategic and International Studies Followed by Discussion* (Mar. 20, 2019), https://perma.cc/M5XB-BQR6 (Acting Secretary of Defense asserts "My goal, and the department's goal, is to grow what we call our margin of dominance in space."); NATIONAL SECURITY SPACE STRATEGY, *supra* note 8, at 1 (reiterating the concept that "space is increasingly *congested*, *contested*, and *competitive*." (italics in original)); JOHNSON-FREESE, *supra* note 7, at 56-65; Theresa Hitchens, *Space Command Launched at Rose Garden, Gen. Raymond Speaks on Anti-Satellite Weapons*, BREAKING DEF. (Aug. 29, 2019) [hereinafter Hitchens, *Space Command*], https://perma.cc/YP8P-SUAB (noting U.S. military's increased willingness to use emphatic rhetoric emphasizing offensive space control operations).

25. U.S. DEP'T OF DEF., UNITED STATES SPACE FORCE 4 (Feb. 2019), https://perma.cc/D9AG-7LLZ (listing functions of proposed Space Force as including "prompt and sustained offensive and defensive space operations to achieve space superiority"); *U.S. Space Force, Top 10 Frequently Asked Questions*, U.S. DEP'T OF DEF., https://perma.cc/253G-XNLP (explaining that the Department of Defense "must reform its military space forces to be prepared to deter and, if necessary, defeat space threats to U.S. interests"); *Remarks by Vice President Pence on the Future of the U.S. Military in Space*, THE WHITE HOUSE (Aug. 9, 2018), https://perma.cc/EZP4-XQ6K (purpose of establishing Space Force is to ensure American dominance in space; proposal calls for "the creation of an elite group of joint warfighters specializing in the domain of space"); U.S. DEP'T OF DEF., FINAL REPORT ON ORGANIZATIONAL AND MANAGEMENT STRUCTURE FOR THE NATIONAL SECURITY SPACE COMPONENTS OF THE DEPARTMENT OF DEFENSE (Aug. 9, 2018), https://perma.cc/MWK2-Z4KD.

military space structures, thereby seizing an advantage, so the U.S. must reciprocate.[26]

Overall, the space environment today is precariously unsettled. Just when more countries and more private companies are entering the milieu, the threats to safe and secure operations are compounding. Especially – but not only – the United States, Russia, and China have enhanced their respective capabilities for confrontation and armed combat in space, and as RAND political scientist Forrest Morgan puts it, "the probability that space systems will come under attack in a future crisis or conflict is ever increasing."[27]

C. Types of Anti-Satellite Weapons

Humanity has demonstrated enormous creativity and persistence in fashioning new genres of ASATs and other devices for space control. For present purposes, three distinct destructive, damaging, or disruptive technologies can be examined.[28]

First, kinetic interceptors rely upon sending into space a physical mass that would collide with, or explode in proximity to, a targeted satellite. Traveling at enormous orbital speed, not much weight (but great accuracy) would be required to fatally damage a target by direct impact. Alternatively, both nuclear and conventional ASAT explosives have been explored. Any of these kinetic interceptors could be employed either in "direct ascent" mode, in which the attacker strikes its target very shortly after launch, or as a "co-orbital" device, which can loiter unobtrusively in space for a lengthy period of time before being activated to maneuver in search of its prey. A somewhat more deft variant would enable the attacking spacecraft to approach very slowly, permitting an inspection, manipulation, damage, or capture.[29]

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26. WEEDEN & SAMSON, *supra* note 14, at 1.22 (describing China's military reorganization), 2.24 (Russia); HARRISON ET AL., *supra* note 7, at 10-11 (discussing China's space organization), 18-19 (Russia); DIA, *supra* note 2, at 14-15 (describing China's space and counterspace organizations), 24 (same for Russia); U.S.-CHINA ECON. & SECURITY REV. COMM'N, 2018 REPORT TO CONGRESS 237 (Nov. 2018), https://perma.cc/S32Q-TLFK (describing China's military space organization); *Interview of Vice President Pence by Robert Costa at the Washington Post's Space Summit "Transformers: Space,"* THE WHITE HOUSE (Oct. 23, 2019), https://perma.cc/34UT-BG6J (citing Russia's and China's reorganizations of space forces as a reason for the United States to do the same); Elsa B. Kania, *China Has a "Space Force." What Are Its Lessons for the Pentagon?*, DEF. ONE (Sept. 29, 2018), https://perma.cc/V5A5-NHCZ.

27. Morgan, *supra* note 12, at ix. This striking combination of the heavy U.S. reliance upon space and the growing vulnerability of the satellite constellation is well summarized by Elbridge Colby: "The United States has therefore built an enormously expensive and delicate architecture of space assets upon which it greatly relies for its military preeminence – and left it increasingly vulnerable to adversary attack or disablement." COLBY, *supra* note 2, at 8.

28. GREGO, *supra* note 13; WEEDEN & SAMSON, *supra* note 14, at xv (noting that an ASAT weapon is just one type of space control device, and a country might seek to attack elements of an adversary's space systems other than the satellite in space; also explaining that offensive capabilities could be employed to deceive, disrupt, deny, degrade, or destroy opposing assets); HARRISON ET AL., *supra* note 7, at 2-7 (describing several types of counterspace weapons with varying features); DIA, *supra* note 2, at appendix B; Mutschler, *supra* note 3, at 109-12; PODVIG & ZHANG, *supra* note 11, at 57-62; HARRISON ET AL., *supra* note 9, at 10-18.

29. HARRISON ET AL., *supra* note 7, at 3; GREGO, *supra* note 13, at 3.

Second, directed energy systems, such as high-energy lasers, could be employed to permanently or temporarily blind or dazzle a satellite's sensors, or to burn a hole in a sensitive location, such as a fuel tank. In principle, such a laser could be stationed in space (where the speed-of-light beam would not be attenuated by the atmosphere) or on an airplane, but to date, the requirement for enormous fuel supplies has kept most such devices firmly rooted on Earth.[30]

Finally, there is the prospect for electronic or cyber ASAT systems, which might be employed to disrupt or even to commandeer the satellite's operations, or to impede or spoof the uplinks and downlinks between the orbiter and its ground control stations or receivers.[31]

Each of these potential kill mechanisms has been explored with zeal and rigor, and protagonists need not commit to just one path. Today, however, the global tide of opinion is flowing against the kinetic interceptors, because their operation would typically generate additional plumes of long-lasting debris in space, which is increasingly recognized as a great common hazard to all spacefaring states.[32] U.S. space leadership has been explicit about this preference, with General John Hyten, then the head of U.S. Space Command, saying "Whatever you do, don't create debris."[33]

The most sophisticated ASAT variants require considerable technological expertise, but some crude exemplars may be available to even the minor space

30. GREGO, *supra* note 13, at 9-11; HARRISON ET AL., *supra* note 7, at 3-4; Jeff Hecht, *A "Star Wars" Sequel? The Allure of Directed Energy for Space Weapons*, BULL. ATOMIC SCIENTISTS (June 28, 2019), https://perma.cc/74S5-R5KT; Bill Gertz, *Satellite Photos Show Chinese Anti-Satellite Laser Base*, WASH. FREE BEACON (Apr. 1, 2019), https://perma.cc/NN9R-YP5F.

31. HARRISON ET AL., *supra* note 7, at 4-5; Jones, *supra* note 13; West, *supra* note 5, at 114-18; Richard B. Langley, *Innovation: GNSS Spoofing Detection*, GPS WORLD (Jan. 1, 2013), https://perma.cc/7HR8-QYCK; Beyza Unal, *Cybersecurity of NATO's Space-based Strategic Assets*, CHATHAM HOUSE RESEARCH PAPER, July 2019.

32. NASA Orbital Debris Program Office, *Frequently Asked Questions*, NASA, https://perma.cc/9SL6-7HLS; West, *supra* note 5, at 11, 19-30 (noting that debris represents a significant, constant, growing, and indiscriminate threat to all spacecraft; there are 23,000 pieces of space debris large enough (ten cm or more in diameter) to be tracked from Earth, 500,000 pieces between one and ten cm, and millions of smaller items that could still be hazardous to spacecraft); LYALL & LARSEN, *supra* note 2, at 270-80; LAMBAKIS, *supra* note 2, at 40; Rose, *supra* note 8, at 1-2; *The Battle Above*, *supra* note 4; Jack Beard, *Soft Law's Failure on the Horizon: The International Code of Conduct for Outer Space Activities*, 38 U. PA. J. INT'L L. 335 (2016); SWISS RE, NEW SPACE, NEW DIMENSIONS, NEW CHALLENGES: HOW SATELLITE CONSTELLATIONS IMPACT SPACE RISK (July 17, 2018), https://www.swissre.com/Library/how-satellite-constellations-impact-space-risk.html.

33. Billings, *supra* note 13; U.S. DEP'T OF DEF., BUDGET JUSTIFICATION: SPACE CONTROL TECHNOLOGY, FISCAL YEAR 2004/2005 (2004), https://perma.cc/8D39-5CZ7 (stating that U.S. military policy is to "focus only on negation technologies which have temporary, localized, and reversible effects."); *see also* Colin Clark & Theresa Hitchens, *STRATCOM's Hyten Calls for Space Rules After India's ASAT Test*, BREAKING DEF. (Apr. 9, 2019), https://perma.cc/BE5B-W6ML (quoting Hyten as recommending international accord to limit the creation of space debris); Theresa Hitchens, *U.S. India ASAT Test React May Backfire, Experts Say*, BREAKING DEF. (Apr. 3, 2019), https://perma.cc/NAF7-PK8C (quoting NASA Administrator Jim Bridenstine as criticizing India's ASAT test as "a terrible, terrible thing" because it created debris that could jeopardize space operations). *But see* Hitchens, *Space Command*, *supra* note 24 (describing new U.S. military rhetoric that may suggest a greater willingness to contemplate kinetic ASAT operations that would create space debris).

powers.[34] The dual capability of some of the relevant technology plays a role, too: the ability to launch long-range ballistic missiles overlaps with the ability to launch satellites, and the testing of ASATs can be intertwined with the testing of missile defenses.[35] Moreover, attribution can be problematic – for example, it may be difficult to discern who has undertaken a laser dazzling of another state's satellite (and even more difficult to prove culpability via unclassified evidence that could persuade a skeptical global audience).[36]

In sum, the modern tools and tactics for possible space warfare are multiple, diverse, and growing. An attack could come from any azimuth and at any time, and the ongoing headlong rush toward additional military space capabilities will only intensify the dangers. Part II of this Article therefore addresses deterrence as one mechanism – currently, the leading and almost the sole approach – for avoiding an armed showdown in space.

II. THE THEORY AND PRACTICE OF DETERRENCE

Deterrence is a hardy perennial, with applications in multiple areas of human interaction.[37] At its core, deterrence is fundamentally a psychological

34. HARRISON ET AL., *supra* note 7, at 4-5 (reporting that the technology necessary to jam many types of satellite signals is commercially available, inexpensive, and difficult to detect); Joel R. Primack, *Debris and Future Space Activities*, *in* FUTURE SECURITY IN SPACE: COMMERCIAL, MILITARY, AND ARMS CONTROL TRADE-OFFS, CENTER FOR NONPROLIFERATION STUDIES 18, 21 (Occasional Paper No. 10 James Clay Moltz ed., July 2002), https://www.nonproliferation.org/10-future-security-in-space-commercial-military-and-arms-control-trade-offs/ (discussing possibilities for cheap but effective low-tech ASATs); MUTSCHLER, *supra* note 3, at 151 (discussing possibility of very low-cost ASAT devices, such as injecting a load of gravel into orbit in front of a target).

35. *New Sanctions Designations on Iran's Space Program*, U.S. DEP'T OF STATE (Sept. 3, 2019), https://perma.cc/R25B-WFSR (explaining that the United States imposes economic sanctions on Iran's space launch vehicles, because those technologies "are virtually identical and interchangeable with those used in ballistic missiles," so Iran's civilian space program "allows it to gain experience with various technologies necessary for development of an ICBM"); LAMBAKIS, *supra* note 2, at 50, 53, 74 (discussing applicability of missile defense assets for a space control mission); GREGO, *supra* note 13, at 2, 11-12 (discussing overlaps between early ASAT and missile defense programs); West, *supra* note 5, at 126-29; JOHNSON-FREESE, *supra* note 7, at 12 (citing the "nearly symbiotic relationship between the capabilities required for missile defense and for an ASAT.")

36. LAMBAKIS, *supra* note 2, at 69 (discussing the difficulty of identifying and attributing an attack against a satellite); Michael Krepon, *Space and Nuclear Deterrence*, *in* ANTI-SATELLITE WEAPONS, DETERRENCE AND SINO-AMERICAN SPACE RELATIONS 15, 28 (Michael Krepon & Julia Thompson eds., 2013) (noting that the attribution problem is likely to be more difficult regarding space attacks than regarding nuclear attacks).

37. The classic and modern literature about deterrence is voluminous and rich. Among the sources most valuable for this Article are: ALEXANDER L. GEORGE & RICHARD SMOKE, DETERRENCE IN AMERICAN FOREIGN POLICY: THEORY AND PRACTICE (1974) (emphasizing ancient roots of the practice of deterrence, and how nuclear deterrence is similar and different); THOMAS C. SCHELLING, THE STRATEGY OF CONFLICT (1960) [hereinafter SCHELLING, STRATEGY] (introducing the structures of game theory for international relations); THOMAS C. SCHELLING, ARMS AND INFLUENCE (1966) [hereinafter SCHELLING, ARMS]; HERMAN KAHN, ON THERMONUCLEAR WAR (1960); Bernard Brodie, *The Anatomy of Deterrence*, 11 WORLD POL. 173, 174 (1959) (stressing that "[d]eterrence as an element in national strategy or diplomacy is certainly nothing new under the sun. However, since the development of nuclear weapons, the term has acquired not only a special emphasis but also a distinctive connotation."); HENRY A. KISSINGER, NUCLEAR WEAPONS AND FOREIGN POLICY (1957); GLENN H. SNYDER,

phenomenon,[38] an effort to persuade another actor to adopt the course of action we prefer (or to refrain from taking actions we disfavor[39]) by altering his or her

Deterrence and Defense: Toward a Theory of National Security (1961); Robert Jervis, *Cooperation Under the Security Dilemma*, 30 WORLD POL. 167 (1978) (highlighting the "security dilemma," the fact that steps taken by one state to increase its security may decrease the security of others, so a military buildup by one may result in offsetting buildups by others, diminishing security for all); FRED C. IKLE & ALBERT WOHLSTETTER, COMM'N ON INTEGRATED LONG-TERM STRATEGY, DISCRIMINATE DETERRENCE (1988), https://perma.cc/AW89-BSG7; KEITH B. PAYNE, THE GREAT AMERICAN GAMBLE: DETERRENCE THEORY AND PRACTICE FROM THE COLD WAR TO THE TWENTY-FIRST CENTURY (2008); Albert Wohlstetter, *The Delicate Balance of Terror*, FOREIGN AFF., Jan. 1959, at 211; Robert Jervis, *Deterrence Theory Revisited*, 31 WORLD POL. 289 (1979) (concluding that deterrence theory "is probably the most influential school of thought in the American study of international relations"); ANDREW F. KREPINEVICH, JR., HUDSON INST., THE DECLINE OF DETERRENCE 6 (Mar. 12, 2019), https://perma.cc/394Y-CF62 (asserting that the United States has relied upon deterrence as the centerpiece of its defense strategy since the end of World War II); MICHAEL J. MAZARR, RAND CORP., UNDERSTANDING DETERRENCE (2018), https://perma.cc/ESB9-9QR9; AUSTIN LONG, RAND CORP., DETERRENCE: FROM COLD WAR TO LONG WAR (2008); Alexey Arbatov, *Nuclear Deterrence: A Guarantee or Threat to Strategic Stability?*, CARNEGIE MOSCOW CTR. (Mar. 22, 2019) [hereinafter Arbatov, *Deterrence*], https://perma.cc/R42E-LPHZ; Richard K. Betts, *The Lost Logic of Deterrence*, FOREIGN AFF., Mar./Apr. 2013, at 87 (critiquing post-Cold War practice of deterrence); THE RETURN OF DETERRENCE: CREDIBIILITY AND CAPABILITIES IN A NEW ERA (William G. Braun III, Stefanie von Hlatky & Kim Richard Nossal eds., 2019); Lawrence Freedman, *Does Deterrence Have a Future?*, ARMS CONTROL ASS'N (Oct. 2000).

38. *See* HENRY A. KISSINGER, WHITE HOUSE YEARS 67 (1979) ("[D]eterrence is a psychological phenomenon."); Robert Jervis, *Introduction: Approach and Assumptions*, *in* PSYCHOLOGY AND DETERRENCE 1 (1985) (writing "[d]eterrence posits a psychological relationship"); LONG, *supra* note 37, at 7 (observing that the etymology of the word "deterrence" is rooted in the Latin "terrēre", meaning "to terrify or frighten"); Karl P. Mueller, *The Absolute High Ground and the Ultimate High Ground: Why Nuclear Deterrence and Space Deterrence Are Strikingly Similar – Yet Profoundly Different*, *in* Krepon & Thompson, *supra* note 36, at 41, 42 ("First, and most fundamentally, deterrence is something that occurs in the mind of the enemy."); GEORGE & SMOKE, *supra* note 37, at 11 ("deterrence is simply the persuasion of one's opponent that the costs and/or risks of a given course of action he might take outweigh its benefits"); Roger G. Harrison et al., *Space Deterrence: The Delicate Balance of Risks*, 3 SPACE AND DEF. 1, 4 (2009) (analyzing the concept that deterrence aims to exercise "decisive influence" over an opponent's decisions about attacking); U.S. DEP'T OF DEF., DETERRENCE OPERATIONS: JOINT OPERATING CONCEPT 19 (Dec. 2006) [hereinafter JOINT OPERATING CONCEPT], https://perma.cc/9TJD-FJLK (asserting that "[t]he central idea of the [U.S. military Joint Operating Concept] is to decisively influence the adversary's decision-making calculus in order to prevent hostile actions against US vital interests."); SNYDER, *supra* note 37, at 13 (examining the deterrer's risk calculation).

39. Some literature in this field differentiates between deterrence and compellence, based on whether the primary actor seeks to motivate another player to refrain from undertaking a particular unwelcome action, or to affirmatively proceed with some other preferred action. For purposes of this Article, that distinction is unnecessary. *See* SCHELLING, STRATEGY, *supra* note 37, at 195–99; SCHELLING, ARMS, *supra* note 37, at 69–91; MAZARR, *supra* note 37, at 2.

A related policy structure seeks to deny a rival state the possibility of acquiring designated weapons, rather than deterring the rival from brandishing or using those weapons once they have been constructed. Efforts at nuclear non-proliferation through political, economic, military, or other means are a prototype of this approach. *See* Christopher Ashley Ford, Nonproliferation with Attitude: Counterproliferation Tools and Diplomacy in U.S. Foreign Policy, Address to the Heritage Foundation (Nov. 14, 2018); Joshua Rovner, *Nobody Loves Deterrence, But We'll Keep Doing It Anyway*, WAR ON THE ROCKS (Oct. 9, 2017), https://perma.cc/S9JT-SCH2 (describing strident U.S. resistance to North Korea and Iran obtaining nuclear weapons and the U.S. unwillingness to accept those states as nuclear powers and then rely on a policy of deterrence); Betts, *supra* note 37 (discussing U.S. policy to prevent Iran from acquiring a nuclear weapon). A policy of non-proliferation of ASAT capabilities is difficult to pursue and is beyond the scope of this Article.

perceptions of self-benefit.[40] We modulate what we say and do, and we adjust our capabilities, commitments, and communications in order to have an effect on someone else's decision-making. To be effective, a deterrence strategy must be premised upon insight into the other actor's values, preferences and assessments of the options available to him or her, our anticipated responses to those options, the likelihood of each possible outcome, and the costs and benefits resulting therefrom.[41]

Deterrence is applied in many walks of life; we all have experience as deterrer and deterree.[42] Negotiations between labor and management, with a threatened strike or lockout on the horizon; the implicit bargaining between oncoming motorists at an uncontrolled intersection; the whole concept and structure of criminal law enforcement; and the threat-and-retaliation cycle between parent and child at a contested bedtime all partake of a deterrence relationship. Not surprisingly, there is now a robust sub-literature focused on the art and science of deterrence in space.[43]

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40. This Article follows much of the standard international relations literature by anthropomorphizing states and treating them as analogous to individual human actors, with human motivations, perceptions, and reasoning capabilities. This conceptualization of states as unitary national actors is obviously a major assumption; for alternative structures, see the three conceptual models developed in GRAHAM T. ALLISON, ESSENCE OF DECISION: EXPLAINING THE CUBAN MISSILE CRISIS (1971).

41. As elaborated *infra*, text accompanying note 74, the assumption that each state actor behaves rationally in calculating costs and benefits is critical. Some often perceive deterrence as insufficient in dealing with an opponent who is driven by non-rational factors such as psychosis, religious zeal, or messianic fervor, or who possesses little of value that we could hold at risk. *See* LONG, *supra* note 37, at 72–84 (discussing deterrence of Saddam Hussein, Iran, North Korea, and al Qaeda); Stephen Maxwell, *Rationality in Deterrence*, 8 ADELPHI PAPERS, no. 50, Aug. 1968, at 1.

42. *See Deterrence, Nuclear Deterrence, Mutually Assured Destruction (MAD)*, 2 ENCYCLOPEDIA OF UNITED STATES NAT'L SECURITY (2006) (defining the key concepts); U.S. DEP'T OF DEF., DICTIONARY OF MILITARY AND ASSOCIATED TERMS 65 (July 2019), https://perma.cc/Z73V-TN3W (defining deterrence as "[t]he prevention of action by the existence of a credible threat of unacceptable counteraction and/or belief that the cost of action outweighs the perceived benefits."); KREPINEVICH, *supra* note 37, at 16 (defining deterrence as an effort to prevent a competitor from pursuing a proscribed action by influencing the target's calculations of costs, benefits and risks).

43. Bleddyn Bowen, *The Art of Space Deterrence*, EUR. LEADERSHIP NETWORK (Feb. 20, 2018), https://perma.cc/P2AE-MJ2M (stressing the intimate relationship between deterrence in space and deterrence on Earth); ALI JAFRI & JOHN A. STEVENSON, SPACE DETERRENCE: THE VULNERABILITY-CREDIBILITY TRADEOFF IN SPACE DOMAIN DETERRENCE STABILITY (Apr. 2018), https://perma.cc/V53P-VLJ5 (arguing that the principles of classic deterrence require careful tailoring for use in the space domain); Triezenberg, *supra* note 13; Harrison, Jackson & Shackelford, *supra* note 38, at 1 (specifying that "[t]here is little to be gained from attacks in space unless they translate into strategic or tactical advantage within the atmosphere. Space and terrestrial deterrence are therefore inextricably linked."), and at 3 (emphasizing that because space is a unique area of operations, "[a]nalogies to Cold War nuclear standoff are therefore suggestive, but not conclusive."); Bryan Boyce, *Twenty-First Century Deterrence in the Space War-Fighting Domain*, 33 AIR & SPACE POWER J. 34 (2019) (calling for multi-domain (with space) deterrence); Bruce W. MacDonald, *Deterrence and Crisis Stability in Space and Cyberspace*, *in* Krepon & Thompson, *supra* note 36, at 81, 87 (comparing features of deterrence in nuclear, space, cyber and conventional realms); MORGAN, *supra* note 12, at 21–35; MUTSCHLER, *supra* note 3, at 32–35 (identifying differing schools of thought about security in space); James P. Finch, *Bringing Space Crisis Stability Down to Earth*, 76 JOINT FORCE Q. 15 (2015); Christopher Stone, *Security through Vulnerability? The False Deterrence of the National Security Space Strategy*, SPACE

It is in the context of international security, however, that the theory and practice of deterrence have reached their apotheosis.[44] In state-to-state dealings when crucial issues of defense policy are at stake, the high priests of deterrence have identified a rich tapestry of genres and styles of deterrence. This Part distills two main types – deterrence by threat of retaliation and deterrence by denial – each of which is further divided into two complementary sub-components.[45] For each category, the following discussion presents the general concepts at play and then illustrates their operation by reference to both the nuclear and the space realms.

Throughout, steady deterrence relies upon a puissant combination of hardware, perception, and political will. First, we must have the military equipment necessary to accomplish the mission – often, a seemingly open-ended mandate for weapons acquisition programs. Second, we must be able reliably and swiftly to assess the nature and origin of a threat. Third, we must possess, and communicate to all concerned, an implacable determination to exert our capabilities as necessary. In all of this, it should be noted that deterrence is not a static yes/no question; it may exist to a certain degree, or as applied to a particular range of opposing countries, types of threats, and circumstances.[46]

Rev. (Apr. 13, 2015), https://perma.cc/9UJC-GXV7; Roger G. Harrison & Deron R. Jackson, *Space Deterrence: A Response*, SPACE REV. (June 22, 2015), https://perma.cc/4G2F-595L; Dean Cheng, *A Good Starting Point for Deterrence*, 3 SPACE & DEF. 31 (2009) (cautioning that other states may not fully accept U.S. notions of deterrence); James P. Finch & Shawn Steene, *Finding Space in Deterrence: Toward a General Framework for "Space Deterrence"*, 5 STRATEGIC STUD. Q. 10 (2011); Cheng, *supra note* 24, at 25 (Nicholas Wright ed., 2018) (describing China's concept of a deterrence or escalation ladder in space); JOHNSON-FREESE, *supra* note 7, at 81–103; Dean Cheng, *Prospects for Extended Deterrence in Space and Cyber: The Case of the PRC*, HERITAGE FOUND. (Jan. 21, 2016), https://perma.cc/5CVZ-HVMC (contrasting U.S. and Chinese views of deterrence regarding space); THERESE DELPECH, NUCLEAR DETERRENCE IN THE 21ST CENTURY: LESSONS FROM THE COLD WAR FOR A NEW ERA OF STRATEGIC PIRACY 141–50 (2012); Damon Coletta, *Space and Deterrence*, 7 ASTROPOLITICS 171 (2009); HARRISON ET AL., *supra* note 9; LAMBAKIS, GUIDE FOR THINKING, *supra* note 16.

44. *See, e.g.*, C. Todd Lopez, *4 Things to Know about U.S. Deterrence Strategy*, U.S. DEP'T OF DEF. (Apr. 1, 2019), https://perma.cc/Q225-WJST (quoting senior Pentagon officials asserting that nuclear deterrence is "our singular, most important mission;" that it is "the bedrock of U.S. national security;" that it "underwrites all U.S. military operations and diplomacy across the globe;" and it "is the backstop and foundation of our national defense.").

This Article sets aside the important related question of whether deterrence of a nuclear attack should be the sole mission for the U.S. strategic nuclear systems, or whether those forces should also be applied to deter attacks by conventional forces, to deter attacks upon U.S. allies, and as a war-fighting asset for other purposes. *See* BRUCE C. BLAIR ET AL., THE END OF NUCLEAR WARFIGHTING: MOVING TO A DETERRENCE-ONLY POSTURE: AN ALTERNATIVE U.S. NUCLEAR POSTURE REVIEW (2018).

45. *See* MAZARR, *supra* note 37, at 2–3 (differentiating deterrence by denial and deterrence by punishment; suggesting that in general, the former is more reliable); SNYDER, *supra* note 37, at 14–16 (examining types of deterrence); Harrison, Jackson & Shackelford, *supra* note 38, at 8, 18–22 (also introducing the concepts of deterrence by entanglement and deterrence by international norms); JOINT OPERATING CONCEPT, *supra* note 38, at 26; GEORGE & SMOKE, *supra* note 37, at 21 (emphasizing that prior to the nuclear age, the distinction between deterrence by threat of retaliation (the ability to hurt the opponent) and deterrence by denial (the ability to defeat the opponent) was not sharp; only with long-range nuclear weapons did it become possible to inflict devastating pain upon opponents without first defeating them on the battlefield); SCHELLING, ARMS, *supra* note 37, at 22 (same); Snyder, *supra* note 37, at 8.

46. *See* COLBY, *supra* note 2, at 26 (directing attention to the question of what is the likelihood of deterring country X from undertaking action Y in circumstance Z); JOINT OPERATING CONCEPT, *supra*

To anticipate the contrast that is developed further *infra*, deterrence is not simply or exclusively about procuring weapons, and arms control is not solely about cutting those inventories. But in practical political terms, a posture of exclusive reliance upon deterrence leads countries toward ceaselessly developing and deploying newer, better, and more weapons to counteract an opponent's ambitions; arms control, on the other hand, attempts to limit or constrain those cycles.

A. Deterrence by Threat of Retaliation

The first variant of deterrence has become so prominent – embodied in the prototypical Cold War nuclear relationship between the United States and the Soviet Union – that it is sometimes spoken of as the sum total of "deterrence" itself, obscuring the fact that in reality it represents simply one of the leading strains of deterrence.

The concept of deterrence by threat of retaliation relies upon the threatened infliction of pain or penalty upon an actor who undertakes practices we dislike. As noted, for the threat to be credible, we must effectively communicate our ability to perceive and attribute the adversary's actions, our physical capability to retaliate effectively, and our resolve to do so. We must possess the assets necessary to impose unacceptable costs upon the opponents, in order to manipulate their assessment of the expected net value of their contemplated action; and we must have the ability to assert, modulate, or withhold, infliction of those costs, depending upon whether the adversary provokes us or refrains from the path we disfavor. In some applications, we must have the ability to calibrate our retaliation with some finesse, to be able to respond in a manner that is discretely proportional to the provocation.[47]

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note 38, at 8 (U.S. military doctrine stresses that deterrence strategy must be robust and flexible to accommodate uncertainty and change in the security environment), 11–12 (underscoring risks and dynamic changes that deterrence strategy must confront).

47. *See* President Ronald Reagan, Address to the Nation on Defense and National Security ("Star Wars" speech), Mar. 23, 1983, https://perma.cc/QU7W-AHHQ (asserting ""Deterrence" means simply this: making sure any adversary who thinks about attacking the United States, or our allies, or our vital interest, concludes that the risks to him outweigh any potential gains. Once he understands that, he won't attack. We maintain the peace through our strength; weakness only invites aggression. This strategy of deterrence has not changed. It still works."); LAMBAKIS, *supra* note 2, at 66. Deterrence can operate even if the probability of a retaliatory response is less than 100%, as long as the adversary must calculate the dangers. *See* SCHELLING, STRATEGY, *supra* note 37, at 187-203 (discussing "the threat that leaves something to chance."); PAYNE, *supra* note 37, at 38 (critiquing this theory).

As a legal matter, the term "retaliation" is not quite the correct concept here. International law requires, *inter alia*, that a use of force be "necessary" for self-defense; a simple desire for revenge or to punish an adversary for harm wrongfully inflicted upon us would not satisfy this criterion. Instead, a counter-strike can be legally justified if it promotes the military defeat of the enemy or if it prevents, disrupts, or deters additional strikes against us. *See* Geoffrey S. Corn, *The Aborted Iran Strike: The Fine Line Between Necessity and Revenge*, LAWFARE BLOG (June 25, 2019, 8:16 AM), https://perma.cc/9LQW-HAEL; Michael Schmitt, *Top Expert Backgrounder: Aborted U.S. Strike, Cyber Operation against Iran and International Law*, JUST SECURITY (June 24, 2019), https://perma.cc/LDD2-PQ93. Nonetheless, the traditional vocabulary in this field refers to deterrence by threat of "retaliation," and this Article adopts that convention.

The two logically distinct sub-types here vary on whether our retaliation would be "in kind" (generally corresponding to the offense committed by the adversary) or asymmetric.

1. Deterrence by Threat of Symmetric Retaliation

Perhaps the most obvious form of retaliation is tit-for-tat: whatever you do to us, we will do to you. The notion is to match the aggression by using our own weapons of the same type, in a mode and location that roughly correlate to what the enemy initially inflicted upon us. The calculation is that by imposing severe costs upon the adversaries, we will deprive them of any net gain that they might have thought they could garner via launching their first strike. They will suffer such egregious mirror-image losses that – even if they can also inflict pain upon us – the exchange will be deemed not worthwhile.[48]

In the nuclear realm, the Cold War doctrine of "mutual assured destruction" (MAD) rested upon each side's ability to wreak unacceptably devastating havoc upon the other, no matter who struck first. The United States and the Soviet Union were each confident that, even if victimized by a sudden nuclear attack, it could retaliate with its own residual strategic weapons with such devastating power that the aggressor would be destroyed. In those circumstances, neither could conclude that a first nuclear strike would be profitable, and each would therefore be deterred from attacking.[49]

In the outer space realm, the cognate communication would be, "If you shoot at our satellites, we will shoot at yours." To be credible, the country making this threat would, as always, have to possess both the physical ability to carry out the threatened action and the political will to do so, even if that path entailed costs and risks. This balancing symmetry has a certain intuitive logic, and can be a powerful dissuader, if conditions are favorable.[50]

2. Deterrence by Threat of Asymmetric Retaliation

The opposite sub-type relies upon cross-domain retaliation, or a response that strikes in a different location or with a different modality of attack. Often, there can be a significant combat advantage in selecting our own military tools, rather

48. It would also be possible to "up the ante," by threatening to harm the aggressors even more severely than they have harmed us. This sort of exaggerated payback is common in some venues, notably the schoolyard playground, but as discussed *infra*, text accompanying note 52, the law of armed conflict requires proportionality between the offense and the retaliatory response.

49. In the classic formulation, offered by Secretary of Defense Robert McNamara in 1967, the United States needed to be able to inflict "unacceptable damage" on the enemy, even after absorbing an enemy first strike, and that retaliation would have to be so devastating that the enemy "would be simply no longer viable in twentieth-century terms. That is what deterrence of nuclear aggression means. It means the certainty of suicide to the aggressor, not merely to his military forces, but to his society as a whole." Robert McNamara, *Mutual Deterrence*, ATOMIC ARCHIVE (Sept. 18, 1967), https://perma.cc/2BDJ-MK2R.

50. *See* MACDONALD ET AL., *supra* note 12, at 18 (observing that China, too, is attentive to this aspect of space deterrence and has developed offensive space capabilities in part to deter a potential U.S. attack).

than being confined to the quiver initially employed by the enemy, so we might well exercise our independent judgment about how best to inflict significant pain upon the aggressor. An opponent who knows that a conflict may spread to diverse theaters and types of battle may be more fully deterred than one who expects to be able to dictate the most favorable battlefields.[51]

Under international law, our retaliation must be "proportional" to the enemy's attack in terms of scale and severity, but it need not be "identical" – the victim may choose to respond in a manner, place, and mode that are more beneficial to its own military capabilities and constraints.[52]

In the Cold War realm, asymmetric deterrence was manifest by the possibilities that if the U.S.S.R. acted in unfavorable ways against U.S. interests or allies in, say, Europe, the United States might respond with offsetting actions against Moscow's assets in Cuba or in East Asia. Likewise, we might retaliate against a use of nuclear or other weapons of mass destruction by employing the vast U.S. conventional forces (or vice-versa).[53] The fundamental point is that the United States could select the type, place, and timing of its response to afford maximum military advantage, even if we departed in various ways from the specific nature of the original provocation.[54]

In the space sector, an asymmetric response could maintain that "If you attack our satellites, we might choose to respond by attacking the ground stations that control your satellites, or the land-based facilities from which your ASAT was launched, rather than attacking your satellites themselves." Another variant would be that if state X attacks state Y's satellites by using one specified type of ASAT (such as a high-energy laser), Y might respond by employing a different

51. NAS REPORT, *supra* note 2, at 40 (emphasizing value of cross-domain response to a space threat). Even more broadly, an asymmetric counter-action could occur entirely outside the military realm, such as by using economic sanctions to inflict pain upon a country that has undertaken a hostile military move. *See, e.g.*, CORY WELT ET AL., CONG. RESEARCH SERV., R45415, U.S. SANCTIONS ON RUSSIA (Jan. 11, 2019) (the U.S. reliance upon economic coercion in response to Russia's annexation of Crimea); Jana Robinson, *Deterring Chinese and Russian Space Hybrid Warfare by Economic and Fiscal Means*, SPACE REV. (Sept. 18, 2017), https://perma.cc/TJT4-WG6Y.

52. Dale Stephens & Cassandra Steer, *Conflicts in Space: International Humanitarian Law and Its Application to Space Warfare*, 40 ANNALS AIR & SPACE L., 2015, at 71, 93-95; YORAM DINSTEIN, WAR, AGGRESSION AND SELF-DEFENSE 282-87 (3d ed. 2017); SEAN D. MURPHY, PRINCIPLES OF INTERNATIONAL LAW 585 (3d ed. 2018) (noting that the concept of proportionality "does not require that the force [used in response to an attack] be a mirror image of the initial attack, nor that the defensive actions be restricted to the particular geographic location in which the initial attack occurred.").

53. MISSILE DEFENSE REVIEW, *supra* note 16, at 16-17 (arguing that U.S. nuclear weapons help deter nuclear and non-nuclear attack against United States and its allies and partners), at 21 (reserving the possibility that the United States might use nuclear weapons in response to a non-nuclear attack, such as via cyber weapons); U.S. DEP'T OF DEF., DANGERS OF A NUCLEAR NO FIRST USE POLICY, https://perma.cc/7E2T-C3YN.

54. An important variant, largely beyond the scope of this Article, concerns the concept of "extended deterrence," through which a major power undertakes to protect a smaller ally, promising to come to its aid if it is attacked, thereby deterring aggression from an opposing major power. *See* Bruce M. Russett, *The Calculus of Deterrence*, 7 J. CONFLICT RESOL. 97 (June 1963); BLAIR ET AL., *supra* note 44, at 16, 22-23, 70; PAYNE, *supra* note 37, at 24-29; Cheng, Extended, *supra* note 43.

ASAT mechanism (such as a kinetic energy "space mine.")[55] Alternatively, a state victimized by an ASAT attack might opt to retaliate in an entirely different theater, such as by attacking the aggressor's ships at sea or armed forces on the ground.[56]

There is no generally-applicable way of choosing *a priori* between symmetric and asymmetric retaliation – in any particular circumstance, either one could be more efficacious. A country might wisely decide to maintain a certain flexibility and ambiguity here, not being explicit about exactly how it might elect to respond to a particular provocation.[57] Sometimes, uncertainty about exactly what price will have to be paid for an act of aggression can provide additional deterrence. U.S. policy, for example, overtly reserves the right to respond in a time, place, and manner of its choosing, in the event of hostilities.[58]

B. Deterrence by Denial

A very different strategy – widely recognized in the literature, but somewhat less prominent among practitioners and the general public – is deterrence by denial.[59] Here, the general purpose is to frustrate the attackers, to drive them to conclude that it is not worthwhile to try to attack us, because they cannot (much) succeed in the effort.

Deterrence by denial relies upon somewhat different logic and completely different hardware, but like deterrence by threat of retaliation, it is a psychological gambit, an attempt to affect the adversaries' actions by altering their calculations about probabilities and possible gains and losses.[60] There is inherent overlap

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55. The notion of symmetry in space warfare can be parsed in many different ways. For example, if state X attacks one of state Y's satellites that is performing a particular type of mission (e.g., one used for tactical battlefield purposes) or one used for (and perhaps owned and controlled by) civilians, Y might respond by attacking a different type of X's satellites.

56. LAMBAKIS, *supra* note 2, at 68 (discussing "source retaliation" – the concept of striking back at an enemy's launch center that had been responsible for initiating an ASAT attack, rather than aiming at enemy satellites). *See* MACDONALD ET AL., *supra* note 12, at 43-46 (comparing crisis stability in four domains: nuclear, space, cyber, and conventional).

57. As a legal matter, all of these variants would have to be exercises of self-defense, pursuant to art. 51 of the U.N. Charter. The permissible goals cannot be solely to "inflict pain upon an enemy" or to "make them pay a price" for their aggression; the purpose must be to defeat the enemy militarily, to disrupt its ability to wage additional attacks. But the threat to inflict suffering in order to achieve deterrence, so as to defend oneself, is legitimate. *See generally* NEWELL HIGHSMITH, LAWRENCE LIVERMORE NAT'L LABORATORY CTR. FOR GLOB. SECURITY RESEARCH, ON THE LEGALITY OF NUCLEAR DETERRENCE (Apr. 2019), https://perma.cc/4CML-TPH6.

58. *President Donald J. Trump Is Unveiling an America First National Space Strategy*, THE WHITE HOUSE (Mar. 23, 2018) (declaring U.S. policy to respond to threats to U.S. satellites "with a deliberate response at a time, place, manner, and domain of our choosing."), https://perma.cc/2LZB-QJPU.

59. ROBERT JERVIS ET AL., PSYCHOLOGY AND DETERRENCE 2 (1985) (asserting that in the nuclear age, "Deterrence by punishment is now more important than deterrence by denial."); A. Wess Mitchell, *The Case for Deterrence by Denial*, AM. INTEREST (Aug. 12, 2015), https://perma.cc/B4FK-8QNH (suggesting that deterrence by denial may be more effective in the future).

60. LAMBAKIS, *supra* note 2, at 66 (stating that "Deterrence is rooted in psychology, decisionmaking, and expected consequences."); JOINT OPERATING CONCEPT, *supra* note 38, at 7 (U.S. military asserts that "Deterrence operations convince adversaries not to take actions that threaten US vital interests by means of decisive influence over their decision-making.").

between the two genres of deterrence, because if the adversaries attempt to strike us, and we successfully fend them off, there is a concomitant likelihood that we will also retaliate and try to inflict pain upon them.[61] But analytically, the two types of deterrence can be usefully isolated for scrutiny, and once again there are two distinct sub-types to consider.[62]

1. Deterrence by Interception

One form of denial of the enemies' attack is to break their kill chain, interrupting the series of steps necessary for their onslaught to succeed. Obviously, a complete interdiction would be the most powerful defensive move, but even a partial success, exercising an ability to significantly attrite but not wholly eliminate the incoming weaponry, could have a significant deterrent effect.

The best illustration of this concept in the nuclear realm would be an operational anti-missile system, capable of detecting, identifying, and tracking incoming ICBM and other warheads, and then reliably directing our anti-missile missiles to intercept and destroy them in flight.[63] This type of missile defense is, of course, an extremely technologically demanding mission; despite devoting decades of engineering effort and billions of dollars, the United States has accomplished, at best, only a limited capability.[64] But the concept is clear, echoing President Ronald Reagan's famous "Star Wars" objective of rendering incoming warheads "impotent and obsolete."[65] Indeed, if that level of "Astrodome" protection could be achieved, it would constitute a marvelous illustration of deterrence by interceptive denial.

Similar concepts for space applications exist only on the drawing boards (or at an even more preliminary stage of visionary development). For example, some analysts imagine a "bodyguard satellite" that could accompany an important

61. COLBY, *supra* note 2, at 26 (stressing that deterrence by retaliation and deterrence by denial can sometimes be complementary, not opposites).

62. *See* Morgan, *supra* note 12, at 31-32 (differentiating between "active" and "passive" means of deterrence by denial, comparable to the sub-categories identified in this Article as interceptive and self-protective).

63. A similar logic would apply to anti-air defenses, designed to shoot down enemy bombers before they could strike their intended targets in our territory; this mission may be substantially easier than intercepting incoming ICBM and related missile warheads.

64. U.S. GOV'T ACCOUNTABILITY OFFICE, MISSILE DEFENSE: DELIVERY DELAYS PROVIDE OPPORTUNITY FOR INCREASED TESTING TO BETTER UNDERSTAND CAPABILITY 1 (June 2019) (noting that from 2002 to 2017, the agency primarily responsible for developing the U.S. missile defense system received $142 billion), at 12-13 (noting progress in the program, but also failure to meet most delivery goals or to conduct all planned tests) https://perma.cc/RN56-GNBF; MISSILE DEFENSE REVIEW, *supra* note 16, at ii (Department of Defense reports that "Missile defense is accorded a high priority in our investment plans"), at 3 (tracking annual budget of Missile Defense Agency); ARMS CONTROL ASSOC., CURRENT U.S. MISSILE DEFENSE PROGRAMS AT A GLANCE (Jan. 2019), https://perma.cc/LKS4-V6UE; *US Missile Defense: Unproven and Unaccountable*, UNION OF CONCERNED SCIENTISTS, https://perma.cc/7JWN-8RNL; Laura Grego, *No, Missile Defense Will Not Work 97% of the Time*, UNION OF CONCERNED SCIENTISTS (Oct. 12, 2017), https://perma.cc/9EAG-Y6QS.

65. Ronald Reagan, *Star Wars Speech* (Mar. 23, 1983), https://www.history.com/speeches/reagan-announces-star-wars.

operational military or civilian satellite through its orbit. If an enemy were to launch a kinetic ASAT attack (direct ascent or co-orbital), the escort could intervene, assaulting the ASAT vehicle during the precious seconds before it could consummate its offensive mission.[66]

2. Deterrence by Self-Protection

The typology of deterrence grows somewhat more complicated here, because a wider array of tools and tactics could become relevant at this stage of the analysis. Overall, the concept is to reduce the vulnerability of the targets, partially immunizing them from attack – again, for the purpose of frustrating the enemy's military objective and thereby deterring a strike. The effort is to curtail the number and degree of casualties we suffer, to protect our population and to enable our civilian and military systems to fail gracefully rather than catastrophically under enemy assault, and to recover relatively swiftly in the aftermath.[67]

The analysis here begins by thinking about approaches that will minimize the vulnerability of our military forces, to ensure the survival of a robust retaliatory capability. In the nuclear realm, in addition to the anti-missile systems discussed *supra*, we would contemplate measures such as "hardening" our ICBM silos, to make them more impervious to attack, or making the missiles mobile; dispersing our bomber fleet to multiple bases and getting many aircraft aloft during a crisis, so they would not be too exposed; and hiding our missile-carrying submarines in remote ocean depths, where the enemy could not find and attack them. Programs to ensure the continuity of national command authorities and communications, such as by relocating leadership figures into deep underground control bunkers are conceptually a similar resiliency measure.[68]

In the space realm, it is difficult to harden a satellite, because heavy armor plating is prohibitively expensive to launch, and enhancing a satellite's ability to maneuver to evade attack carries weight penalties, too. Instead, system-wide concepts would call for enhancing the resiliency of the entire satellite architecture, through

66. Brian G. Chow, *Nuclear Vulnerability: In-orbit Bodyguards Would Help Protect NC3 Satellites from Attacks*, SPACE NEWS (Mar. 25, 2019), https://perma.cc/5VYC-K6V4; LAMBAKIS, *supra* note 2, at 53 (noting that the United States does not currently possess much space-based ability to intercept an enemy's kinetic ASAT, but might be able to adapt ground-based missile defense interceptors for this purpose); Morgan, *supra* note 12, at 33 (noting the affordability challenges of escort satellites); Bart Hendrickx, *Self-Defense in Space: Protecting Russian Spacecraft from ASAT Attacks*, SPACE REV. (July 16, 2018) (reporting that during the Cold War, the U.S.S.R. pursued defensive systems to protect its satellites from potential U.S. attacks, including developing space artillery mechanisms to shoot at the attacker). Note that the concept of bodyguard satellites would not have much relevance against directed energy or cyber ASAT systems, which operate at the speed of light, and even in response to a kinetic ASAT, a successful interception and destruction might simply generate so much debris that the targeted satellite (and many others) were still impacted.

67. Sometimes, this variant of deterrence is referred to as "passive defense," in contrast to the "active defense" method of seeking out and striking at the enemy's attacking force. *See, e.g.*, LAMBAKIS, *supra* note 2, at 44; Billings, *supra* note 13; Jen Judson, *Should the DoD Shift Focus Toward Passive Missile Defense?*, DEF. NEWS (Aug. 7, 2019), https://perma.cc/3HCB-S6WH.

68. Wohlstetter, *supra* note 37 (considering the vulnerability of U.S. bombers and missiles); KAHN, *supra* note 37, at 481-83 (discussing the survivability of U.S. nuclear weapon systems).

means such as disaggregation and proliferation (i.e., relying upon a larger number of smaller, less expensive satellites, rather than putting too many eggs into a few exquisite baskets); dispersal (i.e., consciously placing satellites at different orbital altitudes and inclinations, so they cannot all be attacked simultaneously); the development of a responsive launch capacity (i.e., creating a capability to rapidly launch replacement satellites, restoring service when some are shot down); and enhanced space situational awareness (i.e., developing sensors to provide greater clarity about whether one of our satellites has been attacked, and by whom).[69]

Extending the analysis to the civilian population and its assets, a policy of deterrence by self-protection in the nuclear realm would emphasize efforts at civil defense and emergency response. We would attempt to mitigate the consequences of an attack by training the society about both evacuation and shelter-in-place tactics, and by prepositioning emergency supplies, equipment, and services. We would promote economic resiliency by creating and husbanding the resources to restore a semblance of normal post-war infrastructure and critical assets promptly. These approaches could not realistically hope to eliminate human suffering in the event of a nuclear attack, but they could perhaps mitigate the consequences sufficiently to make a potential attacker think twice about how much lasting harm could be inflicted upon the United States.[70]

The analogous preparations in the space realm could include more thorough linkages between U.S. and allied countries' satellite systems, providing redundant and fallback capabilities that could come on-line during an emergency.[71] Similarly, the United States could make a concerted effort to retain or restore

69. OFF. OF THE ASSISTANT SEC'Y OF DEF. FOR HOMELAND DEF. & GLOB. SECURITY, SPACE DOMAIN MISSION ASSURANCE: A RESILIENCE TAXONOMY (Sept. 2015), https://perma.cc/AH39-RH5W (analysis of multiple concepts for enhancing the reliability and survivability of the U.S. satellite architecture); LAMBAKIS, *supra* note 2, at 43-45, 47-49, 65 (highlighting the effort to make U.S. satellites "hard to find, hard to catch, hard to hit, hard to kill," and stressing that "Today's space deterrence strategy rests firmly on the pillars of 'deterrence-by-denial.'"); MORGAN, *supra* note 12, at 45-46; Omar Lamrani, *What the U.S. Military Fears Most: A Massive Space War*, NAT'L INT. (May 18, 2016), https://perma.cc/3MLV-CKDW; *The Battle Above*, *supra* note 4 (quoting Gen. Hyten, "deterrence in the space world has got to be built on a little bit different construct. It's the ability to convince an adversary that if they attack us, they will fail."); West, *supra* note 5, at 118-23 (recapping improvements in resiliency and reconstitution of satellite architecture); Robert McDougall & Phillip J. Baines, *Military Approaches to Space Vulnerability: Seven Questions*, *in* CENTER FOR NONPROLIFERATION STUDIES, FUTURE SECURITY IN SPACE: COMMERCIAL, MILITARY, AND ARMS CONTROL TRADE-OFFS 11, 12 (James Clay Moltz ed., 2002) (considering various tactics to improve survivability of satellites); HITCHENS & JOHNSON-FREESE, *supra* note 21, at 37-38 (describing measures to enhance the resiliency of space assets as a "classic approach to deterrence by denial.").

70. *See* Department of Homeland Security, *Nuclear Explosion*, READY.GOV, https://perma.cc/YME8-WVZT (advice to citizens on how to prepare for and survive a nuclear explosion); SNYDER, *supra* note 37, at 95–97 (examining deterrent effect of civil defense preparations); PAYNE, *supra* note 37, at 121–23; KAHN, *supra* note 37, at 516–18, 626–40.

71. Interweaving U.S. and allied satellites not only promotes deterrence by denial (by assisting in recovery, through making available alternative modes of space operation), it also enhances deterrence by threat of retaliation (by bringing into the battle the military structures of other countries, who would now also be victimized by an attack on U.S. space assets). *See* MORGAN, *supra* note 12, at 46; MACDONALD ET AL., *supra* note 12, at 39.

fallback terrestrial means for performing some of the military and civilian services that have now been swallowed by satellites – old fashioned telephone land lines and other devices that have been somewhat superseded in the Space Age may become more valuable as emergency backups, in the event of an ASAT encounter.[72]

In sum, deterrence in all its manifestations and modes is critical to U.S. and global security; it deserves a central place in the strategic thinking about both nuclear and space policy. But deterrence alone – whether by threat of retaliation, by denial, or via their combination – is not a perfect system. The next section, therefore, identifies some of the inherent disadvantages or limitations of this vital construct.

C. Weaknesses in the Concept of Deterrence

Much has been written about the risks, costs and adverse consequences of the persistent practice of deterrence;[73] this section highlights six critical features. First, the concept of deterrence relies upon several rigorous assumptions; failure of any of them can render the whole model suspect. For example, the edifice is built upon a depiction of two (or more) actors behaving in intelligent, rational fashion. If any player's judgment is clouded by emotion, psychosis, religious fervor, or an apocalyptic vision of bringing down the world in an Armageddon flash, then the careful calculation of comparative costs and benefits evaporates. The same disruption occurs whenever a key actor's judgment and decision-making in a crisis are afflicted by any of the extensively catalogued forms of cognitive bias now understood to vitiate truly rational behavior in commercial, legal, and other domains. Similarly, the underpinnings of deterrence cannot comfortably tolerate the possibility that a state's leaders might miscalculate or misinterpret another player's actions or messages in a crisis, or act rashly upon incomplete or inaccurate information; still less that they might be victimized, in this era of increasingly automated security systems, by mechanical or cyber malfunction. Once we begin to peel away the artificiality of depicting a state as a unitary, integrated sole actor, the possibilities for unauthorized rogue misadventures, or for inept compromises among rival self-interested bureaucratic units emerge, too. Moreover, the analytically relatively simple exchanges between two principal actors, as characterized by bipolar superpower MAD relations, become ineffably more complex when additional players muddle the arena; even the presence of a third major power

72. LAMBAKIS, *supra* note 2, at 62–64 (addressing the loss in military capability if the United States had to rely on terrestrial alternatives to modern satellite services); MORGAN, *supra* note 12, at 47; HITCHENS & JOHNSON-FREESE, *supra* note 21, at 39 (discussing the possibility of offloading some mission capabilities from satellites to non-space-based platforms); Karl P. Mueller, *Six Propositions About Offense, Defense, and Crisis Stability in Space*, *in* MACDONALD ET AL., *supra* note 12, at 52, 54–55, 67–68.

73. KREPINEVICH, *supra* note 37 (arguing that modern geopolitical and technological changes erode the effectiveness of deterrent strategies); GEORGE & SMOKE, *supra* note 37, at 71–82 (identifying seven necessary simplifications inherent in the theory of deterrence).

(such as China joining the United States and Russia in the space race) threatens the utility of the deterrence apparatus.[74]

Second, deterrence places stringent demands upon a state's ability to collect and process relevant information with speed and reliability – capacities that might be severely strained in the space context. For example, if a state cannot discern that it or its key assets have been attacked (including possessing the ability to differentiate between hostile action, natural hazards of space operations, and internal malfunctions in a satellite), and by whom, then the automaticity of any retaliation is compromised. A comprehensive prowess in attributing misdeeds to the true author cannot be guaranteed in a remote environment where encyclopedic space situational awareness remains an elusive goal, not a current capacity.[75]

Third, deterrence is expansive and therefore expensive. It requires the United States to be perpetually vigilant, armed against any threat – current, emerging, or imaginable – and able to inflict unacceptable damage or disruption on any aggressor who might employ any tools of violence against any of our vital interests at any time. In the nuclear realm, the "triad," a diversification of our weapons into land-, sea-, and air-based modes, has incurred massive expenditures – the current recapitalization campaign is projected to cost the United States more than one trillion dollars over the lifetime of the systems.[76] In space, the creation,

74. SCHELLING, STRATEGY, *supra* note 37, at 16–20 (discussing the conditions for application of deterrence); HARRISON ET AL., *supra* note 7, at 1 (contending that the U.S. ability to deter attacks on its satellites is now less certain, due to the proliferation of counterspace weapons); LAMBAKIS, *supra* note 2, at 67 (deterrence is based on the assumption that an enemy will be rational); KREPINEVICH, *supra* note 37, at 25–26 (problem of multipolarity in deterrence), 50–54 (problem of accidental or unintended war), 62–64 (problem of non-rational human behavior); MAZARR, *supra* note 37, at 6–7 (observing that sometimes a state that objectively ought to be deterred from undertaking aggression will attack nonetheless, because it believes that initiating force is necessary to attempt to achieve important national goals); ALLISON, *supra* note 40 (examining factors other than unilateral national rational choice that influence governmental behavior); Iain King, *What Do Cognitive Biases Mean for Deterrence?*, STRATEGY BRIDGE (Feb. 12, 2019), https://perma.cc/U4M6-SYQY; LONG, *supra* note 37, at 54 (discussing the debate, early in the Cold War, about how the Soviet Union viewed the concept of deterrence and whether the Soviet leadership was non-rational); Mikhail Gorbachev, *The Madness of Nuclear Deterrence*, WALL ST. J. (Apr. 29, 2019), https://www.wsj.com/articles/the-madness-of-nuclear-deterrence-11556577762 (highlighting the dangers of continued reliance upon nuclear deterrence, particularly those arising from technical failure, human error, and especially computer error); Loren Thompson, *What If Deterrence Doesn't Work Anymore? Five Reasons to Worry*, FORBES (Aug. 18, 2014, 2:13 PM), https://perma.cc/PM79-J3CJ; David Krieger, *Hacking Nuclear Weapons Is a Global Threat*, THE HILL (Oct. 8, 2018, 5:30 PM), https://perma.cc/K63A-SSEJ; Wohlstetter, *supra* note 37, at 231 (discussing deterrence and accidental war); Janice Gross Stein, *Calculation and Miscalculation and Conventional Deterrence I: The View from Cairo*, *in* ROBERT JERVIS ET AL., PSYCHOLOGY AND DETERRENCE 34, 56–59 (1985) (stressing the role of miscalculation); PAYNE, *supra* note 37, at 247–77 (challenging the internal contradictions of deterrence theory).

75. *See* KREPINEVICH, *supra* note 37, at 9; NAS REPORT, *supra* note 2, at 38–42 (assessing elements that make space deterrence threats credible).

76. KINGSTON REIF & ALICIA SANDERS-ZAKRE, U.S. NUCLEAR EXCESS: UNDERSTANDING THE COSTS, RISKS, AND ALTERNATIVES, ARMS CONTROL ASSOCIATION (2019) (analyzing the costs and rationales for the projected U.S. nuclear recapitalization); Dmitri Trenin, *Russian Views of US Nuclear Modernization*, BULL. ATOMIC SCIENTISTS (Jan. 2, 2019), https://thebulletin.org/2019/01/russian-views-of-us-nuclear-modernization/ (describing U.S. and Russian nuclear modernization programs).

deployment, and operation of hair-trigger ASAT systems and defenses would doubtless cost far more than we would have to spend in an environment that was free from those types of provocations. And the spending stream has no conceivable end-point: as technology marches on, we can never be confident that we have achieved a durable equilibrium, because the next site of exposure and vulnerability always looms ahead. Deterrence, in fact, invites insatiable arms racing, as each side must ensure that it cannot fall behind in the perpetual contestation.[77]

Fourth, in addition to that type of arms race instability, deterrence also breeds a hazardous type of crisis instability. The repeated confrontations between heavily armed antagonists require each side to demonstrate its implacable will, to prove and re-prove its commitment to threaten and ultimately to risk using, its bristling military might to protect its interests. Any hesitancy or weakness could be exploited by the other side and a reputation for blinking in an eyeball-to-eyeball confrontation could lead to a dangerous downward spiral. Deterrence thus stimulates the protagonists to practice precarious brinkmanship, demonstrating greater risk affinity than either might prefer. Even worse, some configurations of space forces may incentivize states to strike first in a crisis, rather than risk being on the receiving end of space aggression. The dynamic may also encourage low-level risk-taking along any of several slippery slopes, as rivals probe each other with provocations too small to stimulate a massive response, but too important to overlook.[78]

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77. Michael MccGwire, *Nuclear Deterrence*, 82 INTERNATIONAL AFFAIRS 771, 776 (2006) (arguing that deterrence dogma fueled the Cold War arms race); Harrison, Jackson & Shackelford, *supra* note 38, at 23 (arguing that the financial cost of an ASAT arms race is unknowable, but likely very high); HITCHENS & JOHNSON-FREESE, *supra* note 21, at 49–51 (addressing budgetary considerations). *Cf.* RON SUSKIND, THE ONE PERCENT DOCTRINE: DEEP INSIDE AMERICA'S PURSUIT OF ITS ENEMIES SINCE 9/11 62, 150–51 (2006) (attributing to Vice President Dick Cheney the doctrine that if there is a one percent chance that an enemy might acquire a nuclear weapon, "we have to treat it as a certainty in terms of our response."); HERMAN KAHN, ON ESCALATION: METAPHORS AND SCENARIOS (1965) (describing the "escalation ladder," with forty-four rungs of possible conflict).

78. George Shultz et al., *A World Free of Nuclear Weapons*, WALL ST. J. (Jan. 4, 2007), https://www.wsj.com/articles/SB116787515251566636 (arguing that while nuclear weapons were essential to maintain deterrence during the Cold War, they have now become "increasingly hazardous and decreasingly effective."). *See also* LAMBAKIS, *supra* note 2, at 65 (arguing that deterrence can actually invite low level attacks by the other side, as they test whether we would respond in a powerful way to small provocations); KISSINGER, *supra* note 37, at 135 (observing that "the threat of all-out war purchases deterrence at an exorbitant risk); Christopher J. Watterson, *Competing Interpretations of the Stability-Instability Paradox: The Case of the Kargil War*, 24 NONPROLIFERATION REV. 83 (2017); SCHELLING, STRATEGY, *supra* note 37, at 199–201 (discussing brinkmanship); SCHELLING, ARMS, *supra* note 37, at 90–91, 99–105; Michael Krepon, *The New Age of Nuclear Confrontation Will Not End Well*, N.Y. TIMES (Mar. 3, 2019), https://perma.cc/FTF3-3GXF; Mark S. Bell & Julia Macdonald, *How to Think About Nuclear Crises*, TEXAS NAT'L SECURITY REV., https://perma.cc/4C4S-J8GW; GEORGE & SMOKE, *supra* note 37, at 5 (stressing that deterrence, if it succeeds, can result only in frustrating an opponent; the "consequences of continued frustration, however, are not easily predictable and are not necessarily benign," because the opponent may seek later opportunities to overcome the frustration, so deterrence may not be reliable and must be constantly renewed); Patrick M. Morgan, *Saving Face for the Sake of Deterrence*, *in* JERVIS ET AL., *supra* note 75, at 125 (stressing the importance of reputation for deterrence); MACDONALD ET AL., *supra* note 12, at 14–15, 34–38 (discussing incentives for a first strike in space).

Fifth, because deterrence relies upon an opponent's state of mind, we can never concretely measure it; we can never be certain how reliable and durable the *status quo* is. Since our opponents are, by definition, "foreign" and alien to our own culture, values, and experience, we must inherently question our ability to read their minds and we cannot ascertain how they will approach the critical cost-benefit calculations. In short, deterrence will work until the moment when it stops working, and we may have precious little advance warning that our adversary has toted up the threats of our retaliation and the capabilities of our denial mechanisms in a tragically unfavorable way.[79]

Finally, nuclear deterrence is psychologically unsettling and arguably immoral and illegal. The United States and the Soviet Union – and the entire world – lived under a nuclear sword of Damocles through the entirety of the Cold War. The unthinkable gamble paid off, in that the weapons were never again detonated in conflict, but the emotional stress and the sheer absurdity of knowing that our civilizations could perish within a half hour of a leader's rash decision to push a button inflicted their own kinds of psychic suffering. Moreover, an unsatisfying void rests at the core of deterrence: even if we could inflict immense suffering upon any opponents who dare to attack us, that retaliation in no way undoes the suffering they could inflict upon us; we are reciprocally exposed, not reciprocally safe.[80] As Pope Francis has affirmed, this continuing vulnerability of the human species is intolerable; it is unacceptable for humanity to teeter perpetually on the brink of abrupt extermination.[81]

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79. LAMBAKIS, *supra* note 2, at 67 (deterrence is based upon an expectation that opponents will behave in a "rational" way, as understood by "reasonable" Western norms, despite profound societal differences); KREPINEVICH, *supra* note 37, at 70–74 (addressing cultural differences affecting deterrence calculations); Harrison, Jackson & Shackelford, *supra* note 38, at 4 (arguing that we can never be certain about the efficacy of deterrence strategies; even if an enemy does not attack us, there might be other reasons for that forbearance); JOINT OPERATING CONCEPT, *supra* note 38, at 52 (stressing that "the inner workings of an adversary's mind are not readily amenable to external measurement."); PAYNE, *supra* note 37, at 19–20 (highlighting historical instances in which deterrence failed, despite the use of threats that should have succeeded).

80. James E. Doyle, *The Inhumanity of Nuclear Deterrence*, 75 BULL. ATOMIC SCIENTISTS 85 (2019) (arguing that nuclear deterrence is risky, unsustainable, incompatible with human values, and morally indefensible); MccGwire, *supra* note 77 (denying that deterrence strategy deserves the credit for non-use of nuclear weapons during the Cold War, and identifying adverse consequences of the deterrence dogma); PETER RUDOLF, US NUCLEAR DETERRENCE POLICY AND ITS PROBLEMS 20–22 (2018) (exploring ethical dimensions of nuclear deterrence); Steven Kull, *Psychological Dimensions of Nuclear Arms Control*, *in* 1 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 465 (Richard Dean Burns ed., 1993); Robert Jay Lifton, *Beyond Psychic Numbing: A Call to Awareness*, 52 AM. J. ORTHOPSYCHIATRY 619 (1982); Reagan, *Star Wars Speech*, *supra* note 65 (criticizing nuclear deterrence as "a sad commentary on the human condition" and asking "Wouldn't it be better to save lives than to avenge them?"); John F. Kennedy, Address before the General Assembly of the United Nations (Sept. 25, 1961), https://perma.cc/RZS3-D3T7 (describing the nuclear sword of Damocles); FRANCIS BOYLE, THE CRIMINALITY OF NUCLEAR DETERRENCE 182–89 (2002) (asserting the illegality of nuclear deterrence under international law); HIGHSMITH, *supra* note 57 (concluding that the practice of nuclear deterrence is legal).

81. Pope Francis, Address of His Holiness Pope Francis to Participants in the International Symposium "Prospects for a World Free of Nuclear Weapons and for Integral Disarmament" (Nov. 10,

In sum, deterrence is a complex, ubiquitous feature of human existence, one that has been elevated to a central position in the security dogma of the United States and others. The four complementary forms of deterrence sketched here are not rigidly defined or fully differentiated; they overlap and even merge somewhat in practice. They do, however, share important commonalities: deterrence is grounded in the effort to alter the adversaries' strategic calculations, rather than their physical capabilities; it attempts to influence or even to manipulate other states' choices about attacking us, not affecting their sheer ability to do so. The next Part of this Article, therefore, describes the very different concept of arms control, which attempts to re-shape the physical, rather than only the psychological, realities.

III. ARMS CONTROL

In the classic formulations, the key objectives of arms control and disarmament are to reduce the likelihood of war, to mitigate the suffering that warfare would entail, and to diminish the financial costs of preparing for conflict – much of which runs well beyond the scope of deterrence alone.[82] In contrast to deterrence, arms control is not merely a psychological phenomenon; it embodies a physical reality in removing hardware from the active inventories of opposing militaries. Arms control is the only way (at least the only peaceful way) of reducing the numbers of weapons that are pointed at us.[83]

2017), https://perma.cc/S9PM-AF7T; Gerard Powers, *Papal Condemnation of Nuclear Deterrence and What Is Next*, 48 ARMS CONTROL TODAY, May 2018, at 6.

82. THOMAS C. SCHELLING & MORTON H. HALPERIN, STRATEGY AND ARMS CONTROL 2 (1985); Michael Krepon, *On the Objectives of Arms Control*, ARMS CONTROL WONK (May 16, 2018), https://perma.cc/4SAZ-7LKC; Bernard Brodie, *On the Objectives of Arms Control*, 1 INT'L SECURITY, Summer 1976, at 17; Herman Kahn & Anthony Weiner, *Technological Innovation and the Future of Strategic Warfare*, ASTRONAUTICS & AERONAUTICS, Dec. 1967, at 28, 43; VINCE MANZO, NUCLEAR ARMS CONTROL WITHOUT A TREATY? 16–34 (2019) (identifying the objectives of strategic nuclear arms control); JOZEF GOLDBLAT, ARMS CONTROL: THE NEW GUIDE TO NEGOTIATIONS AND AGREEMENTS 11–12 (2002); John D. Maurer, *The Forgotten Side of Arms Control: Enhancing U.S. Competitive Advantage, Offsetting Enemy Strengths*, WAR ON THE ROCKS (June 27, 2018), https://perma.cc/B2EF-LL5Y (arguing that another aspect of arms control, beyond seeking mutually-beneficial cooperation, has been the U.S. pursuit of strategic advantage, by constraining Soviet weapons); MUTSCHLER, *supra* note 3, at 3–5, 17–19 (applying to space the goals of arms control).

Note that the terms "arms control" and "disarmament" are sometimes used interchangeably; alternatively, arms control can be seen as a partial reduction, or a limitation of one particular category of weaponry, with disarmament referring to a complete elimination. *See* GOLDBLAT, *supra*, at 3; MUTSCHLER, *supra* note 3, at 18–19.

83. For contrast, note the controversy generated in October 2018 when Kay Bailey Hutchison, U.S. Ambassador to NATO, commented that the United States might "take out" Russian missiles that the United States views as violating the Intermediate-range Nuclear Forces Treaty. She later clarified that she was not threatening a pre-emptive military strike. *See* David E. Sanger, *'Take Out' Russian Missiles? U.S. Envoy's Remark Spurs Anger, and Pullback*, N.Y. TIMES (Oct. 2, 2018), https://perma.cc/CA5L-FB85; Joel Gehrke, *NATO Ambassador Clarifies: 'I Was Not Talking About Preemptively Striking Russia'*, WASH. EXAMINER (Oct. 2, 2018), https://perma.cc/LJY7-9MXK. *See also* Paul Sonne, *U.S. doesn't yet have a plan to prevent Russia from building more missiles as treaty collapses, top general says*, WASH. POST (Mar. 5, 2019), https://perma.cc/MXN9-PXJW (quoting Army General Curtis Scaparrotti). One country cannot "prevent" another from building or maintaining controversial weapons,

To make that contrasting perspective more vivid, this Part will first briefly survey the very active pursuit of arms control in the nuclear realm (including the assessment that the Trump Administration's current seeming rejection of this tradition should be seen as merely a temporary aberration or hiatus). Then, in stark counterpoint, the Article examines the striking paucity of arms control measures in space, where decades of inaction have afforded militaries relatively free rein. Finally, just as the prior Part discussed the weaknesses or limitations of the practice of deterrence, this Part will conclude with a parallel examination of the inherent problems in relying exclusively on arms control as a tool for enhancing security.

A. The Success of Nuclear Arms Control

In the nuclear realm, the theory and practice of arms control are familiar, persistent, and often successful endeavors.[84] Indeed, the international effort to control nuclear weapons is virtually as old as nuclear weapons themselves, as documented by the Baruch Plan of 1946,[85] the McCloy-Zorin Accords of

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without resorting to either military attacks or peaceful negotiation. *See* Michael Krepon, *The Golden Age of Nuclear Arms Control*, ARMS CONTROL WONK (Apr. 22, 2019), https://perma.cc/XMT4-LHA9 ("The golden age of arms control [1987–2000] became possible because of decades of hard diplomatic labor. Deterrence alone didn't establish conditions for success, because deterrence was and is about threatening terrible destruction. Deterrence doesn't achieve deep cuts; diplomacy does."). Sometimes, of course, a country may decide on its own to reduce its weapons stocks, for financial or other reasons, as when the Nixon Administration foreswore biological weapons, or when the Russian economy collapsed following the Cold War. But these unilateral decisions are not legally binding and may be subject to quick reversal. *See* THOMAS GRAHAM, JR. & DAMIEN J. LAVERA, CORNERSTONES OF SECURITY: ARMS CONTROL TREATIES IN THE NUCLEAR ERA 293 (2003) (discussing U.S. 1969 unilateral decision to renounce biological weapons, even prior to negotiation of a treaty); MUTSCHLER, *supra* note 3, at 127 (discussing the breakdown of the Soviet/Russian economy in the 1990s, and the resulting decline in space activities).

84. *See* GRAHAM & LAVERA, *supra* note 83 (collecting texts of, and narratives about, the sequence of arms control treaties); GOLDBLAT, *supra* note 82 (same); 1 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT (Richard Dean Burns ed., 1993).

In addition, it is noteworthy that within the realm of nuclear arms control, the traditional U.S. objective has been stated as ensuring "parity" with the U.S.S.R./Russia, to guaranty that the American nuclear inventory was qualitatively and quantitatively at least equivalent to that of its principal potential adversary. MANZO, *supra* note 82, at 23–30. In contrast, within the space realm, the U.S. rhetoric emphasizes the importance of achieving "superiority" or "dominance" in space control capabilities. *See supra* note 24 (sampling the U.S. rhetoric about space control). The reasons for, and the significance of that difference are beyond the scope of this Article. *See* MORGAN, *supra* note 12, at 39 (urging adoption of less provocative rhetoric); PAYNE, *supra* note 37, at 5–6, 49–55 (presenting contrasting approaches to deterrence, stability and superiority in arms); JOHNSON-FREESE, *supra* note 7, at 8–16. *See also* Dean Cheng, *Space and the Evolving Chinese Military*, *in* MACDONALD ET AL., *supra* note 12, at 23, 29 (stressing that China also pursues space dominance).

85. The Baruch Plan was an early post-World War II American proposal to establish international controls over the atomic bomb (which only the United States possessed at that time). It evolved through multiple negotiating sessions, but ultimately failed due to disagreement with the U.S.S.R. about inspections to verify compliance. Leneice N. Wu, *The Baruch Plan, 1946-1949*, *in* 2 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 771 (Richard Dean Burns ed., 1993); U.S. Department of State, *The Acheson-Lilienthal & Baruch Plans, 1946*, OFFICE OF THE HISTORIAN, https://perma.cc/2A4S-QF2K; RICHARD DEAN BURNS & JOSEPH M. SIRACUSA, 1 A GLOBAL HISTORY OF THE NUCLEAR ARMS RACE: WEAPONS, STRATEGY, AND POLITICS 74–87 (2013).

1961,[86] and numerous other prominent but misbegotten proposals.[87] Noteworthy early multilateral accomplishments included the 1959 Antarctic Treaty[88] (prohibiting nuclear explosions on the southern continent); the 1963 Limited Test Ban Treaty (LTBT)[89] (barring nuclear explosions in the atmosphere, in space, and under water); and the 1968 Non-Proliferation Treaty[90] (restricting the spread, and the continued possession, of nuclear weapons).

More far-reaching accords were concluded bilaterally by the United States and the Soviet Union (succeeded by Russia), as the planet's nuclear hegemons. The Strategic Arms Limitation Talks (SALT I negotiations) from 1969 to 1972 produced two watershed instruments: the 1972 Anti-Ballistic Missile (ABM) Treaty[91] (restricting each side to only two (later reduced to one) ABM sites) and the 1972 Interim Agreement on Strategic Offensive Arms[92] (freezing each country's inventory of long-range nuclear-armed ballistic missiles). The follow-on 1979 SALT II Treaty[93] was stillborn, but the arms control process continued inexorably with the 1991 Strategic Arms Reduction Talks (START I agreement),[94] which begat the 2002 Moscow Treaty,[95] which begat the 2010 New START

86. The McCloy-Zorin Accords established an agreed international framework for negotiations on nuclear disarmament and general and complete disarmament. These accords were widely endorsed, but ultimately failed to generate noteworthy implementing agreements. Alessandro Corradini, *General and Complete Disarmament Proposals*, *in* 2 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 1041, 1046–47 (Richard Dean Burns ed., 1993); McCloy-Zorin Accords, Sept. 20, 1961, https://perma.cc/GBV7-62WE.

87. Corradini, *supra* note 86 (discussing early proposals for nuclear and other disarmament); GOLDBLAT, *supra* note 82, at 38–46 (describing fruitless disarmament proposals in and around the United Nations in the 1940s and 1950s); JENNIFER E. SIMS, ICARUS RESTRAINED: AN INTELLECTUAL HISTORY OF NUCLEAR ARMS CONTROL, 1945-1960 (1990); BURNS & SIRACUSA, *supra* note 85, at 234–46. The first resolution ever adopted by the U.N. General Assembly focused on the problem of nuclear power and called for the creation of a commission to make proposals for the elimination of atomic weapons. G.A. Res. 1(1), at 1 (Jan. 24, 1946).

88. Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71 (entered into force June 23, 1961).

89. Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, *opened for signature* Aug. 5, 1963, 14 U.S.T. 1313, 480 U.N.T.S. 6964 (entered into force Oct. 10, 1963) [hereinafter Limited Test Ban Treaty or LTBT].

90. Treaty on the Non-Proliferation of Nuclear Weapons, July 1, 1968, 21 U.S.T. 483, 729 U.N.T.S. 169 (entered into force Mar. 5, 1970) [hereinafter NPT].

91. Treaty on the Limitation of Anti-Ballistic Missile Systems, U.S.-U.S.S.R., May 26, 1972, 23 U.S.T. 3435, 944 U.N.T.S. 13 (entered into force Oct. 3, 1972, no longer in force) [hereinafter ABM Treaty].

92. 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 (entered into force Oct. 3, 1972).

93. Treaty Between the United States of America and the Union of Soviet Socialist Republics on the Limitation of Strategic Offensive Arms, U.S.-U.S.S.R., June 18, 1979, S. TREATY DOC. 96-1 (not in force) [hereinafter SALT II Treaty].

94. Treaty on the Reduction and Limitation of Strategic Offensive Arms, July 31, 1991, U.S.-USSR, S. TREATY DOC. NO. 102-20 (1991). *See also* Treaty Between The United States Of America And The Union Of Soviet Socialist Republics On Strategic Offensive Reductions (Start II), Jan. 3, 1993, Treaty Doc. No. 103-1 (never entered into force).

95. Treaty on Strategic Offensive Reductions, May 24, 2002, U.S.-Russia, S. TREATY DOC. NO. 107-8 (2002).

agreement.[96] Collectively these instruments have helped drastically reduce the two parties' nuclear weapons inventories from their Cold War zenith.[97]

Nuclear arms control negotiations flourished in other contexts, too. The United States and the Soviet Union concluded the 1987 Intermediate-range Nuclear Forces (INF) Treaty[98] to restrict land-based missiles of medium and shorter range, as well as the 1974 Threshold Test Ban Treaty[99] and the 1976 Peaceful Nuclear Explosions Treaty,[100] which together restricted the size of permitted underground nuclear detonations. Subsequently, the 1996 Comprehensive Nuclear Test Ban Treaty,[101] designed to bar all nuclear weapons testing, was negotiated; it has attracted 168 contracting states, but has not yet entered into force.[102]

Finally, it is important to note that the modern zeal for nuclear arms control is not confined solely to the superpowers. In several discrete geographic regions, the affected countries have concluded local Nuclear Weapon Free Zone treaties, to reinforce their antipathy for those armaments; these agreements are now in force for most of the Southern Hemisphere.[103] Even more vividly, the 2016 Treaty for the Prohibition of Nuclear Weapons would inaugurate a global

96. Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms, U.S.-Russia., Apr. 8, 2010, S. TREATY DOC. NO. 111-5 (2010) (entered into force Feb. 5, 2011) [hereinafter New START Treaty].

97. At their peak in the 1980s, the global stockpiles of nuclear weapons reached over 70,000; today an estimated 14,000 remain. If only the weapons in the active inventories are counted, the reduction approaches ninety percent. *See Fact Sheet: Nuclear Weapons: Who Has What at a Glance*, ARMS CONTROL ASS'N, https://perma.cc/96JF-EK6T; Hans M. Kristensen & Matt Korda, *Status of World Nuclear Forces*, FED'N OF AM. SCIENTISTS, https://perma.cc/J55C-SZ6U; Christopher Ashley Ford, Address to Heritage Foundation, Rebutting False Disarmament Narratives in Support of NPT Diplomacy (May 16, 2019), https://www.heritage.org/arms-control/event/rebutting-false-disarmament-narratives; BURNS & SIRACUSA, *supra* note 85, at 377–404, 447–77.

98. 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, Dec. 8, 1987, U.S.-U.S.S.R., 1657 U.N.T.S. 485 [hereinafter INF Treaty].

99. Treaty Between the United States of America and the Union of Soviet Socialist Republics on Underground Nuclear Explosions, U.S-U.S.S.R., art. I, July 3, 1974, 13 I.L.M. 906 (1976).

100. Treaty on Underground Nuclear Explosions for Peaceful Purposes, U.S.-U.S.S.R., May 28, 1976, 15 I.L.M. 891, 1714 U.N.T.S. 387 (entered into force Dec. 11, 1990).

101. Comprehensive Nuclear Test-Ban Treaty, Sept. 24, 1996, S. TREATY DOC. No. 105-28, 35 I.L.M. 1439 (not yet in force).

102. *See* COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORG., https://www.ctbto.org/.

103. Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean, Feb. 14, 1967, 634 U.N.T.S. 326 (entered into force Apr. 22, 1968); South Pacific Nuclear Free Zone Treaty, Aug. 6, 1985, 1445 U.N.T.S. 177 (entered into force Dec. 11, 1986); Treaty on the Southeast Asia Nuclear Weapon Free Zone, Dec. 15, 1995, 35 I.L.M. 635 (1996) (entered into force Mar. 27, 1987); Treaty on a Nuclear-Weapon-Free Zone in Central Asia, Sept. 8, 2006, 2790 U.N.T.S., 1 (entered into force Mar. 21, 2009), http://disarmament.un.org/treaties/t/canwfz; Treaty on the Nuclear-Weapon-Free Zone in Africa, Apr. 11, 1996, 35 I.L.M. 698 (1996) (entered into force July 15, 2009). *See* THOMAS GRAHAM JR., THE ALTERNATE ROUTE: NUCLEAR WEAPON-FREE ZONES (2017); *Nuclear-Weapon-Free Zones*, U.N. OFF. FOR DISARMAMENT AFF., https://www.un.org/disarmament/wmd/nuclear/nwfz/; *Nuclear-Weapon-Free Zones (NWFZ) At a Glance*, ARMS CONTROL ASS'N (July 2017), https://perma.cc/5YUY-AUYE.

outlawing of nuclear weapons; it has been endorsed by 121 states, but not yet entered into force.[104]

Of course, nuclear arms control has always been controversial, and each iteration of treaty or non-legally-binding restraint has drawn strident opposition. But the process has plunged ahead nonetheless, and even the nay-sayers have generally framed their resistance as criticism of particular provisions or omissions in a specific accord, rather than rejection of the whole endeavor; even they have routinely paid homage to the underlying goal of negotiated arms reductions. Sound nuclear arms control policy is thus closely mated to the rest of national security policy – it is integrated with, not antagonistic to, deterrence strategies.[105]

In short, nuclear arms control has been a permanent, high-visibility feature on the international security scene for decades. Participants have essayed to reduce the numbers of both offensive and defensive systems, to impede qualitative enhancements in the arsenals, to restrain the further dissemination of nuclear weapons, and to restrict the locations at which the devices may be deployed and tested.

It is true that the current juncture presents a challenging period for nuclear arms control. The Trump Administration's decisions to withdraw from the INF Treaty and to balk at extending the New START accord could mean that after 2021, there would be no bilateral U.S.-U.S.S.R. or -Russia nuclear weapons-reduction agreements in force for the first time since 1972.[106] For some observers, these retrograde developments herald "the end of an era" for nuclear arms control.[107]

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104. Treaty on the Prohibition of Nuclear Weapons, *opened for signature* Sept. 20, 2017, 52 I.L.M. 347 [hereinafter TPNW], https://perma.cc/U3KJ-64Z5; *Signature/Ratification Status of the Treaty on the Prohibition of Nuclear Weapons*, INT'L CAMPAIGN TO ABOLISH NUCLEAR WEAPONS, https://perma.cc/U9XQ-S8VC; *Positions on the Treaty*, INT'L CAMPAIGN TO ABOLISH NUCLEAR WEAPONS, https://perma.cc/SS4D-CCN5 (noting that 122 states voted in favor of adopting the TPNW, 70 states have signed it, and 23 have ratified). The countries that possess nuclear weapons, and their close allies, have declined to support the treaty.

105. Keith B. Payne, *Nuclear Deterrence in a New Age*, REAL CLEAR DEF., Dec. 14, 2017, https://perma.cc/6J8C-WXJR (framing the case against modern nuclear arms control, but conceding that most discussions of deterrence "must pay homage to the goal of negotiated nuclear reductions lest they seem unsophisticated."). *But see* COLIN S. GRAY, HOUSE OF CARDS: WHY ARMS CONTROL MUST FAIL (1992) (opposing the whole concept of arms control).

106. *President Donald J. Trump to Withdraw the United States from the Intermediate-Range Nuclear Forces (INF) Treaty*, WHITEHOUSE.GOV (Feb. 1, 2019), https://perma.cc/9Q9T-GFFX; Michael R. Pompeo, *U.S. Withdrawal from the INF Treaty on August 2, 2019*, U.S. DEP'T OF STATE (Aug. 2, 2019), https://perma.cc/9MSE-5T4A; *John Bolton Pushing Trump to Withdraw from Russian Nuclear Arms Treaty*, THE GUARDIAN (Oct. 19, 2018, 1:46 PM), https://perma.cc/7BFG-NFBB (discussing pressure not to extend New START); Maggie Tennis, *U.S.-Russian Arms Control at Risk: An Assessment and Path Forward*, ARMS CONTROL ASS'N (Jan. 2018), https://perma.cc/J6WQ-FVLC. *But see* U.S. DEP'T OF STATE, REPORT ON THE REASONS THAT CONTINUED IMPLEMENTATION OF THE NEW START TREATY IS IN THE NATIONAL SECURITY INTERESTS OF THE UNITED STATES (2018) (Trump Administration report to Congress declaring that the New START Treaty serves to regulate competition with Russia and to provide key data regarding Russian strategic nuclear forces, increasing transparency and stability in the relationship).

107. Eugene Rumer, *A Farewell to Arms. . .Control*, CARNEGIE ENDOWMENT FOR INT'L PEACE (Apr. 2018) (observing that "arms control is in trouble," and "There appear to be few, if any solutions to this

But optimists believe this interregnum may prove to be merely a hiccup in the historical progression.[108] Arms control has experienced rough patches before, and managed to bounce back from some of the most severe setbacks during the Cold War.[109] That track record of success, of course, cannot constitute a promise of renewed future performance, but the longstanding bipartisan support for nuclear arms control is pronounced – both Democratic and Republican presidents have brought treaties home, and their rejection has been the aberration. Even the Trump Administration has sometimes nodded in the direction of nuclear arms control, probing Russia and China for interest in a renewal of the dialogue.[110]

B. The Lack of Arms Control in Space

In contrast, the story of arms control in space is mostly a tale of the dog that has not (much) barked in the night. There is an appreciable quantity of operational general international law applicable to space, beginning with the 1967 Outer Space Treaty[111] (OST), but the specific restrictions on weapons activities in

challenge."), https://perma.cc/2BWT-743K; *Bilateral Nuclear Disarmament Has Exhausted Itself, Says Lavrov*, TASS (Mar. 20, 2019), https://perma.cc/7F33-KYNU (quoting Russian Foreign Minister saying that the process of bilateral nuclear arms control should be replaced); Arbatov, *Deterrence*, *supra* note 37 (discussing "the collapse of arms control"); Benjamin Hautecouverture, *The End of Arms Control?*, FOUND. STRATEGIC RES. (June 20, 2019), https://perma.cc/V8RK-GY83.

108. Alexandra Bell & Andrew Futter, *Reports of the Death of Arms Control Have Been Greatly Exaggerated*, WAR ON THE ROCKS (Oct. 4, 2018), https://perma.cc/9VZQ-QGNS (seeing "an opportunity to reinvigorate the concept [of nuclear arms control] and tailor it to modern challenges."); *Expert Survey: Is Nuclear Arms Control Dead or Can New Principles Guide It?*, RUSSIA MATTERS (July 30, 2019), https://perma.cc/U86D-ZJNY; Lawrence J. Korb, *A Path Toward Renewing Arms Control*, BULL. ATOMIC SCIENTISTS (July 18, 2019), https://perma.cc/3YAY-V83C; Report on New START, *supra* note 106 (concluding that the New START limits on Russian nuclear forces "contribute currently to the national security of the United States").

109. JAMES E. GOODBY, HOOVER INST., THE US ARMS CONTROL AND DISARMAMENT AGENCY IN 1961-63: A STUDY IN GOVERNANCE, (July 18, 2107), https://perma.cc/B4T8-9FG5 (explaining that the Limited Test Ban Treaty was concluded in 1963, only shortly after the Bay of Pigs invasion, the erection of the Berlin Wall, and the Cuban Missile Crisis); Rumer, *supra* note 107 (describing how "The arms control process came to a halt in the early 1980s" and the entire framework of arms control appeared threatened, but negotiations were later revived); Paul Bracken, *Whatever Happened to Nuclear Abolition?*, THE HILL (Mar. 19, 2019), https://perma.cc/C5JN-ZAAV (asserting that "Arms control will come back" as it did following low points after the 1962 Cuban Missile Crisis and the 1980s Reagan nuclear build-up).

110. *See* Krepon, *supra* note 83 (recalling landmark successes in arms control achieved by Republican Presidents Ronald Reagan and George H.W. Bush); Theresa Hitchens, *Trump's Arms Control Plan: Genius or Disingenuous?*, BREAKING DEF. (Apr. 30, 2019), https://perma.cc/8RHF-X2F8; Tom O'Connor, *Donald Trump Says "We All Have to Get Rid of" Nuclear Weapons; Russia Responds: Let's Make a Plan*, NEWSWEEK (Apr. 26, 2019), https://perma.cc/8RYK-WX77; Paul Sonne & John Hudson, *Trump Orders Staff to Prepare Arms-Control Push with Russia and China*, WASH. POST (Apr. 25, 2019), https://perma.cc/D9HQ-BJMR.

111. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty or OST]. *See also* Agreement on the Rescue of Astronauts and the Return of Objects Launched in Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119; Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187; Convention on Registration of Objects Launched into Outer Space, Jan. 14,

the exoatmospheric regions are sparse.[112]

The principal legal military-related commitments for space arise under article IV of the OST, where parties are prohibited from placing nuclear weapons or other weapons of mass destruction into orbit, installing such devices on celestial bodies, or stationing such devices in space in any other manner.[113] Additionally, the Moon and other celestial bodies are reserved "exclusively for peaceful purposes," and the establishment of military bases, installations, or fortifications, as well as the testing of any type of weapons and the conduct of military maneuvers, are forbidden there.[114]

Equally noteworthy, however, is what these talismanic provisions do not address. For example, the prohibition against placing nuclear weapons into orbit does not impede nuclear-armed missiles temporarily transiting space *en route* to a terrestrial target, nor does it address non-nuclear (and non-WMD) arms of any sort. Likewise, the injunction against testing weapons on the Moon or other celestial bodies does not apply to experiments conducted in the void of space. In the same vein, while OST parties cannot lawfully establish military facilities on the Moon or other celestial bodies, nothing in the treaty inhibits the construction of fully militarized artificial satellites of any size or function.[115] In sum, it is hard to resist the cynical conclusion that the treaty was designed to solemnly ban the particular types of weapons activities that the leading parties either could not accomplish or had no interest in attempting, while preserving their full freedom to conduct any of the deployments, tests, and construction they might someday find militarily valuable.

Some other shards of international law also contribute to arms control or limits on military operations in space.[116] For example, the LTBT's proscription of

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1975, 28 U.S.T. 695, 1023 U.N.T.S. 15; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3. 13. Regarding the OST, *see generally* LYALL & LARSEN, *supra* note 2, at 49-73.

112. LYALL & LARSEN, *supra* note 2, at 49-73; THE SPACE TREATIES AT CROSSROADS: CONSIDERATIONS DE LEGE FERENDA (George D. Kyriakopoulos & Maria Manoli eds., 2019); *Raymond L. Garthoff, The Outer Space Treaty, 1967 to the Present*, *in* 2 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT, at 877 (Richard Dean Burns ed., 1993); COLBY, *supra* note 2, at 16 (commenting that "Formal, treaty-based space arms control has long been a non-starter"); Mutschler, *supra* note 3, at 104-48; GOLDBLAT, *supra* note 82, at 166-72; Mischa Hansel, *The USA and Arms Control in Space: An IR Analysis*, 26 SPACE POL'Y 91 (2010); GALLAGHER & STEINBRUNNER, *supra* note 13, at 7-16 (describing early efforts to create international legal protection for satellites).

113. Outer Space Treaty, *supra* note 111, art. IV, ¶ 1.

114. Outer Space Treaty, *supra* note 111, art. IV, ¶ 2. *See also* OST art. IX (establishing procedures for consultation in the event of "potentially harmful interference" with the space activities of another state).

115. Michael N. Schmitt, *International Law and Military Operations in Space*, 10 MAX PLANCK Y.B UNITED NATIONS L. 89, 104-05 (2006); OFF. OF GENERAL COUNSEL, DEP'T OF DEF., DEPARTMENT OF DEFENSE LAW OF WAR MANUAL § 14.10.3 (June 2015) (updated May 2016) (discussing legal restrictions on military activities in space).

116. *See* LYALL & LARSEN, *supra* note 2, at 189-225 (discussing the International Telecommunication Union, whose Constitution, Convention, and Administrative Regulations establish rules for radio communications, which affect satellite communications and orbital placements); Schmitt, *supra* note 115

nuclear explosive tests in space has already been noted.[117] Likewise, the ABM Treaty banned the development, testing or deployment of ABM components that are space-based,[118] and SALT II similarly prohibited comparable preliminary activities regarding systems for placing into orbit nuclear weapons or other weapons of mass destruction.[119] Several treaties also provide protection for "national technical means of verification," the most prominent of which are reconnaissance satellites employed to monitor other states' compliance with arms limitations.[120] Again, however, most of these restrictions appear to be more focused on the control of nuclear weapons *per se*, rather than specifically addressing the security of space, and they may seem like paltry afterthoughts, compared to the voluminous jurisprudence that has been constructed step-by-step regarding the principal constraints of nuclear arms control.[121]

Nor is there much prospect for swift augmentation of the legal restrictions on weapons in space. The United Nations General Assembly annually adopts, usually via unanimous endorsement, ritualized resolutions promoting the peaceful uses of outer space,"[122] the "prevention of an arms race in outer space,"[123] and "no first placement of weapons in outer space."[124] As politically valuable as these pronouncements may be, the General Assembly lacks the authority to establish

(surveying other international law applicable to military operations in space); Bill Boothby, *Space Weapons and the Law*, 93 INT'L LEGAL STUD. 179 (2017).

117. LTBT, *supra* note 89, art. I.1(a), and accompanying text.

118. ABM Treaty, *supra* note 91, art. V.1, and accompanying text.

119. SALT II Treaty, *supra* note 93, art. IX.1(c), and accompanying text.

120. ABM Treaty, *supra* note 91, art. XII; New START Treaty, *supra* note 96, art. X; AMY F. WOOLF, CONG. SERV., REP. R41201, MONITORING AND VERIFICATION IN ARMS CONTROL (Dec. 23, 2011) (describing satellites as a key element of national technical means); MUTSCHLER, *supra* note 3, at 86-87. *See also* Agreement on Measures to Reduce the Risk of Outbreak of Nuclear War Between the United States of America and the Union of Soviet Socialist Republics, Sept. 30, 1971, 807 U.N.T.S. 57, art. 3 (requiring immediate notification if "signs of interference" arise regarding space-based missile warning and communications systems); Agreement Between the United States of America and the Union of Soviet Socialist Republics on Measures to Improve the U.S.A.-U.S.S.R. Direct Communications Link, Sept. 30, 1971, 806 U.N.T.S. 402, art. 2 (obligating parties "to take all possible measures" to protect high-speed, reliable satellite "hot line" crisis communications systems); Schmitt, *supra* note 115, at 112.

121. Meyer, *supra* note 14, at 5 (lamenting the incipient weaponization of space and the downplaying of diplomacy, and calling for countervailing diplomatic efforts to preserve the special pacific legal regime for space); Stephens & Steer, *supra* note 52; Ryan M. Esparza, *Event Horizon: Examining Military and Weaponization Issues in Space by Utilizing the Outer Space Treaty and the Law of Armed Conflict*, 83 J. AIR L. & COM. 333 (2018).

122. G.A. Res. 73/91 (Dec. 7, 2018); G.A. Res. 72/77 (Dec. 7, 2017); G.A. Res. 71/90 (Dec. 6, 2016). *See generally* Paul Meyer, *Washington Sparks a Space Spat at the United Nations*, BULL. ATOMIC SCIENTISTS (Dec. 11, 2018) (describing U.S. 2018 opposition to four annual space-related General Assembly resolutions).

123. G.A. Res. 73/30 (Dec. 5, 2018); G.A. Res. 72/26 (Dec. 4, 2017); G.A. Res. 71/31 (Dec. 5, 2016). *See* Meyer, *supra* note 14, at 5-6.

124. G.A. Res. 73/31 (Dec. 11, 2018); G.A. Res. 72/27 (Dec. 11, 2017); G.A. Res. 71/32 (Dec. 9, 2016). *See* Meyer, *supra* note 14, at 10-11 (describing diplomatic discord over this resolution); West, *supra* note 5, at 141-42 (noting that in 2017, four of the seven General Assembly resolutions about space were adopted unanimously).

them as binding legal obligations.[125] The General Assembly has also endorsed "transparency and confidence-building measures [TCBMs] in outer space activities,"[126] and it has sponsored a series of Groups of Governmental Experts (GGE) to promote these types of political accommodations.[127] But TCBMs are defined as measures that do not directly reduce or limit the armaments of participating states, and therefore they fall short of true arms control and disarmament,[128] and moreover, the most recent space-related GGE whimpered to conclusion without adopting any recommendations or report.[129]

The Conference on Disarmament – the traditional discussion and negotiation venue within which new multilateral arms control treaties have been articulated[130] – has long been moribund, specifically by perpetual discord over how to approach possible additional constraints on space weaponry.[131] There is now little

125. LYALL & LARSEN, *supra* note 2, at 39. Regarding the space-related activities and programs of the United Nations Office for Disarmament Affairs, see https://www.un.org/disarmament/topics/outerspace/. *See also* LYALL & LARSEN, *supra* note 2, at 12-21 (describing U.N. and other international space bodies).

126. G.A. Res. 73/72 (Dec. 13, 2018); G.A. Res. 72/56 (Dec. 4, 2017); G.A. Res. 71/42 (Dec. 5, 2016). *See* Porras, *supra* note 8, at 17-21 (discussing possibilities for operationalizing various confidence-building measures in space).

127. The General Assembly established a first Group of Governmental Experts (GGE) on Transparency and Confidence-Building Measures (TCBMs) in Outer Space Activities, pursuant to General Assembly resolution 65/68 in 2010. That GGE convened in three sessions in 2012 and 2013 and submitted its consensus report on July 29, 2013, recommending a set of TCBMs in outer space activities for implementation by states and international organizations on a voluntary basis. U.N. Off. For Disarmament Affairs, Rep. of the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer-Space Activities, A/68/189 (July 29, 2013) [hereinafter Reports of GGEs]; THERESA HITCHENS, FORWARDING MULTILATERAL SPACE GOVERNANCE: NEXT STEPS FOR THE INTERNATIONAL COMMUNITY 12-14 (Aug. 2018), https://perma.cc/4XMY-Q94E. Subsequently, the General Assembly created a second, enlarged GGE on the same topic in 2017, via resolution 72/250. That group was unable to reach consensus on a substantive report; the draft of such a report was made available by the African Union in a working paper submitted to the Chair of the U.N. Disarmament Commission, as document A/CN.10/2019/WP.1.

128. Transparency- and confidence-building measures include agreements that do not directly reduce the number or quality of weapons that states may possess but do enhance international security by assuring states that their potential rivals are not employing space capabilities in an aggressive or destabilizing way. *See* Reports of GGEs, *supra* note 127.

129. *UN Talks on Space Peace Treaty Fail to Reach Consensus*, PHYS.ORG (Mar. 29, 2019), https://perma.cc/M22D-SUWT; U.N. Secretary-General, *Group of Governmental Experts on Further Practical Measures for the Prevention of an Arms Race in Outer Space*, U.N. Doc. A/74/77, (Apr. 9, 2019) (noting that the GGE was unable to reach consensus on a final report). *See also* Meyer, *supra* note 14, at 8-9 (discussing failure to implement the report of the 2013 space GGE).

130. *An Introduction to the Conference*, U.N. OFF. AT GENEVA, https://perma.cc/8WAS-TSNA (describing the Conference on Disarmament and its success at negotiating several important prior multilateral arms control agreements); GOLDBLAT, *supra* note 82, at 14-17.

131. Meyer, *supra* note 14, at 7 (describing how the CD's procedural requirement for consensus has led to deadlock, precluding work on space weaponization since 1982); Porras, *supra* note 8, at 15 (describing CD efforts on space); Yleem D. S. Poblete, *Statement by Assistant Secretary Poblete at the Conference on Disarmament*, U.S. MISSION TO INT'L ORG. IN GENEVA (Mar. 19, 2019), https://perma.cc/M6LS-TFVR [hereinafter Poblete, *March 2019 Statement*] (criticizing politicization that has led to inaction in CD).

prospect that innovative measures of arms control in space will spontaneously spring from this source.[132]

Into this void, two groups of countries have floated interesting proposals for space, but without notable success. The European Union has promulgated an evolving draft Code of Conduct for space activities.[133] This instrument would be non-legally-binding, and would constitute little if any additional arms control – and even so, it has met widespread diplomatic apathy or antipathy.[134] Russia and China have similarly circulated sequential iterations of a proposed treaty on the Prevention of the Placement of Weapons in Space,[135] but it has likewise failed to excite sufficient support.[136]

This diplomatic and legal torpor cannot be ascribed to any shortage of sound, workable, and provocative proposals for meaningful arms control in space. The contemporary literature abounds with innovative and diverse concepts, arising from multiple azimuths, calling fruitlessly for reenergized efforts to build a safer, more stable, more comprehensive regime.[137]

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132. GOLDBLAT, *supra* note 82, at 16-17. *See also* Meyer, *supra* note 14, at 14-15 (expressing doubt about the current promise of the other possible diplomatic implements for generating new diplomacy for space); Scott Pace, *Space Development, Law, and Values*, Address at the Galloway Space Law Symposium (Dec. 13, 2017), at 2, https://perma.cc/6QQ9-X2S6 (reflecting upon the slow pace of development of space law and norms); West, *supra* note 5, at 136-44 (summarizing developments at multilateral fora for expanding space governance).

133. *Draft International Code of Conduct for Outer Space Activities*, E.U. EXTERNAL ACTION SERV. (Aug. 8, 2016), https://perma.cc/3AVQ-7C2D.

134. Beard, *supra* note 32; Meyer, *supra* note 14, at 9–10 (describing the failure of the EU Code); Hitchens, Forwarding, *supra* note 127, at 6–8; Michael Krepon, *Space Code of Conduct Mugged in New York*, ARMS CONTROL WONK (Aug. 4, 2015), https://perma.cc/FTR3-5MD7.

135. Draft Treaty on the Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects, Russia-China, June 10, 2014, CD/1985, https://documents-dds-ny.un.org/doc/UNDOC/GEN/G14/050/66/PDF/G1405066.pdf?OpenElement.

136. U.S. Government, Analysis of the 2014 Russian-China Draft "Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Space Objects" (PPWT), Sept. 2, 2014, CD/1998, https://documents-dds-ny.un.org/doc/UNDOC/GEN/G15/007/57/PDF/G1500757.pdf?OpenElement; Follow-up Comments by the Russian Federation and China on the U.S. Analysis of the PPWT, Sept. 11, 2015, CD/2042, https://documents-dds-ny.un.org/doc/UNDOC/GEN/G15/208/38/PDF/G1520838.pdf?OpenElement; Meyer, *supra* note 14, at 7–8 (discussing impasse over the PPWT); Poblete, *August 2018 Remarks*, *supra* note 17 (criticizing "the many flaws" of PPWT); COATS, *supra* note 7, at 17 (emphasizing that China's and Russia's proposals "do not cover multiple issues connected to the ASAT weapons they are developing and deploying"); Brian G. Chow, *Space Arms Control: A Hybrid Approach*, 12 STRATEGIC STUD. Q. 107, 111–13 (2018); MUTSCHLER, *supra* note 3, at 136–42; Arbatov, *Arms Control*, *supra* note 13, at 155–56.

137. *See, e.g.*, COLBY, *supra* note 2, at 21–25; Daniel Porras, *Towards ASAT Test Guidelines*, UNIDIR SPACE DOSSIER, File 2, 2018; Beard, *supra* note 32, at 51–60; Alex B. Englehart, *Common Ground in the Sky: Extending the 1967 Outer Space Treaty to Reconcile U.S. and Chinese Security Interests*, 17 PAC. RIM L. & POL'Y J. 133 (2008); Working Paper submitted by Nigeria on behalf of the African Union to the U.N. Disarmament Commission, April 25, 2019, https://undocs.org/A/CN.10/2019/WP.1 (containing the draft report of the U.N. Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities); Chow, *supra* note 136; Brian G. Chow, *Stalkers in Space: Defeating the Threat*, 11 STRATEGIC STUD. Q. 82 (2017) [hereinafter Chow, *Stalkers*]; HITCHENS, *supra* note 127, at 16–36; Patricia Lewis, *Create a Global Code of Conduct for Outer Space*, CHATHAM HOUSE (June 12, 2019), https://perma.cc/G9Z3-V4C7; HITCHENS & JOHNSON-FREESE, *supra* note 21; David A. Koplow, *The Fault Is Not in Our Stars: Avoiding an Arms Race in Outer Space*, 59

This sad inactivity is not solely a product of the Trump Administration; it has deep roots in U.S. policy across multiple Republican and Democratic leadership teams, with only a few sputtering attempts at exceptions.[138] More recently, the George W. Bush space policy was frankly opposed to arms control in space.[139] The Obama Administration was slightly more forward-leaning, declaring a willingness to "consider" additional proposals in the field, but never asserting any fresh initiatives, and never sponsoring any positive concepts or treaty texts of its own.[140]

HARV. INT'L L.J. 331 (2018); LAURA GREGO & DAVID WRIGHT, SECURING THE SKIES: TEN STEPS THE UNITED STATES SHOULD TAKE TO IMPROVE THE SECURITY AND SUSTAINABILITY OF SPACE (2010); 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 AIR & SPACE L. 44 (2008); James Clay Moltz, *Breaking the Deadlock on Space Arms Control*, 32 ARMS CONTROL TODAY, Apr. 2002, at 3; Cheng Jingye, *Treaties as an Approach to Reducing Space Vulnerabilities*, *in* FUTURE SECURITY IN SPACE: COMMERCIAL, MILITARY, AND ARMS CONTROL TRADE-OFFS 48 (James Clay Moltz ed., 2016); Rebecca Johnson, *NGO Approaches and Initiatives for Addressing Space Security*, *in* FUTURE SECURITY IN SPACE: COMMERCIAL, MILITARY, AND ARMS CONTROL TRADE-OFFS 61 (James Clay Moltz ed., 2016); Nina Tannenwald, *Law Versus Power on the High Frontier: The Case for a Rule-Based Regime for Outer Space*, 29 YALE J. INT'L L. 363 (2004); PODVIG & ZHANG, *supra* note 11, at 66–76; Icho Kealotswe, *The Rule of Law in Outer Space: A Call for International Cooperation* (Mar. 2018), https://perma.cc/AY2R-4VEN; Daniel Porras, *Anti-Satellite Warfare and the Case for an Alternative Draft Treaty for Space Security*, BULL. ATOMIC SCIENTISTS (June 28, 2019), https://thebulletin.org/2019/06/anti-satellite-warfare-and-the-case-for-an-alternative-draft-treaty-for-space-security/; Arbatov, *Arms Control*, *supra* note 13, at 157–58; Gerardine Meishan Goh, *Keeping the Peace in Outer Space: A Legal Framework for the Prohibition of the Use of Force*, 20 SPACE POL'Y 259 (2004); GALLAGHER & STEINBRUNNER, *supra* note 13, at 76–83.

138. John Pike and Eric Stambler, *Anti-Satellite Weapons and Arms Control*, *in* 2 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 991, 995–96 (Richard Dean Burns ed., 1993) (noting failed efforts to negotiate additional constraints on space weapons under Presidents Jimmy Carter and Ronald Reagan); MUTSCHLER, *supra* note 3, at 120–22 (discussing the abortive 1978-79 ASAT negotiations); Meyer, *supra* note 14, at 7 (describing the United States as being "theoretically open to new legal instruments" regarding arms control in space, but in practice opposed); IKLE & WOHLSTETTER, *supra* note 37 (resisting arms control in favor of deterrence in space); Fact Sheet, The White House, National Space Policy, PDD/NSCC 49 (PDD/NSTC 8) (Sept. 19, 1996), https://perma.cc/SB33-5HUB (Clinton-era U.S. space policy declared that "The United States will consider and, as appropriate, formulate policy positions on arms control and related measures governing activities in space, and will conclude agreements on such measures only if they are equitable, effectively verifiable, and enhance the security of the United States and our allies.").

139. U.S. National Space Policy, NSPD 49, at 2 (Aug. 31, 2006) (George W. Bush Administration policy declaring "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. Proposed arms control agreements or restrictions must not impair the rights of the United States to conduct research, development, testing, and operations or other activities in space for U.S. national interests."); John Bolton, Undersecretary of State for Arms Control and International Security Affairs, stated the U.S. position as "We are not prepared to negotiate on the so-called arms race in outer space. We just don't see that as a worthwhile enterprise." *State's Bolton Says U.S. Favors Treaty to Ban Fissile Materials*, U.S. DEP'T OF STATE, INT'L INFO. PROGRAMS (Sept. 24, 2004), https://perma.cc/3HN8-TNPE; Hansel, *supra* note 112, at 92 (reporting statement by U.S. space representative "there is no, repeat no, problem in outer space for arms control to solve."); Eric M. Javits, *A U.S. Perspective on Space*, *in* FUTURE SECURITY IN SPACE: COMMERCIAL, MILITARY, AND ARMS CONTROL TRADE-OFFS 51, 52 (James Clay Moltz ed., 2016).

140. National Space Policy of the United States of America, at 7 (June 28, 2010), https://perma.cc/DYU6-T6TG (Obama Administration space policy declares "The United States will pursue bilateral and

The Trump Administration has exercised its leadership assiduously in the retrograde direction, militating against new international law for space.[141] Instead, the bombastic rhetoric is all about building the capacity to fight and win a war in space, and about asserting U.S. dominance and space control. The premise is that the United States should prepare to win an arms race in space, not try to avoid one, and the underpinning rationale sounds exclusively in deterrence. The hoary catch phrases about "peace through strength" are trotted out, with the sole emphasis placed on over-matching the military space ambitions of any rival. Rejecting any proposals for arms control in space, the concept today – whether exercised through a nascent Space Force or via other means – is to persuade any opponents that they cannot succeed in defeating the United States in space (deterrence by denial) and that any attempt to do so would be met by overwhelming retaliation (deterrence by threat of response).[142]

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multilateral transparency and confidence-building measures to encourage responsible actions in, and peaceful use of, space. The United States will consider proposals and concepts for arms control measures if they are equitable, effectively verifiable, and enhance the national security of the United States."); NATIONAL SECURITY SPACE STRATEGY, *supra* note 8, at 5–6, 10; ROSE, *supra* note 8, at 6 (discussing Obama Administration space initiatives, including establishment of over twenty formal bilateral space security dialogues with partner nations); Victoria Samson, *Making a Mark in Space: An Analysis of Obama's Options for a New U.S. Space Policy*, ARMS CONTROL TODAY (Oct. 2009), https://perma.cc/Z8YU-4RTN; MUTSCHLER, *supra* note 3, at 129–33 (describing evolution of U.S. space policy since 1991), 166–67 (expressing surprise that the United States has not produced its own proposals for arms control in space); HITCHENS & JOHNSON-FREESE, *supra* note 21, at 3 (describing how the Obama Administration slipped back to the Bush Administration rhetoric about dominance and control of space).

141. THE WHITE HOUSE, *supra* note 58 (declaring a policy of "peace through strength," "to ensure unfettered access to, and freedom to operate in space" and that "any harmful interference with or attack upon critical components of our space architecture that directly affects this vital interest will be met with a deliberate response at a time, place, manner, and domain of our choosing" and "the United States will seek to deter, counter, and defeat threats in the space domain that are hostile to the national interests of the United States and our allies."); Meyer, *supra* note 14, at 11–13 (critiquing tone and content of Trump space policy documents); ROSE, *supra* note 8, at 7 (noting Trump Administration officials calling for creation of norms of behavior in space); Weeden, *supra* note 13.

Occasionally, Trump Administration officials have nodded in the direction of acknowledging the potential utility of arms control in space, but without offering any specifics or follow-through. *See* Sandra Erwin, *Pentagon Space Posture: Don't Even Try to Mess with Us*, SPACE NEWS (Jan. 19, 2018), https://perma.cc/Y5B3-FRJR (quoting then-Secretary of Defense Jim Mattis saying that preferably, conflicts in space should be resolved diplomatically, "We'll come up with arms control agreements at some point, and we'll start getting this under control. . .. But for right now, it's about sizing up the problem and making certain that our diplomats will be negotiating from a position of strength."); Sandra Erwin, *State Dept. Official: "We Need to Have Discussions about Space"*, SPACE NEWS (Sept. 8, 2018), https://perma.cc/B6D5-99MZ (quoting Under Secretary of State Andrea Thompson saying that she does not foresee new treaties on space, but predicts there will be more international dialogue, "We need to have discussions. What is a responsible nation state behavior in space? Those discussions are just starting.").

142. Insinna, *supra* note 24; Poblete, *March 2019 Statement*, *supra* note 131 (criticizing actions of Russia, China and others and doubting the sincerity of their interest in pursuing meaningful measures of arms control in space); Poblete, *August 2018 Remarks*, *supra* note 17 (arguing that adversaries have already transformed space into a warfighting domain, and the United States is simply responding to that provocation); *Remarks by President Trump at a Meeting with the National Space Council and Signing of Space Policy Directive-3*, THE WHITE HOUSE (June 18, 2018), https://perma.cc/M74P-GYPY (asserting that "When it comes to defending America, it is not enough to merely have an American presence in space. We must have American dominance in space."); *Remarks by Vice President Pence at the Satellite*

C. Weaknesses in the Concept of Arms Control

The foregoing analysis should not be interpreted simply as a paean to the majesty of arms control; there are persistent difficulties in this field that make it implausible for the United States to rely exclusively on this tool of foreign and security policy.[143] Four prominent hurdles stand out in this context.

First, any proposal for arms control in space must begin with the foundational puzzle about what, precisely, the diplomats would seek to regulate, limit, or abolish.[144] The definition of the to-be-governed activity or hardware can be nettlesome in any endeavor, and it is especially challenging in a milieu such as outer space that is pervasively characterized by the phenomenon of dual capability. Many of the satellites, their operations, and their controls can be applicable both to peaceful civilian activities across the breadth of the economy and to offensive weapons. For example, the ability to approach and inspect a non-cooperating satellite may be advantageous for future servicing and salvaging operations, but could obviously also be adapted to attack a spacecraft. Likewise, the development of enhanced space cyber capabilities may be essential for efficient control and use of satellites as the radio frequency spectrum becomes more crowded, but those techniques could also readily be exploited for hostile purposes.[145]

Second, arms control must perpetually confront the question of adequate verification of compliance by opposing states: how can we be confident that our treaty partners are faithfully fulfilling their commitments, when the crucial action takes place hundreds or thousands of kilometers removed from human presence? Any

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2019 Conference, THE WHITE HOUSE (May 6, 2019), https://perma.cc/38UW-WHE4 (calling for peace through strength in space); Matthew T. King & Laurie R. Blank, *International Law and Security in Outer Space: Now and Tomorrow*, 113 AJIL UNBOUND 125, 126 (2019) (stating that "DoD guidance emphasizes protection, deterrence, resiliency, redundancy, and international partnership as avenues for continued freedom of operations in space," and not mentioning arms control as a possible approach).

143. *See generally* Patrick Glynn, *Critics of Arms Control and Disarmament*, *in* 1 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 325 (Richard Dean Burns ed., 1993); MUTSCHLER, *supra* note 3, at 19–25.

144. Billings, *supra* note 13 (quoting Gen. Hyten about the ambiguity of defining a space weapon); Beard, *supra* note 32, at 54; Joan Johnson-Freese, *Space and National Security*, *in* THE OXFORD HANDBOOK OF U.S. NAT'L SECURITY 435, 439 (Derek S. Reverson et al. eds., 2018); Ben Baseley-Walker & Brian Weeden, *Verification in Space: Theories, Realities, and Possibilities*, 11 DISARMAMENT F. 39, 45–46 (2010); JOHNSON-FREESE, *supra* note 7, at 67–68.

145. PORRAS, *supra* note 8, at 10–12 (discussing dual- and multiple-use space technology); Carlo Munoz, *China's Moon Landing Boosts Trump's Space Force*, WASH. TIMES (Jan. 9, 2019), https://perma.cc/3L5Q-YMVY (asserting that the technology for a lunar mission can be applied to military space missions); Benjamin Bahney & Jonathan Pearl, *Why Creating a Space Force Changes Nothing*, FOREIGN AFF. (Mar. 26, 2019), https://www.foreignaffairs.com/articles/space/2019-03-26/why-creating-space-force-changes-nothing (arguing that additional arms control treaties for space will not work); Sebastien Roblin, *Russia's "Killer" Space Satellites: A Real Threat or a Paper Tiger?*, NAT'L INT. (Aug. 24, 2018), https://perma.cc/7U4H-E5ZX (describing dual capability of maneuverable inspection satellites built by Russia, China, and the United States); *Remarks by President Trump at Signing Ceremony for Space Policy Directive-4*, THE WHITE HOUSE (Feb. 19, 2019), https://perma.cc/8BM5-4R5H (describing U.S. efforts to respond to space activities of adversaries, saying "And they're doing it, and we're doing it. And that's going to be a very big part of where the defense of our nation – and you could say "offense" – but let's just be nice about it and let's say the defense of our nation is going to be.").

concept for on-site pre-launch inspection of space objects would collide with legitimate concerns for secrecy rooted in both national security and commercial secrecy. Here, the negotiators of any treaty must ensure a close correspondence between the specific limits that would be imposed and the timely ability to observe states' performance. Durable arms control cannot be based on trust, but must ensure reciprocal and visible fidelity in honoring the commitments.[146]

The third critical element concerns enforcement: what can be done if an important treaty violation is discovered? Arms control here partakes of the same distress that characterizes all of international law: the problem of effectively redressing breaches in a system that lacks the customary compulsory authorities. To maintain stability, wise arms control measures must ensure that even a sudden "breakout" from the regime would not provide the violator a vital advantage.[147]

Finally, and most fundamentally, arms control is by definition the product of international negotiation; it requires the affirmative assent of mutually-suspicious rival states who must simultaneously agree on a balanced package of restraints. Neither participant can unilaterally impose its will; one-sided proposals will simply fail. The craft of diplomacy can succeed only if two willing partners share a genuine, complementary interest in reaching mutual accommodation – not an easy juggling act, even in the best of circumstances. In contrast, a policy of emphasizing the weapons-procurement aspects of deterrence is at least something that an individual country can pursue on its own; building more weapons remains within the realm of unilateral national actions.[148]

In sum, arms control is no panacea – any more than deterrence alone is. Each strategy offers unique strengths and weaknesses, and what is most remarkable at

146. Allan S. Krass, *Arms Control Treaty Verification*, *in* 1 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 297 (Richard Dean Burns ed., 1993); MUTSCHLER, *supra* note 3, at 156–60 (discussing difficulty of verifying compliance with a space weapons treaty); AMY F. WOOLF, MONITORING AND VERIFICATION IN ARMS CONTROL (2011); Steven Pifer, *Washington-Moscow Nuclear Verification: Tensions and Solutions*, 74 BULL. ATOMIC SCIENTISTS 297 (2018); GOLDBLAT, *supra* note 82, at 309–45; Baseley-Walker & Weeden, *supra* note 144.

147. Fred Charles Ikle, *After Detection—What?*, 39 FOREIGN AFF. 208 (1961) (contemplating mechanisms for enforcement of arms control treaties); Brad Roberts, *Revisiting Fred Ikle's 1961 Question, "After Detection—What?"*, 8 NONPROLIFERATION REV. 10 (2001); U.S. DEP'T OF STATE, ADHERENCE TO AND COMPLIANCE WITH ARMS CONTROL, NONPROLIFERATION, AND DISARMAMENT AGREEMENTS AND COMMITMENTS (2019) (assessing other states' fidelity in fulfilling their arms control responsibilities, and reporting U.S. efforts to achieve better behavior); Gloria Duffy, *Arms Control Treaty Compliance*, *in* 1 ENCYCLOPEDIA OF ARMS CONTROL AND DISARMAMENT 279 (Richard Dean Burns ed., 1993); Alexander Lanoszka, *The INF Treaty: Pulling Out in Time*, 13 STRATEGIC STUD. Q. 48 (2019) (examining the difficulty in responding to Russia's violation of the INF Treaty); LAMBAKIS, *supra* note 2, at 74–76 (stressing non-compliance with arms control treaties by Russia and others); Poblete, *March 2019 Statement*, *supra* note 131; Peter Pry, *The Case Against Arms Control*, REAL CLEAR DEF. (June 24, 2019), https://perma.cc/5UU4-VUAM.

148. KISSINGER, *supra* note 37, at 203–09 (arguing that possession of weapons is not the cause of international tensions; diplomacy cannot resolve international conflicts but can provide a forum for settlement of disputes, maintain channels of communication, and enable each side to convey its intentions to the other); NAS REPORT, *supra* note 2, at 38 (emphasizing that deterrence also rests upon a relationship between two or more actors; it is not something either participant can accomplish on its own).

this juncture is that both approaches have been applied collaboratively in the nuclear realm, but only one of them, deterrence, has been admitted into today's dialogues about space. This asymmetry is all the more surprising in light of the assessment – to be developed in the next Part – that the strategy of deterrence suffers several significant systemic flaws as applied to space.

IV. LIMITATIONS ON DETERRENCE IN SPACE

This Part undertakes to assess the four sub-types of deterrence in the context of space security. The bottom line is not that deterrence is irrelevant or that pursuit of the quartet of overt manifestations of deterrence in space is necessarily harmful; instead, the critique is that each of the sub-types knows limits and that each may be less suited to space than it is to the nuclear realm.[149]

A. Limitations on Deterrence by Threat of Symmetric Retaliation in Space

The primary factor that renders symmetric retaliation less suitable in space is the profound asymmetry in the use of space by the United States compared to its rivals. As noted above, the United States owns and operates more satellites than any other country and derives more benefit, and more diverse types of benefits, from them, advancing American civil and military interests in multiple ways.[150] However, that peacetime comparative advantage could quickly morph into a wartime vulnerability. The American military and economy have succeeded in exploiting space more extensively than others and have concomitantly become more heavily reliant upon satellite services; our relative potential exposure is therefore immense. If U.S. customers were suddenly denied access to now-ubiquitous space-borne functions, the results would be catastrophic – far more so than for our potential adversaries, who have not yet invested so comprehensively in space.

In strategic terms, the asymmetric exposure in an ASAT war – what some have labeled a "vulnerability gap" – would result in the United States lacking "escalation dominance";[151] as the hostilities accelerated, we would suffer more than our opponents. Put more crudely, even if our ASAT capabilities were superior to others', we would run out of satellite targets to shoot at long before our opponents did.[152]

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149. *See generally* Krepon & Thompson, *supra* note 36; Mueller, *supra* note 72, at 42 (arguing that "nuclear deterrence and space deterrence differ in so many ways that the contrasts between them are far more pronounced, and more illuminating, than the characteristics that they have in common."); Kazuto Suzuki, *A Japanese Perspective on Space Deterrence and the Role of the Japanese-US Alliance in Sino-US Escalation Management*, *in* OUTER SPACE; EARTHLY ESCALATION? CHINESE PERSPECTIVES ON SPACE OPERATIONS AND ESCALATION 44, 45 (Nicholas Wright ed., 2018) (emphasizing the difficulty of deterrence in space).

150. *See supra* text accompanying note 10 (describing the numbers of U.S. and other satellites).

151. Harrison et al., *supra* note 38, at 9–11 (developing the concept of a "vulnerability gap"); Aaron Miles, *Escalation Dominance in America's Oldest New Nuclear Strategy*, WAR ON THE ROCKS (Sept. 12, 2018), https://perma.cc/6B8T-M9KP; MORGAN, *supra* note 12, at 18.

152. *Cf.* Harrison et al., *supra* note 38, at 1 (Cold War deterrence assumed a rough equality of capability and risk between the superpowers, but in space today, the United States is both uniquely

Moreover, if the percolating space battle were conducted by kinetic means and resulted in significant accumulations of additional orbital debris, that increased space pollution would redound distinctly to the U.S. disadvantage, too. As the leading user of satellites, the United States has the most to lose if large swaths of space become uninhabitable, especially if the hazards could persist for years or decades after the conflict had ended.[153] That exposure would – and should – inhibit any U.S. resort to a reciprocal kinetic ASAT retaliation, and would likewise undercut deterrence.

It is true that Russia and China, among others, are now moving toward space with increasing alacrity, mimicking the United States in pursuit of similar military and civilian benefits. But for the foreseeable future, the lack of congruent investment will remain – their ASATs could inflict more pain on the United States than our ASATs could inflict upon them. Threats of symmetric retaliatory uses of force in space cannot therefore accomplish the same deterrent effect traditionally available in other theaters.[154]

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capable and uniquely vulnerable); LAMBAKIS, *supra* note 2, at 18 (asserting that "Without a doubt, the United States has the most to lose and the most to gain in space."); DIA, *supra* note 2, at 24 (reporting that "Russia views America's perceived dependence on space as the "Achilles heel" of U.S. military power"); COLBY, *supra* note 2, at 27 (noting problems with a mirror-image response to an attack on a U.S. satellite); MORGAN, *supra* note 12, at 2–3 (arguing that the United States has the most to lose in a conflict in space; even if it could "win" a military engagement, it would suffer greatly), 26–27 (suggesting that enemy leaders "might even welcome a game of satellite tit-for-tat, as the benefits of denying space support to U.S. forces would likely outweigh the costs of losing their own assets in return.").

153. LAMBAKIS, *supra* note 2, at 68 (arguing that for the United States to retaliate in kind after a debris-creating kinetic ASAT attack "may be akin to shooting yourself in the foot."); Nathaniel Scharping, *Space Wars Will Look Nothing Like Star Wars*, ASTRONOMY (Feb. 19, 2018), https://perma.cc/L3AP-DUGC (quoting Col. Shawn Fairhurst, deputy director of Air Force Strategic Plans, Programs, Requirements and Analysis, "Everybody assumes that if we get somebody that shoots at me in space, we're going to shoot back in space. Well, that's a horrible idea. When you blow something up on the ground, it falls back to the ground. If you blow something up in the air, the airplane comes back to the ground. The problem is, when you blow something up in space, it creates debris that never comes down."); COLBY, *supra* note 2, at 30 (emphasizing the development of space attack capabilities that do not generate debris). Note that any use of a nuclear weapon in space could be even more destructive; the radiation effects would indiscriminately damage all satellites even at great distances and cause destructive electromagnetic pulse effects on Earth. *See Nuclear Weapon Effects in Space*, NASA, https://perma.cc/STP3-EV55; Phil Plait, *The 50th Anniversary of Starfish Prime: The Nuke That Shook the World*, DISCOVER MAG. (July 9, 2012), https://perma.cc/K5ES-4VQP.

154. LAMBAKIS, *supra* note 2, at 67 (observing that "Retaliation in kind for an attack on U.S. satellites may not work against an adversary that does not rely on space systems to the same degree as the United States"); DIA, *supra* note 2, at 24 (reporting that "Moscow wants to avoid becoming overly reliant on space to carry out its national defense mission."); MacDonald, *supra* note 43, at 83 (suggesting that as China and other states increase their space capabilities, their vulnerability to U.S. attacks will grow, too); MORGAN, *supra* note 12, at 27 (opining that no other state is likely to approach the level of U.S. investment in space in the foreseeable future, so the balance of interests in space will not fundamentally shift); Harrison et al., *supra* note 38, at 10 (suggesting that "other space-faring nations will see our example as one to avoid rather than to emulate. They may be alert to the distinction between reliance and over-reliance on space.").

B. Limitations on Deterrence by Threat of Asymmetric Retaliation in Space

This concept, too, can play a role in managing crises in space, but it also poses special problems in implementation. The core notion is imminently sensible: if, in a particular situation, a tit-for-tat retaliation would be inappropriate, ineffective, or unwise, perhaps an asymmetric response would be more prudent. The United States could elect to respond to an enemy's hostile action in space, not by reciprocally attacking the enemy's satellites, but by undertaking other types of counter-offensives, launched at a time, place, and manner of our choosing.

For example, the U.S. retaliation could plausibly aim at the ground stations that had launched or controlled the enemy's offensive ASATs, or more broadly at the facilities that service other types of enemy satellites. Further afield, the United States could elect to strike at the enemy's other military assets on land, sea or air. As noted *supra*, principles of the law of armed conflict mandate that any such response must be proportional to the enemy's initial provocation, but there is nothing in the laws and customs of war that would demand strict congruity in the means and methods of a counter-strike.[155]

However, in the space context, such a shift in the nature of the second strike could be unhelpfully escalatory. If state X shoots at state Y's satellite, that attack might damage Y's military capability in meaningful ways, but if Y responds by striking at X's launch facilities (or at X's other military assets), that could well be interpreted as a much more important violation of X's territorial integrity and could result in human casualties among X's nationals. In a strict sense, Y's response might nonetheless pass the proportionality test, because the harm inflicted by X's initial strike could have been substantial. But to many observers, Y would have upped the ante, by converting the confrontation from a bloodless encounter in remote space to a more grisly detonation inside sovereign territory, with immediate human casualties.[156] Y might accordingly feel significant political inhibitions against undertaking that type of asymmetric response, and outside

155. *See supra* text accompanying note 52 (explaining that the proportionality requirement does not mandate a response in kind); COLBY, *supra* note 2, at 29 (calling for the United States to develop a tailored response capability).

156. LAMBAKIS, *supra* note 2, at 68–69 (noting that space launch facilities are generally not located near heavily populated areas, so a retaliatory attack against a site that had launched an ASAT attack might not generate large numbers of human casualties), 71 (observing that "killing" a satellite is not the same as drawing blood on Earth, and may undercut public support for the retaliation); MORGAN, *supra* note 12, at 29–30 (arguing that an asymmetric attack on enemy territory could be seen as highly escalatory, condemned in domestic and world public opinion). *But see* Bowen, *supra* note 43 (pointing out that while hostile destruction of a satellite does not immediately cause human casualties, it can inflict significant military disadvantage, which can indirectly result in great harm). *See also* Michel Bourbonniere & Ricky J. Lee, *Jus ad Bellum and Jus in Bello Considerations on the Targeting of Satellites: The Targeting of Post-Modern Military Space Assets*, 44 ISRAEL Y.B. HUM. RTS. 167, 180–83 (2014) (suggesting that responding to an ASAT attack by striking the enemy's non-space-related military assets might be illegal). *Cf.* James A. Lewis, *Reconsidering Deterrence for Space and Cyberspace*, *in* Krepon & Thompson, *supra* note 36, at 61, 66 (noting that massive retaliation in response to a cyber attack would be bizarre); Suzuki, *supra* note 149, at 45–46.

observers, too, might assess it as inappropriate. The deterrence value of the threat to respond in this way would therefore lose some degree of credibility.[157]

C. Limitations on Deterrence by Denial via Interception in Space

Having the ability to effectively intercept an enemy's ASAT offensive would be highly desirable, but it is also an extraordinarily difficult mission to accomplish. Space is an environment in which the offense has inherent advantages: satellites are relatively few in number; they are hard to shield; they follow known, predictable trajectories; many are non-maneuverable; and they are expensive and cannot be replaced quickly – in short, they are precious, vulnerable sitting ducks.[158] In contrast, the attacker may be able to rely upon relatively simpler, less costly technology, and need not achieve 100% success in order to significantly degrade the other side's space capabilities. In a persistent arms race between attacker and defender, the practicalities in space favor the predator.[159]

Moreover, there is an inherent overlap between some defensive space technologies (such as might be embodied in the concept for a bodyguard satellite) and those of an offensive ASAT vehicle. The maneuverability, the sensors, and the capacity to shoot at (or otherwise counteract) an incoming ASAT would likely also be readily applicable in an effort to initiate an attack against another state's satellites.[160] So our effort to achieve these "defensive" space capabilities could well be interpreted by others as a covert attempt to secure an "offensive" strength, too – and it could further incentivize them to do likewise. This action/reaction phenomenon would fuel an arms race, undercutting stability, and would also

157. COLBY, *supra* note 2, at 17–18 (reflecting doubt about the credibility of a U.S. threat to respond massively to a limited attack on U.S. satellites). *Cf.* Erin Cunningham, Missy Ryan & Dan Lamothe, *Trump Says He Called Off Iran Strikes, Citing Potential Casualties*, SALT LAKE TRIB. (June 21, 2019), https://perma.cc/6Z3V-P9JQ (reporting that President Trump cancelled a planned attack on Iranian military sites, originally approved as a response to Iran's downing of an unmanned U.S. surveillance drone, because he considered the likely deaths of 150 Iranians disproportional); Kenneth Watkin, *Proportionality and 150 Iranian Lives: Do They "Count"?*, JUST SECURITY (Aug. 16, 2019), https://perma.cc/ND28-BQ43.

158. Read, *supra* note 14 (quoting defense expert Adam Routh who argues that "The cost proposition is so in favor of the ASAT capability. It suggests it's cheaper to attack those satellites than it is to replace them."); MORGAN, *supra* note 12, at 2 (arguing that space is an offense-dominant environment, with substantial incentives for striking first), 14–15 (noting that satellites are fragile and travel predictable paths devoid of geographical cover); Harrison, Jackson & Shackelford, *supra* note 38, at 11–12; Dan Drollette, *"Big, Fat, Juicy Targets" – The Problem with Existing Early-Warning Satellites. And a Solution*, BULL. ATOMIC SCIENTISTS (Sept. 2019).

159. COLBY, *supra* note 2, at 11 (discussing the difficulty of protecting the inherently fragile satellites and concluding that "the job of attackers is, generally speaking, going to be easier than the defender's"), 26 (noting that while deterrence by denial might be the preferable option, it is not attainable in space); MORGAN, *supra* note 12, at 31–32 (referring to satellites as "high-value, low-density assets" and emphasizing how difficult it is to defend them); MACDONALD ET AL., *supra* note 12, at 34 (suggesting that credible ASAT systems are relatively inexpensive).

160. *See supra* text accompanying note 66 (discussing the concept of a bodyguard satellite); GREGO & WRIGHT, *supra* note 137, at 38–40 (doubting the effectiveness and wisdom of a bodyguard satellite against various ASAT threats); Suzuki, *supra* note 149, at 45.

create perverse incentives to strike first in a crisis, further damaging the prospects for restoring peaceful order.[161]

The comparison to the persistent, quixotic efforts to develop terrestrial missile defense capabilities is instructive here. In principle, a protective shield against incoming ICBM warheads could be marvelous – but the goal has proven elusive, to say the least. Despite investments of billions of dollars over decades of incessant efforts, the best available system still fails as often as it succeeds, even in carefully scripted low-stress tests. At the same time, dogged pursuit of this chimeric goal has roiled international politics, undercutting other important U.S. diplomatic objectives.[162]

D. Limitations on Deterrence by Denial via Protection or Resiliency in Space

The clear consensus among space professionals is that measures to enhance the resiliency of the U.S. satellite architecture are important, overdue, and attainable – but also that such efforts are costly and time-consuming, and can never provide a complete solution to the vulnerability problems.[163] The United States can, and should, do more to safeguard the family of satellites that we have come to rely upon, but we are unlikely to be able to protect them sufficiently to achieve robust deterrence by denial.

For example, the newfound interest in exploiting new generations of small, inexpensive satellites to supplement the traditional exquisitely engineered national security behemoths is welcome, and our deploying swarms of diverse, expendable orbiters would surely complicate the task of any enemy targetters. But it will surely take time to reconfigure the satellite architecture, and this is a case where "you get what you pay for," because there are some missions that simply cannot be performed as well by less-capable craft. Likewise, if we endeavor to make our satellites harder and more mobile, they will become more expensive. If we make them more numerous, there will be additional challenges for space traffic management.[164] If we decide to return to relying somewhat more upon

161. *See* Chow, *Stalkers*, *supra* note 137, at 99–105 (advocating preemptive self-defense against co-orbital ASATs and suggesting the establishment of self-defense zones well before a conflict, but acknowledging the danger that an act of self-defense could be mistaken for aggression).

162. Mueller, *supra* note 72, at 50–51 (comparing the difficulties of defense in space and missile defense); Patrick Tucker, *Trump's New Missile Defense Policy Relies Heavily on Largely Unproven Technologies*, DEF. ONE (Jan. 17, 2019), https://perma.cc/J5W2-73SE (surveying inadequacies of existing missile defense equipment); Laura Grego, *The Faulty and Dangerous Logic of Missile Defense*, SCI. AM. (Apr. 24, 2018), https://perma.cc/RZ8L-GEV3; MUTSCHLER, *supra* note 3, at 62–83.

163. COLBY, *supra* note 2, at 14 (summarizing the important advantages of enhancing the overall resiliency of the U.S. space architecture, but explaining that this approach by itself can never be sufficient); NAS REPORT, *supra* note 2, at 36–37; Bradley Townsend, *Space: An Offense-Dominant Environment?*, PURVIEW (Dec. 26, 2018), https://perma.cc/LG9X-VYSN (arguing that disaggregation and other resiliency-enhancing adaptations can protect the satellite architecture from attack); MORGAN, *supra* note 12, at 31–32 (noting that efforts to make satellites more survivable, such as by enhancing their maneuverability, come at a cost); NATIONAL SECURITY SPACE STRATEGY, *supra* note 8, at 11; MUTSCHLER, *supra* note 3, at 112 (surveying possibilities for enhancing protection of satellites against interference and attack).

164. *See* Space Policy Directive 3, National Space Traffic Management Policy, THE WHITE HOUSE (June 18, 2018), https://perma.cc/S9MC-S8L7 (discussing problem of space traffic management,

terrestrial fallback systems, we would be foregoing some of the unique benefits of the space platforms, and we would incur the additional costs of funding redundant systems.[165] And of course, we would also have to contemplate the dynamic nature of the space competition: our adversaries will surely react to, and attempt to negate, any resiliency-enhancing adaptations the United States adopts.

Overall, regarding each of the four versions of deterrence, there are limits to what can be accomplished in space. Each of the manifestations of deterrence is worth attempting, or at least contemplating, depending upon the costs and the emergence of relevant technologies. And the four categories may be mutually-supportive; in concert, they may undercut a potential adversary's zeal for space warfare more than any one of them could accomplish solo.[166] But singly or in concert, these deterrence measures cannot suffice to provide security for the United States in space; something more – the concept of arms control in space – is also necessary, as elaborated in the next Part.

V. ARMS CONTROL IN SPACE

This Part does not recommend particular measures for arms control in space – there is plenty of additional literature that proffers useful, intriguing, powerful ideas.[167] Instead, the argument here is simply that arms control, in general, should be marshaled – for what would be almost the first time in half a century – to help pursue U.S. national security and global stability in the space ecosystem.

No one should suppose that negotiations for ASAT restrictions would be easy or quick – there are too many substantive hurdles to overcome, and the process could well proceed, as nuclear arms control famously has, via a series of partial, incremental accords, only gradually tightening the noose on the excessive and destabilizing weapons. Still there are several reasons to be confident that prudent, well-crafted arms control would offer special advantages, running well beyond what can be accomplished by deterrence alone.

First, each of the leading players has powerful, albeit partially asymmetric, reasons for contemplating legal limitations on space weapons. For the United States, the prime incentive is to take meaningful steps toward enhancing the stability and security of the exoatmospheric realm. As noted above, the United States depends more than anyone else upon space assets for enormous civil and military benefits; ensuring the enduring viability of those fragile orbiters should be a top priority. On the other hand, Russia and China, poised a step or two behind the United

applicable both for military purposes and for orderly space traffic management); LYALL & LARSEN, *supra* note 2, at 268–70; Brian G. Chow, *Two Ways to Ward off Killer Spacecraft*, DEF. ONE (July 30, 2019), https://perma.cc/HX62-AT43 (stating that it will take until the 2030s for the United States to fully deploy a resilient military satellite constellation).

165. COLBY, *supra* note 2, at 14–16 (considering the advantages of terrestrial and airborne alternatives to satellites, but also stressing the disadvantages of that approach); Coletta, *supra* note 43, at 186.

166. MORGAN, *supra* note 12, at 37 (noting the advantages of attempting to manipulate both sides of an opponent's cost-benefit calculation simultaneously).

167. *See supra* text accompanying note 137 (citing diverse proposals for arms control in space).

States in the investment in satellite services, should be motivated by an offsetting interest in reining in the burgeoning and potentially overwhelming U.S. pursuit of additional space control capabilities.[168]

Second, the cat is not yet completely out of the bag. ASATs have been tested and operational systems have been deployed, the institutional infrastructure of space control has been refined, and the bellicose rhetoric has been ramped up. But no ASAT has ever been used in combat; no state has ever fired a destructive tool at another state's satellite.[169] For the most part, the potential implements of space warfare are still undergoing development and testing; certainly, no large-scale arsenals have been manufactured and fielded. International legal restrictions have historically been much easier to emplace when the weapons have not yet been exercised in combat, and when a military-industrial constituency has not yet fully blossomed.[170] In contrast to nuclear weapons, therefore, arms control in space could gain purchase quickly.[171]

Third, the number of relevant countries is still small. Although the roster of spacefaring states is lengthy and growing, only a few have already rigorously explored the options for space control. To a large extent, the active problem has been confined to ASAT testing by three leading states, China, Russia, and the United States – now joined by India. In contrast, there are now nine states widely credited with nuclear weapons, and several more with the capability to attempt that status, should their ambitions so require.[172] In general, the more states

168. Paul B. Larsen, *Outer Space Arms Control: Can the USA, Russia and China Make This Happen*, 23 J. CONFLICT & SECURITY L. 137, 158 (2018) (identifying the leading states' shared interests in peace in space).

169. In 2006, reports surfaced about China allegedly illuminating some overflying U.S. satellites with lasers without inflicting any damage, but details about the incident have never been revealed. HARRISON ET AL., *supra* note 7, at 14; Gertz, *supra* note 30; Johnson-Freese, *supra* note 144, at 438.

170. For example, these conditions may help account for the success of the Antarctic Treaty, *supra* note 88, as well as the 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, (entered into force May 18, 1972) and the Convention on the Prohibition of Military or Other Hostile Use of Environmental Modification Techniques, May 18, 1977, 1108 U.N.T.S. 152, https://perma.cc/VYW5-T4TY, which dealt with potential weapon concepts that no state had actively pursued. *See also Treaty on Outer Space, Hearings Before the Comm. On Foreign Relations*, 90th Cong. 79-80 (1967) (Statement of Cyrus R. Vance, Deputy Secretary of Defense) (explaining that it "is certainly better [to prevent the spread of new weapons into new areas such as space now] than to try to control or reduce them later after they have been developed and deployed, after inertia and investment make it so difficult to pursue reductions in armaments.").

171. *See* Krepon, *supra* note 36, at 15 (emphasizing that in contrast to the deployment of thousands of nuclear weapons, the weaponization of space has yet to occur); Michael Krepon & Sonya Schoenberger, *A Comparison of Nuclear and Anti-Satellite Testing, 1945-3013*, *in* ANTI-SATELLITE WEAPONS, DETERRENCE AND SINO-AMERICAN SPACE RELATIONS 131 (Michael Krepon & Julia Thompson eds., 2013) (calculating that the United States, the Soviet Union/Russia, and China have collectively conducted 1790 tests of nuclear devices, and only 61 ASAT tests).

172. *Fact Sheet*, *supra* note 97; Kristensen & Korda, *supra* note 97; *Nuclear Disarmament Resource Collection*, NTI (Aug. 7, 2018), https://perma.cc/C3LD-HK3H. Israel's official policy is to neither confirm nor deny possession of nuclear weapons, and the United States' official policy is to support that posture.

participating independently in the dialogue, the more difficult and prolonged we should expect the negotiations to become.

Fourth, there are already some preliminary understandings about "rules of the road" for safe, sustainable, equitable national activities in space. As noted *supra*, there is a handful of older space treaties;[173] these have recently been supplemented by a growing array of non-legally-binding but well-respected codes regarding minimization of the creation of space debris[174] and regarding the long-term sustainability of space operations.[175] For the most part, these diplomatic enterprises have shied away from addressing military matters, but perhaps they evince a growing appreciation for the widely-shared interest in harmonious uses of space and a willingness to engage. More difficult to document, but of even greater relevance, there already seems to be a widely shared antipathy to at least one particular type of ASAT operations – those that rely upon kinetic interceptions or explosions to destroy a target and thereby risk creating clouds of persistent, mutually hazardous space debris. At least the three major military space states have refrained from deliberate collisions for the past decade, and the American authorities may be expressing a common understanding in overtly opposing ASAT operations that so indiscriminately jeopardize space.[176]

Fifth, the private sector has a substantial and growing presence in space. Multiple corporations based in the United States and elsewhere have announced plans to deploy hundreds or thousands of new satellites[177] or to explore the alluring prospects for mining the Moon or asteroids.[178] As these ambitious enterprises proceed, they will depend on the maintenance of a stable and secure regime in space – the owners and operators (and their financial backers and insurers) may be able to succeed despite all the natural hazards inherent in functioning in such a

173. *See supra* text accompanying note 111 (describing the foundational space treaties).

174. U.N. OFFICE FOR OUTER SPACE AFFAIRS, SPACE DEBRIS MITIGATION GUIDELINES OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE (2010), https://perma.cc/KG6K-K7JX; LYALL & LARSEN, *supra* note 2, at 275–79; HITCHENS, *supra* note 27, at 8; ROSE, *supra* note 8, at 3; Beard, *supra* note 32, at 33 (noting that these debris guidelines "have made a widely recognized, significant contribution to preserving the outer space environment"). *But see* Inter-Agency Space Debris Coordination Committee (IADC)—An Overview of IADC's Annual Activities, at 13 (Jan. 29, 2018–Feb. 9, 2018), https://perma.cc/3D5D-2CYR (concluding that the current level of state implementation of some of the debris mitigation guidelines "is considered insufficient and no apparent trend towards a better implementation is observed.").

175. *Long-term Sustainability of Outer Space Activities*, U.N. OFFICE FOR OUTER SPACE AFFAIRS, https://perma.cc/Y3FM-X3U7; HITCHENS, *supra* note 127, at 8–12; Brian Weeden & Victoria Samson, *New UN Guidelines for Space Sustainability Are a Big Deal*, BREAKING DEF. (Apr. 4, 2018), https://perma.cc/GUA3-Y4WF; ROSE, *supra* note 8, at 3.

176. *See supra* text accompanying notes 32–33 (describing growing rejection of debris-creating ASAT tests).

177. *See supra* text accompanying note 9 (describing democratization of space and large new fleets of private satellites).

178. Amanda Jane Hughes, *Mining Asteroids Could Unlock Untold Wealth – Here's How to Get Started*, THE CONVERSATION (May 2, 2018), https://perma.cc/FDR7-TCN9; Luke Dormehl, *Asteroid Mining Is Almost Reality. What to Know About the Gold Rush in Space*, DIGITAL TRENDS (Sept. 4, 2018), https://perma.cc/B9L6-Z46J; PLANETARY RES., http://www.planetaryresources.com (company dedicated to mining asteroids).

harsh environment, but they may find it intolerable to accept, in addition, the risks of increased human-caused dangers. In general, when the relevant private sector concerns have been supportive, arms control efforts have enjoyed greatly enhanced prospects.[179]

Sixth, there is already broad multilateral support for the concept of space arms control, even if differences persist about how best to proceed. The annual dialogues inside the U.N. General Assembly about space security and the avoidance of an arms race have become largely ritualistic, but they nonetheless document a widespread endorsement of certain underlying norms. Likewise, the U.N.-created Groups of Governmental Experts have advanced the discourse, if only incrementally, giving diplomats a suitable starting point for more ambitious negotiations and drafting.[180]

Seventh, there is no shortage of good ideas for arms control in space to ponder, pursue, and refine. This Article does not undertake to rehearse the options or to contemplate the pros and cons of the various proposals, but it is noteworthy that the proponents would not have to start from scratch if the global political conditions suddenly permit progress – much of the intellectual spade work has already been undertaken. When national leaders finally awaken to their manifest shared interest in regulating ASATs, there are plenty of alternatives for them to cultivate.[181]

In sum, the dearth of arms control in space is as puzzling as it is distressing. The objective conditions seem to be favorable – at least as favorable as the conditions that have led to recurrent, wide-ranging success in the nuclear arms control enterprise over the decades. No one would suppose that it would be easy to generate new international agreements to restrain the headlong pursuit of unilateral national military advantage in space – inducing states to try to climb back down the ladder of confrontation and tension is always a profound challenge. But it should be do-able.

CONCLUSION

Of course, the philosophical and strategic rivalry between deterrence and arms control is not as stark as intimated above. The two approaches are complementary, not opposite or antagonistic, and U.S. policy can wisely draw upon both in due measure.[182] This is certainly not a plea for "unilateral disarmament" in space;

179. *See* GRAHAM & LAVERA, *supra* note 83, at 295 (reporting U.S. chemical industry support for the 1993 Chemical Weapons Convention (which successfully entered into force) in contrast to U.S. pharmaceutical industry opposition to the proposed strengthening of 1972 Biological Weapons Convention (where the effort to negotiate a verification protocol failed)), 8 (reporting private sector opposition to 1925 Geneva Protocol (which the United States did not ratify until 1975)), 1169 (noting American Chemical Manufacturers Association's consistent support for the Chemical Weapons Convention).

180. *See supra* text accompanying note 127 (discussing the work of the Group of Governmental Experts).

181. *See supra* text accompanying notes 137 (citing diverse proposals for arms control in space).

182. *See* SCHELLING, ARMS, *supra* note 37, at 259 (explaining the enduring relationship between deterrence and disarmament, at any level of retained weaponry, concluding "[i]f disarmament were to work, it would have to stabilize deterrence. The initiation of war would have to be made unprofitable. It cannot be made impossible."); HITCHENS & JOHNSON-FREESE, *supra* note 21, at 25–31 (calling for a "strategic rebalancing" of U.S. policy in space, to emphasize diplomacy), 42 (discussing retention of an

the United States may well seek to maintain its offensive ASAT capabilities as a hedge and as a bargaining chip in future negotiations. The contemporary problem is simply that deterrence has gained such a monopoly position in American doctrine – especially regarding the security of space – that it has squeezed out rational thinking about competing methodologies. Within the nuclear realm, policy has traditionally drawn upon both elements, but in dealing with space, deterrence has become such a powerful trope that it is sometimes difficult to remember that there are other useful concepts, too.[183]

As stressed above, arms control is not merely a psychological phenomenon, as deterrence fundamentally is. Arms control accomplishes real changes in the physical world – it directly reduces the numbers (and the types, capabilities and locations) of the weapons available to our potential enemies; it diminishes the level of harm they could inflict upon us if, despite deterrence, they tried to do so.[184]

Certainly, arms control is not a magic solution, any more than deterrence – or a movie maker's MacGuffin – is. Arms control measures must be prudent, balanced, verifiable, and enforced. Treaties cannot single-handedly and instantaneously abolish all ASAT weapons and counterspace capabilities; diplomacy cannot be simply a reaction to what we might think of as "deterrence fatigue." None of the goals of arms control will be easy to attain, especially in the uniquely challenging circumstances of space. But achieving effective arms control in the nuclear realm is not easy, either, and the effort has sometimes succeeded there.

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offensive space capability as a hedge); MACDONALD ET AL., *supra* note 12, at 50–51 (identifying desirable characteristics for an offensive U.S. counterspace capability); Brian Chow, *Is It Time for 'Space Arms Control'?*, NAT'L INT. (Dec. 9, 2018), https://perma.cc/G3E3-334G.

183. *See Remarks by Acting Secretary Shanahan at the 35th Space Symposium, Colorado Spring, Colorado*, U.S. DEP'T OF DEF. (Apr. 9, 2019), https://perma.cc/H7Y6-LV7C (asserting that due to actions by Russia and China, "The threat is clear. We're in an era of great power competition. And the next major conflict may be won or lost in space. Because of their actions, space is no longer a sanctuary. It is now a warfighting domain. This is not a future or theoretical threat. This is today's threat. We are not going to sit back and watch. We are going to act. We are going to deter conflict from extending into space, and ensure we can respond decisively if deterrence fails." But he notably did not address any possibilities of arms control.); *Cf.* Krepinevich, *supra* note 37, at 78 (arguing that policymakers should neither excessively rely upon deterrence, nor abandon it, but should be aware of both its utility and its limitations); Steven L. Kwast, *Space Diplomacy: A Better Way to Combat China's Challenge*, THE HILL (Mar. 19, 2019), https://perma.cc/CB9C-U2K2 (calling for "the clever use of space diplomacy" to deal with emerging threats to the security of space); DEPTULA, *supra* note 16, at 30 (identifying four "possible lines of effort to mitigate adversary counterspace capabilities," starting with diplomacy); Harrison et al., *supra* note 38, at 18–20 (arguing that arms control can be an aid to deterrence); JOHNSON-FREESE, *supra* note 7 (arguing for a comprehensive, layered strategy for space security, not reliance upon military and technological solutions alone, saying "the United States continues to concentrate primarily on military shibboleths to complex space challenges.").

184. In the nuclear realm, this relationship is well-appreciated, even (or especially) by military leaders. *See* Valerid Insinna, *STRATCOM head on lawmaker's arms control agenda: 'If You Want to Save Money, Change the Threat'*, DEF. NEWS (Nov. 15, 2018), https://perma.cc/PA6T-LJJ7 (quoting Gen. Hyten saying that renegotiating nuclear arms control treaties with Russia was the best way to roll back spending on U.S. nuclear missiles; "if you want to save money, change the threat" by negotiating reductions in the number of Russian nuclear weapons).

The point is that we need to start trying.[185]

The emerging security threats to space are severe; all states share an interest in ensuring that the unique orbital environment is preserved for future generations. The prescription offered here is not to minimize the dangers, but to think about them creatively, to marshal all our resources along multiple paths for addressing the problems, not simply relying on any single tool of national security policy.[186] In particular, it will be up to the United States to lead in the articulation of an enlightened arms control agenda for space. The United States has always been at the forefront of space diplomacy; it should now rouse itself out of a reactive or hostile posture, to fashion plausible, mutually-beneficial international measures.[187]

This is not the place to specify precisely how the arms control process for space issues should begin, nor to speculate about what longer term solutions would be negotiable and valuable; there are numerous possibilities floating in the literature. One point that is already clear is that the objective has to fly well beyond the level of simply articulating non-legally-binding norms of behavior or aspirational comity-based rules of the road. The world needs now to progress past the elementary stage of confidence-building measures, to pursue genuine treaty limitations and reductions in space weapons, aiming for true arms control and, eventually, disarmament in this lofty realm.[188]

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185. GREGO & WRIGHT, *supra* note 137, at 14 (noting that perfect safety for satellites is impossible to attain, but use of multiple approaches can help); Douglas Loverro, *Why the US must lead again*, SPACE REV. (Aug. 14, 2017), https://perma.cc/Y8QT-WG4P (arguing that the United States has for too long failed to envision new principles for leading the international discussions about security in space).

186. *Cf.* Lewis, *supra* note 156, at 70 (observing that ASATs and cyber malware do not carry the same taboo against use that nuclear weapons have inspired); MORGAN, supra note 12, at 42–43. *See also* Stewart Patrick & Kyle L. Evanoff, *The Right Way to Achieve Security in Space*, FOREIGN AFF. (Sept. 17, 2018), https://www.foreignaffairs.com/articles/space/2018-09-17/right-way-achieve-security-space (stressing the benefits of international cooperation in space to address a host of hazards); Weeden, *supra* note 13 (arguing that the United States should "play a leadership role not only in the development of military might but also comprehensive political and diplomatic solutions to space threats"); GREGO & WRIGHT, *supra* note 137, at 2, 13–14 ("Given its preeminence in space, the United States must provide leadership if progress is to be made [toward sustainability and security in space]"); Brian Weeden, *The Trump Administration needs to exercise leadership in space security diplomacy*, SPACE REV. (Aug. 20, 2018), https://perma.cc/LT46-WS5A.

187. Harrison et al., *supra* note 38, at 28 (calling for the United States to seize the political initiative in sponsoring a new regime of rules for space). *Cf.* The following statement by Mike Pence "But above all else, we choose to lead in space because we know that the rules and values of space, like every great frontier, will be written by those who get there first – and we owe it to mankind to bring American values to the boundless expanse of the heavens." Quoted in Pace, *supra* note 132, at 2.

188. *See* ROSE, *supra* note 8 (advocating development of norms of responsible behavior for space); Beard, *supra* note 32 (critiquing non-legally binding "soft law" for space); THOMAS KIRCHBERGER & SIGMAR STADLMEIER, SOFT LAW IN OUTER SPACE: THE FUNCTION OF NON-BINDING NORMS IN INTERNATIONAL LAW (Irmgard Marboe ed., 2012); LYALL & LARSEN, *supra* note 2, at 45–48; LAMBAKIS, *supra* note 2, at 72–73 (casting doubt on the utility of non-binding norms or rules of the road, which do not sufficiently constrain rogue actors); COLBY, *supra* note 2, at 20 (pursuing the possibility of negotiating mutually-satisfactory rules for limiting conflict in space); Pace, *supra* note 132, at 4 (stating that the Trump Administration "seeks to develop non-binding international norms that are complementary to the existing legal regime," rather than new space treaties or arms control agreements); GREGO & WRIGHT, *supra* note 137, at 13 (conceding that the temptation to rely on informal agreements may be hard to avoid, but noting important benefits of formal legal arrangements).

It is easy to fail in this ambitious enterprise. If the United States were to advance simply one-sided proposals for arms control in space, then of course Russia, China, and the others would reject them.[189] If we try to run too far too fast, the international and domestic political realities will interpose obstacles. But we can find a suitable cadence for win-win solutions. Decades were required to accomplish meaningful restraints on nuclear arsenals, with an elaborate step-by-step minuet. It took that long for far-sighted strategic thinkers to persuade the U.S. executive branch and the U.S.S.R.'s suspicious leadership – as well as the U.S. Congress and the American public – about the mutual benefits of the SALT and START processes, and how the international bargaining does not have to be a zero-sum game.[190]

The rhetoric used by national leadership makes a difference, too. The multi-generational process that established a powerful taboo against the use of nuclear weapons can be replicated for ASATs. Instead of hawking the prospects for a "space Pearl Harbor," as if itching for a fight, we should condemn any such hypothetical attacks, reject the pursuit of space hegemony, and emphasize humanity's shared interest in promoting security and sustainability in space.[191]

There is no inherent reason why diplomacy and arms control should be more difficult in space than in the nuclear or other realms. In the half-century since the basic restraints of the Outer Space Treaty were created, the world has witnessed welcome increments of binding legal discipline upon chemical, biological, conventional, and other weapons – only in space has the process ground to an artificially tranquilized premature halt.[192]

At the moment of this writing, times are admittedly tough for arms control; the international and domestic U.S. political climate is decidedly frosty. But arms control has succeeded in the past during tough times, including accomplishing

189. COLBY, *supra* note 2, at 19 (urging the development of "plausible norms of limitation" that would permit critical U.S. space operations but enlist some significant degree of buy-in from self-interested adversaries).

190. Jonathan Schell, *The Folly of Arms Control*, 79 FOREIGN AFF. 22 (2000) (describing the unsatisfying tension between arms control and deterrence during and after the cold war).

191. MORGAN, *supra* note 12, at 38; Rumsfeld Commission, *supra* note 24, at 8, 13; SCHELLING, ARMS, *supra* note 37, at 287–303 (discussing the power of the nuclear taboo).

192. GRAHAM & LAVERA, *supra* note 83 (presenting the historical sequence of arms control treaties on various topics); GOLDBLAT, *supra* note 82. The disconnect between the relative success of arms control in dealing with other types of weapons, compared to the curious lack of progress regarding arms control initiatives in space, is all the more striking, because military authorities emphasize that any armed conflict in space would very likely be intimately connected with armed conflict on Earth. The United States should not focus on the prospect of a "space war," isolated from terrestrial combat – so why should arms control in space be categorically more problematic than comparable diplomacy devoted to other weapons? *See Space Warfighting Readiness: Policies Authorities, and Capabilities: Hearing Before the House Armed Servs. Comm.*, 115th Cong. (2018) (statement of C. Robert Kehler), at 2, 3, https://perma.cc/T8S6-VAMR (emphasizing that "Deterrence is always the preferred outcome" and space is so integral to U.S. warfighting plans that an isolated "space war" is unlikely); (statement of Douglas L. Loverro) at 5, https://perma.cc/M8KT-723C ("deterring space attack cannot be considered in isolation any more than conflict in space can be viewed in isolation."); MACDONALD ET AL., *supra* note 12, at 52, 54–55.

major successes during some of the darkest days of the Cold War. Indeed, sometimes it is precisely during those periods of heightened danger, when the public and the national leadership become extra sensitized to the perils, that progress is most compelling and achievable. Those are the occasions when we may best recognize the mutual benefit in preserving stability, and when we should pivot with greatest alacrity toward sensible approaches to mitigate the rising threats to the peaceful, sustainable exploitation of space.[193]

The bottom line is that exclusive reliance upon deterrence – resorting solely to the rhetoric of unilateral strength and the inevitable exercise of arms racing – takes us further and faster in a direction we do not want to go. Militarizing space and propagating the notion that the exoatmospheric realm is simply one more forum for arms competition and armed conflict will inevitably make space less useful. That degradation will redound to the disadvantage of the United States most of all, since it relies so heavily upon satellites for the host of civilian and military services. It would be the equivalent of the person who lives in the glassiest house teaching the world how to throw rocks farther, faster, and more accurately.[194]

Instead, the United States has the greatest interest in preserving or restoring whatever remains of the notion that space can be something of a sanctuary from routine terrestrial conflict. We may not – indeed, we do not – like the fact that U.S. space assets are increasingly vulnerable to challenge from potential adversaries, but that is the reality, today and into the future. No matter what counterspace prowess the United States invents and deploys, the harsh fact is that our critical satellites will never be impervious to attack.[195] The only way to directly mitigate the danger is to persuade other countries to voluntarily surrender some of their capabilities via arms control – simple foot-stomping the floor in advocacy for strength and deterrence cannot accomplish that job.

Arms control remains the only assured, peaceful mechanism for requiring our adversaries to decrease the number of weapons pointed at us and to refrain from testing and developing new ASATs and other counterspace capabilities. In short,

193. Brian Weeden, *Insight - Avoiding Conflict in Outer Space*, SECURE WORLD FOUND. (May 6, 2019), https://perma.cc/CX9J-U5RJ (identifying several recent developments suggesting that perhaps movement toward arms control in space may be possible). *Cf*. John Maurer, *Why Cyber Arms Control Is Not a Lost Cause*, NAT'L INT. (Sept. 11, 2018), https://perma.cc/EYJ9-LCW3 (comparing the challenges of cyber arms control today with the challenges throughout the Cold War in dealing with nuclear weapons, and arguing that progress today should be feasible); Erin D. Dumbacher, *Limiting Cyberwarfare: Applying Arms-Control Models to an Emerging Technology*, 25 NONPROLIFERATION REV. 203 (2018); Joseph S. Nye Jr., *Deterrence and Dissuasion in Cyberspace*, 41 INT'L SECURITY 44 (2016).

194. *See* Jones, *supra* note 13 (quoting U.K. defense expert saying, "You won't get the Pentagon to agree to a treaty [on space arms control]. . .but sooner or later Washington is going to have to realise that something needs to be done. We are only increasing our dependence on space. The Pentagon is envisaging a world of single-country dominance, but these emerging [ASAT] technologies are equalisers. They reduce the gap and they make developed countries the most vulnerable.").

195. COLBY, *supra* note 2, at 17 (concluding that "some degree of vulnerability in space appears to be inevitable," so the United States must find some way to persuade adversaries not to exploit those vulnerabilities.) (emphasis in the original).

at a time when the world seems poised on the brink of the creation and deployment of dangerous new armaments, the best way to reduce the threat to U.S. space systems is, *mirabile dictu*, to do just that: reduce the threat to U.S. space systems.[196]

In perhaps the greatest exemplar of the cinematic use of a MacGuffin, at the end of "The Maltese Falcon," the hard-boiled detective Sam Spade (Humphrey Bogart) is asked what the bird statuette is, and he enigmatically replies simply that it's "the stuff that dreams are made of." Deterrence is, of course, much more substantial than that – it has deservedly been the foundation of U.S. defense strategy for decades. But in the ongoing melodrama of space security, deterrence is not, and should not be, the only available dream.[197]

196. An emphatic assertion of this principle comes from the Senate ratification hearings for the OST in 1967. Deputy Secretary of Defense Cyrus R. Vance testified "A major question in consideration of the treaty is whether or not it will enhance the security of the United States both now and in the future. We have studied this problem carefully. We have looked at the implications for weapons development programs and at verification considerations, and we have concluded that this treaty will enhance our national security. We have also looked at the greater issue of the long-term safety of the citizens of this country. Security is not, after all, solely a matter of the number of weapons that we have in ready condition. If the number of weapons, and the kinds of weapons, pointed at the United States can be limited, our security can be better assured than by increasing our own armaments. The space treaty does just this." *Treaty on Outer Space, Hearings Before the Comm. On Foreign Relations*, *supra* note 170.

197. As another indication of the need for patience and steadfast endurance in the pursuit of an important objective (whether it be a movie MacGuffin or arms control initiatives in space) it may also be remembered that just before that climactic scene in the movie, Kaspar Gutman (Sydney Greenstreet) realizes that the particular statuette they have been wrestling over in San Francisco is a fake. He nonetheless immediately vows to continue his relentless pursuit of the true Maltese Falcon, this time to Istanbul. After all, he reasons, he's been chasing the relic for seventeen years, and if the quest now requires yet another year, he stolidly accepts that increment as only "an additional expenditure in time of five and fifteen-seventeenths percent." *The Maltese Falcon Script – Dialogue Transcript*, SCRIPT-O-RAMA, https://perma.cc/LE7G-7WPB.

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