2022-06

MULTILATERAL DETERRENCE FORMATION AND FUTURE US SPACE SECURITY CHALLENGES

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http://hdl.handle.net/10945/70635

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

MULTILATERAL DETERRENCE FORMATION AND FUTURE U.S. SPACE SECURITY CHALLENGES

by

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June 2022

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** June 2022	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE MULTILATERAL DETERRENCE FORMATION AND FUTURE U.S. SPACE SECURITY CHALLENGES	**5. FUNDING NUMBERS**
6. AUTHOR(S) Steven P. Bourdow II	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.	**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

An increase in the number of satellites from commercial and military actors in the future will cause space to become more congested and contested. The increase in actors raises the question of how the United States could conduct space deterrence with proliferated space operations. The significance behind this is that the proliferation of satellites will impact the stability and security of space, creating more orbital debris and opportunities for adversary activities. Stability and security are characteristics that the United States deems critical for the future, as outlined in the 2020 National Defense Space Strategy. The United States' new challenge in space raises the importance of a flexible deterrence strategy. Options the United States could exercise include space weapons, allied cooperation, or legal methods, such as norms, codes of conduct, or treaties. Electronic warfare techniques such as jamming would be the best approach for flexible deterrence with space weapons to minimize orbital debris and conflict escalation. Multinational space networks would provide flexible approaches to deterrence in offensive or defensive constellations, while strengthening relationships between partners. An increase in the awareness and transparency surrounding space behavior could result in better monitoring of inappropriate behavior and facilitate the new norms, codes of conduct, or treaties on responsible behavior, leading to a more secure and more stable space domain.

14. SUBJECT TERMS deterrence, space policy, space weapons, coalition, space situational awareness, norms, treaties, codes of conduct, multinational, strategy, domain, space power, security, stability, space operations, debris, escalation	**15. NUMBER OF PAGES** 119
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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MULTILATERAL DETERRENCE FORMATION AND FUTURE U.S. SPACE SECURITY CHALLENGES

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MASTER OF SCIENCE IN SPACE SYSTEMS OPERATIONS

from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

An increase in the number of satellites from commercial and military actors in the future will cause space to become more congested and contested. The increase in actors raises the question of how the United States could conduct space deterrence with proliferated space operations. The significance behind this is that the proliferation of satellites will impact the stability and security of space, creating more orbital debris and opportunities for adversary activities. Stability and security are characteristics that the United States deems critical for the future, as outlined in the 2020 National Defense Space Strategy. The United States' new challenge in space raises the importance of a flexible deterrence strategy. Options the United States could exercise include space weapons, allied cooperation, or legal methods, such as norms, codes of conduct, or treaties. Electronic warfare techniques such as jamming would be the best approach for flexible deterrence with space weapons to minimize orbital debris and conflict escalation. Multinational space networks would provide flexible approaches to deterrence in offensive or defensive constellations, while strengthening relationships between partners. An increase in the awareness and transparency surrounding space behavior could result in better monitoring of inappropriate behavior and facilitate the new norms, codes of conduct, or treaties on responsible behavior, leading to a more secure and more stable space domain.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABM	Anti-Ballistic Missile
ADR	Active Debris Removal
AEHF	Advanced Extremely High Frequency
ASAT	Anti-Satellite Weapon
C2W	Command and Control Warfare
COPOUS	Committee on the Peaceful Use of Outer Space
CSpOC	Combined Space Operations Center
DARPA	Defense Advanced Research Project Agency
DIME	Diplomatic, Information, Military Economic
FOBS	Fractional Orbital Bombardment Systems
GGE	Group of Governmental Experts
GPS	Global Positioning System
ICOC	International Code of Conduct
ISR	Intelligence, Surveillance, and Reconnaissance
LTS	Long Term Sustainability of Outer Space Activities
NATO	North Atlantic Treaty Organization
ODMSP	Orbital Debris Mitigation Standard Practice
OEWG	Open Ended Working Group
OODA	Observe, Orient, Decide, Act
OSI	Outer Space Institute
PNT	Position, Navigation, and Timing
PPWT	Treaty on Prevention of the Placement of Weapons in Outer Space and of Threat or Use of Force Against Outer Space Objects
RAND	Research and Development
SALT	Strategic Arms Limitations Treaty
SATCOM	Satellite Communications
SDA	Space Domain Awareness
SDI	Strategic Defense Initiative
SSA	Space Situational Awareness
TCBMs	Transparency and Confidence Building Measures

USSF	United States Space Force
USSPACECOM	United States Space Command
USSTRATCOM	United States Strategic Command
WGS	Wideband Global Satellite Communications

ACKNOWLEDGMENTS

I would like to thank Professor Moltz for acting as my thesis advisor and continuously pushing me to improve my writing and critical thinking skills. His expertise and knowledge on space policy significantly helped me in narrowing down my approach to answering my thesis question. I would also like to thank the Space Systems Academic Group and the staff for the past two years. Each of them played a part in my analytical and critical thinking skills as a space student. Lastly, I would like to thank my parents for the continued support they provided these past two years. From wanting to hear about what I was working on, as complicated as it seemed to them, to just asking how life was, went a long way. All the support I received from my time here at Naval Postgraduate School pushes me to ensure what I have learned here is put to good use.

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I. INTRODUCTION

A. MAJOR RESEARCH QUESTION

The major research question I seek to analyze is how the United States could conduct space deterrence with proliferated space operations. The ability and opportunities to deter on a terrestrial scale have become normalized over the last several centuries, making it commonplace in terrestrial operations. Deterrence in space operations with increasing technology and capabilities brings forth concerns from multi-domain activities.[1] Space deterrence differs from nuclear deterrence; it is not all or nothing; there are different levels of deterrence that can take place.[2] Due to the nature of space and lack of territorial boundaries, the challenges of facing deterrence in space are significantly higher.

This thesis will investigate and analyze three areas to address the research question in how the United States could take actions to deter hostile adversarial space activities. The first area this thesis seeks to analyze is the relationship between space weapons and deterrence. The second area for analysis is allied contributions to deterrence. Lastly, the final area to analyze looks at contributions by norms, codes of conduct and treaties to deterrence.

B. SIGNIFICANCE OF THE RESEARCH QUESTION

In the coming years, the number of satellites in constellations will increase, "providing communication to unserved and underserved communities, enable global monitoring of Earth and enhance space observation."[3] The increase in the number of space

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[1] Executive Office of the President, "Weapons Of Mass Destruction," Scribd, accessed August 28, 2021, https://www.scribd.com/document/367463173/NSS-Final-12-18-2017-0905.

[2] Maj Bryan Boyce, "Twenty-First Century Deterrence in the Space War-Fighting Domain," *Air and Space Power Journal* 33, no. 1 (2019): 16.

[3] Giacomo Curzi, Dario Modenini, and Paolo Tortora, "Large Constellations of Small Satellites: A Survey of Near Future Challenges and Missions," *Aerospace* 7, no. 9 (September 2020): 133, https://doi.org/10.3390/aerospace7090133.

systems will impact future policies.[4] To the United States, this is crucial because the stability and security of space is of great importance, per the 2020 National Defense Space Strategy.[5] The proliferation of space systems also raises the potential of adversary opportunities to hinder or destroy friendly systems. The rapid ongoing changes in the space environment illustrate the need to focus on efforts for future deterrence opportunities, such as space weapons, as the number of satellites in orbit will dramatically increase posing safety and security concerns to U.S. space systems.

Part of the United States Space Strategy focuses on building coalitions to enhance security capabilities and support the development of international space norms,[6] so it is imperative that the U.S. deepen its engagements with other countries' space programs. Space deterrence studies focus mainly on three countries: the United States, Russia, and China because the preponderance of space systems is possessed by these countries.[7] Once countries like Iran, North Korea and other adversary space-faring nations put more space systems into orbit, the stability of the environment is subject to change. The stability may affect the geopolitical landscape of space relations with allied countries. Diplomatic, Information, Military Economic (DIME) ties may transition into a new era where countries are all capable of contributing to Space Situational Awareness (SSA). The 2020 National Space Policy calls for a group coalition effort for space deterrence.[8] This is a concept that must be considered due to adversary countries with growing counterspace capabilities.

Another concept that must be examined and is crucial to deterring actions in space are contributions by norms, codes of conduct and treaties. Operations conducted on air, land, and sea currently all have norms that are well developed; however, space norms are

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[4] The Aerospace Corporation, "Space Policy," accessed September 1, 2021, https://aerospace.org/policy.

[5] Department of Defense, "2020 Defense Space Strategy Summary," 2020, 18.

[6] Department of Defense.

[7] David Vergun, "U.S. Will Not Let China, Russia Deny Its Space Superiority, DOD Officials Say," U.S. Department of Defense, accessed September 1, 2021, https://www.defense.gov/Explore/News/Article/Article/2096883/us-will-not-let-china-russia-deny-its-space-superiority-dod-officials-say/.

[8] Executive Office of the President, "The National Space Policy," Federal Register, December 16, 2020, https://www.federalregister.gov/documents/2020/12/16/2020-27892/the-national-space-policy.

still under development. Current international law does not allow for boundaries, territories, or ownership in space.[9] Norms, international law, codes of conduct and treaties regarding space operations, actions and relationships are imperative to deterrence for the sustainment of a stable and secure space environment. If norms, international law, codes of conduct, and treaties do not align with one another, there will be no way to hold countries or companies liable for their actions and deterrence will likely fail.

C. LITERATURE REVIEW

Prior to the launch of Sputnik by the Russians in 1957 space was unused, outside the scientific research conducted on it terrestrially. Sputnik kickstarted the space race between the United States and the Soviet Union. Space was a new domain that would show a country's power and capabilities. This continued for many years until ultimately the United States reached a historical moment in landing the first people on the moon; however, competition in space has remained. Fast forward more than five decades into the future and we see that space has become a significantly greater asset to the United States. The sheer number of space systems the United States utilizes plays an important role in infrastructure.[10] The importance that these space systems have to the United States is concerning, especially with the proliferation and capabilities of systems from other countries. Deterrence is key to the stabilization and security of space going forward. Three key areas: space weapons, multinational policy and or systems, and international norms, rules and laws are analyzed in relation to deterrence.

Deterrence, according to Andre Beaufre, is defined as "an activity to stop a hostile power from making the decision to use its weapons, or more generally, from acting or reacting in a particular situation."[11] Deterrence is achieved by possessing the means to

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[9] United Nations General Assembly, "Outer Space Treaty," 1967, https://outerspacetreaty.org/.

[10] Forrest E. Morgan, *Deterrence and First-Strike Stability in Space: A Preliminary Assessment*, RAND Corporation Monograph Series (Santa Monica, CA: RAND, 2010). Morgan.

[11] Rafał Kopeć, "Space Deterrence: In Search of a 'Magical Formula,'" *Space Policy* 47 (February 2019): 121–29, https://doi.org/10.1016/j.spacepol.2018.10.003.

create a sufficient threat and to create a desired psychological effect.[12] Ultimately, the true output desired from deterrence is to have an adversary think and act in a manner where the cost-to-risk ratio is negative and therefore not in his best interests to act upon, whether through punishment or denial.

As former Air Force officers Gleason and Hays write, "To deter, the United States must be able to attribute an attack on its satellites…to justify a punitive response elsewhere."[13] Gleason and Hays propose a concept that is best described as deterrence through attribution and is better suited vice either punishment or denial.[14] They deem that it is easier and less of a cost to attack a satellite vice defend it. Ultimately, Gleason and Hays adhere to the notion that to deter attacks, a country must be able to attribute them to a perpetrator, which we currently struggle with.[15] An appropriate attribution strategy drives the spectrum of technology, decision-making and architectures to maintain deterrence. They also explain that for deterrence by punishment or denial to be the most credible, greater attribution capabilities are required. An actor must have evidence of what took place and be willing to share it publicly.[16] Therefore, deterrence through punishment or denial still requires attribution.

Professor Christopher Stone, former Assistant to the Deputy Assistant Secretary of Defense for Space Policy, argues against Gleason and Hays. His view is that deterrence is a cognitive issue, meaning the mind of an adversary must be clearly understood to have deterrence credibility, and attribution is not needed to deter threats.[17] Stone explains that

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[12] André Beaufre, *An Introduction to Strategy: With Particular Reference to Problems of Defence, Politics, Economics, and Diplomacy in the Nuclear Age* (London: Faber and Faber, 1965), http://archive.org/details/introductiontost0000beau.

[13] Michael P Gleason and Peter L Hays, "Getting The Most Deterrent Value From U.S. Space Forces," 2020, 7.

[14] Gleason and Hays, "Getting the Most Deterrent Value from U.S. Space Forces."

[15] Christopher M. Stone, "Deterrence in Space: Requirements for Credibility | RealClearDefense," December 1, 2020, https://www.realcleardefense.com/articles/2020/12/01/deterrence_in_space_requirements_for_credibility_651410.html.

[16] Gleason And Hays, "Getting the Most Deterrent Value From U.S. Space Forces."

[17] Stone, "Deterrence in Space."

adversaries possess capabilities to deter in space and that it is necessary that an innovative thinking framework be implemented. His framework looks at four areas: adversary decision-making, offensive environment, defense as credible deterrence and space systems as critical infrastructure.[18][19] Additionally, Stone disagrees with Forrest Morgan on his concept of first-strike stability. Morgan explains that first-strike stability is centered around the "balance of capabilities and vulnerabilities that could make a crisis unstable should a confrontation occur."[20] Stone reiterates that Morgan's thought process did not consider any psychological or cultural factors that may present themselves.[21]

1. Space Weapons and Deterrence

Space weapons may be any asset, land, air, sea or space-based, that may be used to harm a target in space or on Earth.[22] Directed-energy weapons as defined by the DOD are "those using concentrated electromagnetic energy, rather than kinetic energy, to incapacitate, damage, disable, or destroy enemy, facilities, and/or personnel."[23] Kinetic-energy weapons may be employed from ground to space or space to ground.[24] Nuclear weapons are those that derive energy from a fission reaction or a combination of fission and fusion reactions. An example of the combined reactions is the testing and development

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[18] Stone.

[19] Christopher Stone, "Reversing the Tao: A Framework for Credible Space Deterrence," *MSU Graduate Theses*, December 1, 2015, https://bearworks.missouristate.edu/theses/1505.

[20] Morgan, *Deterrence and First-Strike Stability in Space*.

[21] Stone, "Reversing the Tao."

[22] Karl D. Hebert, "Regulation of Space Weapons: Ensuring Stability and Continued Use of Outer Space," *Astropolitics* 12, no. 1 (January 2, 2014): 1–26, https://doi.org/10.1080/14777622.2014.890487.

[23] "CRS Search Results," accessed August 28, 2021, https://crsreports.congress.gov/search/#/0?termsToSearch=defense%20primer%20directed%20energy%20weapons&orderBy=Date.

[24] Robert Preston et al., *Space Weapons Earth Wars* (RAND Corporation, 2002), https://www.rand.org/pubs/monograph_reports/MR1209.html.

of the hydrogen bomb, where the fusion reaction acted as a trigger.[25] The development of the hydrogen and nuclear bombs led to weapons testing in space.

Space weapons testing began following the launch of the Sputnik and Corona satellites from the Soviet Union and United States. The testing from each country consisted of nuclear warhead tests for missile defense and anti-satellite purposes.[26] However, harmful effects of nuclear warhead testing, and its dangers led to the Partial Nuclear Test Ban Treaty and UN resolutions of 1963. During the Cold War era the deterrence of space war was entangled with the deterrence of nuclear war.[27] Looking forward, space war may not be seen as tied to the threat of nuclear war by all actors, which consequently makes deterrence more challenging.[28] The U.S. decision to declare space as a warfighting domain further complicates the challenge of space weapons and deterrence.[29] Space weapons may be able to deter adversarial actions through the ability to project power globally, provide persistent orbital presence, and respond to adversarial actions rapidly.[30] However, space weapons could create greater risks, especially when it comes to decision makers and perceived threats to nuclear deterrence.[31] Space weapons could prompt regional instability, which could lead to escalation into all-out nuclear war.[32,33] In this manner, space weapons may also undermine the utilization of gray zone activities, primarily where we expect to

25 "10.7: Nuclear Fusion," Physics LibreTexts, November 1, 2016, https://phys.libretexts.org/Bookshelves/University_Physics/Book%3A_University_Physics_(OpenStax)/Book%3A_University_Physics_III_-_Optics_and_Modern_Physics_(OpenStax)/10%3A__Nuclear_Physics/10.07%3A_Nuclear_Fusion. "10.7."

26 Bonnie Triezenberg, *Deterring Space War: An Exploratory Analysis Incorporating Prospect Theory into a Game Theoretic Model of Space Warfare* (RAND Corporation, 2017), https://doi.org/10.7249/RGSD400.

27 Triezenberg.

28 Morgan, *Deterrence and First-Strike Stability in Space*.

29 Michael P Gleason and Peter L Hays, "A Roadmap for Assessing Space Weapons," 2020, 13.

30 Gleason and Hays.

31 Gleason and Hays.

32 Deblois, "The Advent of Space Weapons."

33 Gleason and Hays, "A Roadmap for Assessing Space Weapons."

see deterrence capabilities. The gray zone is where the use of force or other means are taken to achieve objectives while minimizing escalation.[34] The push for space weapons may tempt adversaries to utilize space weapons in the gray zone, thus weakening space stability and ultimately deterrence opportunities. Weaponizing space also increases the likelihood of collateral damage and de-stabilization again adding to the challenges of deterrence.[35]

One reason for the future regulation of space weapons relates to the potential for collateral damage and space debris. Article IV of the Outer Space Treaty states "states parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner."[36] This article does not mention the use of conventional weapons or those that do not directly impact people or infrastructure. The article leaves a gap in international law and the interpretation on what is and is not allowed, further complicating the U.S. approach to deterrence.[37] If legally justified and abiding by the Outer Space Treaty, countries can have a form of offensive capability in space. However, space weapons do not exhibit the characteristics of first-strike deterrence and are not inherently offensive or defensive in nature.[38] The ambiguity of the Outer Space Treaty article also impacts the potential for increased debris in space, including the risk of the Kessler Syndrome, which describes a situation in which debris begin colliding uncontrollably with other debris, rendering humans incapable of stopping it.[39] Debris caused from space weapons in conjunction with

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[34] Raphael S. Cohen et al., "Peering into the Crystal Ball: Holistically Assessing the Future of Warfare" (RAND Corporation, May 11, 2020), https://www.rand.org/pubs/research_briefs/RB10073.html.

[35] Everett Carl Dolman, "The Case for Weapons in Space: A Geopolitical Assessment," SSRN Scholarly Paper (Rochester, NY: Social Science Research Network, August 30, 2010), https://doi.org/10.2139/ssrn.1676919.

[36] United Nations General Assembly, "Outer Space Treaty."

[37] Hebert, "Regulation of Space Weapons."

[38] Hebert.

[39] Donald J Kessler and Nicholas L Johnson, "The Kessler Syndrome: Implications to Future Space Operations," *American Astronaut Society*, February 6, 2010, 16.

the Kessler Syndrome, a study illustrating that the number of orbital debris would exponentially increase over time even if space operations were to stop, may promote serious implications to future deterrence. The increase in debris also decreases the stability and security of space, which does not align with U.S. Space Strategy and further undermines the opportunities to deter hostile or irresponsible behavior.[40]

2. Possible Allied Contributions to Deterrence

Recommendations from current literature regarding allied contributions to deterrence suggest the possible role of allied countries in space operations and SSA.[41] Inclusion of allied countries for space operations meshes with the United States Space Force (USSF) lines of effort. The USSF lines of effort consist of expanding, strengthening, and leveraging relationships that provide niche capabilities or access and possess the will to project global power against shared adversaries.[42] The USSF lines of effort and U.S. Space Strategy seek to expand joint space relationships. A manner that allows for the inclusion of allied countries with capabilities and space access is via multinational space systems.

Multinational systems, as discussed in James Clay Moltz's 2011 and 2019 articles on coalition networks and changing dynamics of space, could create new practices and thus transform space security and awareness into an allied network.[43,44] Multinational systems could then contribute to deterring any questionable adversarial activities in space as they would increase resilience and reduce vulnerability. An attack on those multinational

40 Department of Defense, "2020 Defense Space Strategy Summary."

41 James C. Moltz, "Coalition Building in Space: Where Networks Are Power:" (Fort Belvoir, VA: Defense Technical Information Center, October 1, 2011), https://doi.org/10.21236/ADA555238.

42 US Space Command, "USSPACECOM Campaign Plan, New Mission Focus on Defeating Adversaries," United States Space Command, accessed September 21, 2021, https://www.spacecom.mil/News/Article-Display/Article/2193524/usspacecom-campaign-plan-new-mission-focus-on-defeating-adversaries/.

43 Moltz, "Coalition Building in Space."

44 Naval Postgraduate School and James Moltz, "The Changing Dynamics of Twenty-First-Century Space Power," *Journal of Strategic Security* 12, no. 1 (April 2019): 15–43, https://doi.org/10.5038/1944-0472.12.1.1729.

systems would also be an attack on multiple countries. Additionally, the costs of satellite operations would decrease by a substantial margin for the U.S.[45] Funds could then be spent to improve the survivability and capabilities of current and future multinational systems that contribute to more opportunities for deterrence. An allied network in conjunction with multinational space systems would require the sharing of information amongst countries. U.S. Strategic Command has established international data-sharing agreements that create opportunities to improve space safety and operations.[46] The sharing of information and expertise within this allied network provides the means to deter more effectively over multiple domains. All countries involved in a network for SSA may further the development of responsible behavior in space, which promotes deterrence and ultimately protects allied global power.

3. Possible Contributions by Norms, Codes of Conduct, and Treaties to Deterrence

Much of the work surrounding multinational space policy is concentrated on voluntary approaches.[47] The European Union draft "Code of Conduct on Outer Space Activities" calls for the reinforcing and expanding norms for behaviors in space.[48] The draft desires not a legally binding treaty, but a set of political commitments making them therefore voluntary. Similarly, the Long Term Sustainability of Outer Space Activities (LTS) working group at Committee on the Peaceful Use of Outer Space (COPOUS) seeks to improve transparency by establish principles reducing risks in space operations.[49] The

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45 Naval Postgraduate School and Moltz.

46 Debra Werner, "International SSA Agreements Could Pave the Way for Further Space Cooperation, Panelists Said," SpaceNews, April 18, 2018, https://spacenews.com/international-ssa-agreements-could-pave-the-way-for-further-space-cooperation-panelists-said/.

47 Theresa Hitchens, "Forwarding Multilateral Space Governance: Next Steps for the International Community," 2018, 38.

48 Jinyuan Su and Zhu Lixin, "The European Union Draft Code of Conduct for Outer Space Activities: An Appraisal," *Space Policy* 30, no. 1 (February 1, 2014): 34–39, https://doi.org/10.1016/j.spacepol.2014.01.002.

49 United Nations Office for Outer Space Affairs, "Working Groups of the Committee and Its Subcommittees," accessed September 21, 2021, https://www.unoosa.org/oosa/en/ourwork/copuos/working-groups.html.

LTS working group efforts remain a draft due to countries not seeing eye to eye with the proposal and recommending a voluntary basis to implement guidelines.[50] A third effort, Group of Governmental Experts (GGE), worked on improving compliance between countries regarding disarmament and space security from 2012 to 2013.[51] The GGE recommendations were thorough but again adopted on a voluntary basis. Differing opinions on requirements, across the three agreements, for appropriate space debris mitigation promote a level of uncertainty and creates a significant challenge for U.S. deterrence options. If left alone the uncertainty for future space security may likely result in traditional weapon developments as a solution. Mechanisms for different deterrence measures will likely be reduced to a select few to prevent traditional weapons developments, which takes away from U.S. and allied countries opportunities to deter adversary actions.

A treaty effort from 2008 and revised in 2014 to shape norms is the Sino-Russian Treaty aimed to prohibit weapons deployment in space.[52] The goal in introducing the treaty was to short-circuit any American attempt to revive the "Brilliant Pebbles" program, a plan to place numerous ballistic missiles in orbit for ballistic missile defense.[53] The basis of the treaty was formed from Article IV of the Outer Space Treaty of 1967, although it also built on a prior Soviet proposal for space arms control attempted in 1983. The reasoning behind using the Outer Space Treaty as a basis is stated in the Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects as follows:

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[50] "2020 COPUOS STSC – U.S on Long-Term Sustainability of Outer Space Activities," U.S. Mission to International Organizations in Vienna, February 3, 2020, https://vienna.usmission.gov/2020-copuos-stsc-long-term-sustainability-of-outer-space-activities/.

[51] Hitchens, "Forwarding Multilateral Space Governance: Next Steps for the International Community."

[52] Paul Meyer, "Arms Control in Outer Space: Mission Impossible or Unrealized Potential?," Canadian Global Affairs Institute, 2020, https://www.cgai.ca/arms_control_in_outer_space_mission_impossible_or_unrealized_potential.

[53] Larry M. Wortzel, "China and the Battlefield in Space," The Heritage Foundation, accessed October 11, 2021, https://www.heritage.org/asia/report/china-and-the-battlefield-space.

> ..while the existing international agreements related to outer space and the legal regime thereof play a positive role in regulating outer space activities; they are unable to fully prevent the placement of weapons in outer space,…recalling the resolutions of the United Nations General Assembly 'Prevention of an arms race in outer space' which inter alia emphasize the need to examine further measures in the search for effective and verifiable bilateral and multilateral agreements in order to prevent an arms race in outer space.[54]

The vernacular of this treaty proposal gives a sense that the sponsors saw the threat of an arms race during the time of these drafts and sought to deter U.S. deployments in space via an international treaty. This treaty was first discussed in 2001 when the U.S. withdrawal from the Anti-Ballistic Missile (ABM) Treaty of 1972 was imminent. The ABM Treaty would affect Russian and Chinese ballistic missile deterrence options. Russia would still have a credible deterrent, but the Chinese ballistic missile deterrent could be significantly minimized by what was expected to be a robust U.S. missile defense, possibly including space-based deployments. The Sino-Russian Treaty would be effective for Russia and China because they could both retain flexible deterrent options, while simultaneously minimizing U.S. control and abilities to contribute to norm developments.

Besides space weapons, the orbital debris problem is another focus area for norm developments and the consideration of treaties. In the context of the U.S. Space Strategy and USSF Campaign Plan, debris threatens the security and stability the U.S. desires to achieve. An important piece of U.S. policy that focuses on debris and traffic management revolves around the Orbital Debris Mitigation Standard Practice (ODMSP).[55] The ODMSP seeks to establish standardized practices for mitigation of debris. However, international practices for activities in outer space are the result of treaties, conventions and coalitions dedicated to space-related issues. The Outer Space Treaty is the focal point for much of the existing international space law and it relates to orbital debris, regarding the liability of

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[54] Ministry of Foreign Affairs of the People's Republic of China, "Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects(Draft)," accessed October 11, 2021, https://www.fmprc.gov.cn/mfa_eng/wjb_663304/zzjg_663340/jks_665232/kjfywj_665252/t1165762.shtml.

[55] Michael R. Migaud, "Protecting Earth's Orbital Environment: Policy Tools for Combating Space Debris," *Space Policy* 52 (May 1, 2020): 101361, https://doi.org/10.1016/j.spacepol.2020.101361.

space-based assets.[56] Future proliferation presents political and security concerns that can hinder deterrence. These concerns are due, in part, to the potential dual use of Active Debris Removal (ADR) and satellite servicing capabilities causing instability and mistrust.[57] Adversary nations could steal technology, interfere with, or capture satellites when collecting debris or "servicing" their satellites and create future weapons capabilities, which could lead to an arms race or instability.[58][59] The Outer Space Treaty and Convention on International Liability for Damage Caused by Space Objects address this through the stipulation that a space object is under the jurisdiction of a launching state.[60] Therefore, any interference is a breach of that state's sovereignty. But the Liability Convention does not have a requirement to categorize every piece of debris, although various national and commercial systems are now capable to categorize orbital debris to a certain size. Tampering with active satellites and the lack of potential recourse against an adversary represent gaps in existing space law and areas where new forms of deterrence are needed. The continued increase of commercial operators in space would amplify the likelihood of tampering with satellites, which could create even greater challenges for deterrence. An increase in commercial actors drives the need for international norms with space traffic and SSA.[61]

One avenue of approach that could drive international norms and provide a means to deter is using SSA in conjunction with United States Space Command (USSPACECOM). United States Strategic Command (USSTRATCOM) had established SSA-sharing agreements with various companies, nations and intergovernmental

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56 United Nations General Assembly, "Outer Space Treaty."

57 Brian Weeden, "Overview of the Legal and Policy Challenges of Orbital Debris Removal," *Space Policy* 27, no. 1 (February 1, 2011): 38–43, https://doi.org/10.1016/j.spacepol.2010.12.019.

58 Migaud, "Protecting Earth's Orbital Environment."

59 Weeden, "Overview of the Legal and Policy Challenges of Orbital Debris Removal."

60 Weeden.

61 Paul B Larsen, "Minimum International Norms For Managing Space Traffic, Space Debris, and Near Earth Object Impacts," *Journal of Air Law and Commerce* 83, no. 4 (2018): 48.

organizations prior to the transfer of authorities to USSPACECOM.[62] These agreements provide the ability to share a wealth of information furthering the effort to establish responsible behavior. The U.S. military greatly benefits from the use of commercial space systems, Iridium, IntelSat, Harris, and ExoAnayltics, and in the future, it is likely the military will become even more reliant on commercial systems.[63] Commercial systems may then provide a kickstart to shape space and its policy. It is at that point where the environment may be shaped to deter any arms proliferation while promoting the growth of commercial activities.[64] Other recommendations for commercial involvement range from increasing support for developing technologies for space debris removal to space-faring countries taking unilateral measures to enhance multilateral approaches.[65] Individual actors such as the military have documented standards, established procedures and other rules for safe operations in space, therefore sharing those with commercial operators allows for further development in behavioral guidelines for deterrence.[66] The future proliferation of commercial satellite constellations reinforces this point, as it is likely military space operations will utilize commercial systems as described above. To combat this challenge, a proposed plan from Audrey Schaffer is to analyze international law manuals from other domains of warfare.[67] These manuals and deterrence concepts might be applied and then utilized to develop space laws and a code of conduct that encompasses all sectors of space operations, furthering deterrence opportunities.

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62 James D. Rendleman and Sarah M. Mountin, "Responsible SSA Cooperation to Mitigate On-Orbit Space Debris Risks," in *2015 7th International Conference on Recent Advances in Space Technologies (RAST)*, 2015, 851–56, https://doi.org/10.1109/RAST.2015.7208459.

63 Charles V. Peña, "U.S. Commercial Space Programs: Future Priorities and Implications for National Security," Future Security in Space: (James Martin Center for Nonproliferation Studies (CNS), 2002), https://www.jstor.org/stable/resrep09905.6. Peña.

64 Peña, "U.S. Commercial Space Programs."

65 Hitchens, "Forwarding Multilateral Space Governance: Next Steps for the International Community."

66 Audrey M Schaffer, "The Role of Space Norms in Protection and Defense," 2017, 5.

67 Schaffer.

The manuals and models for different warfighting domains could provide a general framework to design and generate an appropriate code of conduct.[68] These manuals and models would exist as precedents available as guides. Using manuals and models is an approach, however, with the push towards using commercial space systems, the use of commercial best practices could present the best approach for developments. For a code of conduct centering around commercial satellites and their impact to deterrence, a decision-making regime is needed, and a framework built around it to oversee space activities. Another framework, proposed by Robin Dickey, that would contribute to the developments of international norms and deterrence is a four-level process matrix.[69] The levels consist of domestic buy-in, initial partners, generating international commitment and setting a target for relevancy.[70] The framework discusses that through these decision processes international norms of behavior may be generally accepted. It is important to note that this is not a one size fits all framework. It will have its advantages and disadvantages. Dickey suggests that to effectively utilize this framework and meet national policy goals it is imperative that policy makers combine existing space norms with this framework. Dickey's framework presents a new avenue where space deterrence through norms might develop and thrive.

D. POTENTIAL EXPLANATIONS AND HYPOTHESES

This thesis will test several hypotheses regarding space deterrence. These hypotheses will be split into three separate areas. The areas to be analyzed and tested are space weapons and deterrence, allied contributions to deterrence, and contributions by norms, codes of conduct and treaties to deterrence. In the first section of space weapons and deterrence I will be investigating the advantages and disadvantages of deploying space weapons for deterrence. Additionally, I will be examining the relative contributions of

[68] Larsen, "Minimum International Norms for Managing Space Traffic, Space Debris, and Near Earth Object Impacts."

[69] Robin Dickey, "Building Normentum: A Framework for Space Norm Development | The Aerospace Corporation," Aerospace Corporation, accessed October 3, 2021, https://aerospace.org/paper/building-normentum-framework-space-norm-development. Dickey.

[70] Dickey, "Building Normentum." Dickey.

different systems and their costs, including in terms of possible collateral damage and reactions from adversaries, arms race behavior. In the second section surrounding allied contributions to deterrence, I will be investigating the advantages and disadvantages of creating an allied space network for the purposes of deterrence. Specific issues I will be examining will be multinational systems, command and control, information sharing, SSA, and space traffic management. In the third and final section I will focus on the advantages and disadvantages of norm-and rule-building efforts in promoting space deterrence. I will analyze the effects that policies, codes of conduct and treaties might contribute to promoting deterrence.

E. RESEARCH DESIGN

The plan of action for this thesis is to analyze three possible contributions to space deterrence space weapons, allied space networks and norms, codes of conduct, and treaties. U.S. space strategy points out key areas that involve the topics to be analyzed as they are important to the future stability and security of space. The reason behind analyzing the United States is because we are the leading nation in space. What the U.S. decides to do going forward will influence the future space environment and deterrence, for better or worse. The actions the U.S. takes with respect to space weapons, allied contributions, norms, codes of conduct and treaties will play a sizeable role future success or failure of the international community's ability to deter hostile or irresponsible behavior in space.

To analyze space weapons and deterrence, information will need to be obtained from current military and commercial systems and effects on other space systems. It is expected that this information will be found through published technical manuals, government briefings and books written by space professionals. The analysis of allied nations contributions to deterrence requires the assessment of current allied countries' capabilities, allied countries' space policies, and draft outer space policy proposals on allied cooperation. This information is expected to be found in books written by space professionals, allied countries' published strategies, and published policy documents. To analyze the contributions of norms, codes of conduct, and treaties to deterrence, information required is dependent upon analyzing draft proposals and space policy articles from academia and United Nation bodies of government. This documentation will consist of draft policy proposals, technical material on space debris and SSA, and proposed frameworks for space norm development. Based on the analysis of each area, recommendations will be provided on a suitable way forward for the U.S.

F. THESIS OVERVIEW

This thesis structure will consist of an introduction, three main body chapters and conclusion. Chapter II will analyze space weapons and deterrence, Chapter III allied contributions to space deterrence, and Chapter IV contributions by norms, codes of conduct, and treaties to deterrence. The reason for choosing this structure is it allows for explicit analytic studies from each case. The conclusion of this thesis will summarize the findings of each chapter, address any unanswered questions and potential for future thesis work, and provides recommendations for the United States going forward.

II. SPACE WEAPONS AND DETERRENCE

This chapter will analyze space weapons as a potential part of U.S. deterrence strategy. Satellites are critical to infrastructure and to the planning and execution of strategic operations. The proliferation of satellites in the coming years may increase challenges related to the protection of space assets. The United States might employ space weapons as a form of deterrence to maintain the stability and security of space. A line of effort within the U.S. deterrence strategy focuses on denying the benefit of aggression. This strategy is a logical arena for space weaponry to play a role.[71] This chapter will analyze the following: the concept of deterrence, the history of space weapons and arms control, types of space weapons, the possible advantages and disadvantages of each type of weapon, and what weapons might best serve the U.S. deterrent effort without constraining current relationships or ruining the space environment. The findings from these sections will provide U.S. policy and decision makers a potential approach that may be included in future deterrence strategies.

A. WHAT IS DETERRENCE

Deterrence is a primary theme in U.S. defense policy and includes efforts to discourage actors from taking any unwanted actions that negatively impact security and stability across all operating domains. Currently, the United States is presented with a significant challenge in developing effective deterrence methods for space because of adversaries' increased capabilities. Moreover, these increased capabilities also increase the risk of a major conflict, making it imperative to deter adversary actions. To deter at the appropriate level, it is necessary that a fundamental understanding of deterrence be established. With that understanding we can incorporate the concept of deterrence into the space domain.

[71] Department of Defense, "DoDD 3100.10" (Department of Defense, October 18, 2012), https://www.esd.whs.mil/Directives/issuances/dodd/.

Deterrence has always been a part of military operations, whether it is referred to as such or not. It is conducted through actions such as posturing forces for quick reactions, positioning of military bases, and demonstrations of tactical capabilities. These are just a select few of the many activities that the United States does on a regular basis. To the common eye, it may just seem like these are run-of-the mill operations, but in strategic contexts deterrence operations are a baseline for the conduct of military operations. Deterrence operations conducted by the United States are motivated by the perceived effects they will have on adversaries. To estimate this effect, an assessment of adversaries' objectives, interests, and motives within the confines of their values is needed. In this sense, deterrence is more than just threatening an adversary with potential actions; it involves the shaping of adversary perceptions.

Deterrence can be categorized by its type, circumstance, and timing.[72] Deterrence in its pure form is the "practice of discouraging or restraining someone from taking unwanted actions, primarily involving efforts to stop or prevent."[73] It is not an effort to force an adversary to act, as that would fall under the category of coercion. The categories falling within deterrence aid in the shaping of perceptions leading to a desired psychological effect. Once that effect is established, it will provide the means for friendly forces to expand and increase the number of opportunities to deter said adversary. To reach the desired psychological effect, it is first important to understand the types of deterrence at one's disposal so they may be tailored appropriately.

The two types of deterrence associated with classical deterrence theory literature are denial and punishment. "Deterrence by denial" seeks to deter an adversary action by making it unlikely to succeed, which then provides the psychological effect of minimizing the adversary's confidence in reaching his objectives. Deterrence by denial represents the ability to deter through defense, resilience, or reconstitution. "Deterrence by punishment" focuses on threatening an adversary with something that will significantly impact them,

[72] Michael J. Mazarr, "Understanding Deterrence," *RAND Corporation*, April 19, 2018, 14.

[73] Mazarr.

such as economic sanctions or a devastating nuclear attack. The threats surrounding deterrence by punishment are subject to local and global economic sanctions for an adversary, which then raise cost of an attack. Sanctions may minimize the confidence of an adversary to take such actions when their losses outweigh the benefits, especially if they are long-term losses.

Determining what type of deterrence strategy to utilize is primarily dependent on its reliability. Classical studies suggest that deterrence by denial is more reliable than deterrence by punishment.[74] The ability to deny, such as posturing military forces across the globe, is quantifiable. The threat of punishment against an adversary is harder to quantify, and therefore an adversary may begin to doubt actions will be taken when the deterring country does not want to increase escalation. It can be assumed that there are threats that countries have made that they would prefer not to complete because of the secondary and tertiary effects they may have on themselves and allied nations. That assumption provides the grounds to state that deterrence by denial has fewer weaknesses than deterrence by punishment; however, certain circumstances may drive deterrence efforts.

Circumstances where deterrence can be used are direct or extended. When a country seeks to deter action against itself its use of deterrence is characterized as "direct." When deterrence is used to minimize actions on allied or partner nations, it is characterized as "extended." Examples of both types of circumstances were present during the Cold War. Direct deterrence focused on discouraging Soviet nuclear attacks on United States territory, while extended deterrence aimed at preventing a Soviet attack on North Atlantic Treaty Organization (NATO) nations and allies in Asia.[75] Extended deterrence presents challenges. It is more difficult to deny an attack and attribute an attack when it is not within the deterring country's field of view or ability to control space capabilities. For an adversary to be convinced that a defending nation will use their postured forces, the

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[74] Paul Huth and Bruce Russett, "Deterrence Failure and Crisis Escalation," *International Studies Quarterly* 32, no. 1 (March 1, 1988): 29–45, https://doi.org/10.2307/2600411.

[75] Huth and Russett.

defending nation must be committed to using those forces. Extended deterrence also implies that there are several actions a defending nation would take to ensure the protection of allied and partner nations. As discussed above, those threats are likely to result in more negative outcomes then positive. Therefore, it is likely that an effective deterrence strategy will account for complexities from extended and direct deterrence based on national and international interests.

The timeliness of implementing a deterrence strategy will be important for said strategy's success or failure. "General" and "immediate" deterrence are the two categories of deterrence with respect to time. General deterrence refers to persistent efforts over extended periods of time to deter actions, whereas immediate deterrence represents short-term efforts that surround a specific event or crisis. Comparing these two periods, general deterrence is easier to conduct because it reduces the need for immediate deterrence. If general deterrence becomes common, then it is possible that its dissuasive effects will cause habitual hesitations for an adversary when thinking of taking an action.[76] In deterrence, perception is everything and it is the ultimate driver in shaping effects.

There is no "one size fits all" for deterrence. Requirements for effective deterrence are dependent on potential adversaries' objectives and desired end state.[77] These all play important roles in tailoring an appropriate strategy for adversaries, but the overriding decision is determined by the perceptions of adversaries. Once adversary perceptions are analyzed and determined, U.S. deterrence strategy may be tailored to create subjective psychological effects that favor security and stability. We do live in a complex environment with multi-domain activities; therefore, deterrence could fall within the notion of an enterprise. The complexities associated with deterrence create challenges for the United States in its development of a flexible deterrence strategy for the space domain. Space weapons are a potential tool the United States might incorporate in its strategy for security and stability.

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[76] Michael J Mazarr, "Understanding Deterrence," 14.

[77] U.S. Department of Defense, *Nuclear Posture Review*, 2018, https://www.defense.gov/News/Special-Reports/NPR-2018.

B. HISTORY OF SPACE WEAPONS AND DETERRENCE

It is expected that technology will improve at a rapid pace bringing further advancements in satellite capabilities to those invested in space, meaning a greater number of satellites in orbit.[78] For those heavily invested, this will raise questions of how to best protect their assets and ensure they are available for use. One approach to ensuring the protection and availability of satellites is the utilization of space weapons. Space weapons are not a new capability and have been around for quite some time. To tailor a deterrence strategy appropriately, it is crucial to review the history of space weapons and arms control, to know what is already banned, specifically during the Cold War era. Following the launch of Sputnik by the Soviet Union in 1957, the United States developed reconnaissance satellites to monitor Soviet activities at the direction of President Eisenhower.[79] By 1960 the United States flew a variety of satellites with capabilities for communications and intelligence gathering. These satellite developments were primarily conducted through United States military channels. President Eisenhower's views on space during that period steered the course of such developments, due to the potential positive impacts on international prestige.[80]

One of the first big debates on space weapons surrounded the use of bombardment satellites as delivery platforms for nuclear weapons. Advisors from both Eisenhower's staff and the Air Force went back and forth on the effectiveness of using such satellites.[81] A Research and Development (RAND) corporation study conducted in 1963 looked at the feasibility of using these bombardment satellites as delivery vehicles. The study found that there were a number of problems, including accuracy, timing, reliability, and control,

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[78] Tate Ryan-Mosley, Erin Winick, and Konstantin Kakaes, "The Number of Satellites Orbiting Earth Could Quintuple in the Next Decade," *MIT Technology Review*, accessed September 1, 2021, https://www.technologyreview.com/2019/06/26/755/satellite-constellations-orbiting-earth-quintuple/.

[79] Preston et al., *Space Weapons Earth Wars*.

[80] Dwight D. (Dwight David) Eisenhower, *Waging Peace, 1956-1961; the White House Years* (Garden City, N.Y., Doubleday, 1965), http://archive.org/details/wagingpeace1956100eise.

[81] Preston et al., *Space Weapons Earth Wars*.

which would cause more problems for the U.S. than good.[82] This study and others surrounding bombardment satellites happened to occur around the same timeframe as international negotiations to ban the use of nuclear weapons. The Cold War era saw numerous nuclear weapons tests. Nuclear testing at the time was necessary for future developments. Heightened tensions between the United States and Soviet Union drove these developments, leading towards tests in a variety of locations: ground, sea, underground, and space.

Many of the tests conducted did not consider the long-lasting effects on the environment. The nuclear explosions left radioactive particles embedded in each environment that would affect living organisms and any electronics. Looking specifically at space operations, a nuclear blast would negatively impact the potential for manned operations in space and increase the challenge of launching satellites into orbit for national or international use, mainly disruptions in communications and satellite functionality.[83] The Starfish Prime exo-atmospheric nuclear weapons test, part of United States efforts to understand the effects of nuclear weapons, brought such nuclear effects to the forefront. This test was one of a series of nuclear weapons tests conducted within the Fishbowl series in 1962.[84] These tests resulted in the creation of an artificial radiation belt causing the loss of multiple satellites.[85] Tests such as these further caused reason for negotiations on banning their use.

The rising concern about the radioactive effects on Earth and in space led to the Limited Test Ban Treaty of 1963. In terms of arms control, this treaty was one that gathered interest internationally, which had not been seen since World War II.[86] The reason behind

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[82] Howard J. Taubenfeld, "Outer Space in World Politics," *American Journal of International Law* 59, no. 1 (January 1965): 192–93, https://doi.org/10.2307/2197175.

[83] "NUCLEAR WEAPON EFFECTS IN SPACE," accessed January 5, 2022, https://history.nasa.gov/conghand/nuclear.htm.

[84] E G Stassinopoulos, "The STARFISH Exo-Atmospheric, High-Altitude Nuclear Weapons Test," 2015, 5.

[85] Stassinopoulos.

[86] U.S. Department of State, "Limited Test Ban Treaty (LTBT)," U.S. Department of State, accessed September 4, 2021, //2009-2017.state.gov/t/avc/trty/199116.htm.

the international efforts was that if radioactive effects were to increase from further testing, no country would be safe from radioactive particles. The interest of the public also grew surrounding nuclear testing, leading to a consensus to discontinue a majority of nuclear testing. The Limited Test Ban Treaty prohibited nuclear weapons testing "or any other nuclear explosion" in the atmosphere, space, or in water.[87] The treaty did not prohibit the use of nuclear testing underground under the condition that the testing country be able to contain radioactive debris within their jurisdiction. Further discussion on weapons in space were conducted within the United Nations, regarding the General Assembly Resolution 1721, on legal principles for space, which banned the orbiting of weapons of mass destruction.

The Outer Space Treaty focused on the preservation of space. As stated in Article II, "Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[88] The developers of this treaty had the foresight to see the benefit that space activity could provide globally. They wanted to ensure the protection of space for future use and technological developments, which meant keeping conflicts in space to a minimum. Article I of the treaty reinforces this, stating that all activities "shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind."[89] Article IV of the treaty, which was linked to space weapons in subsequent paragraphs states, "Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner."[90] This article provided the means to stop the employment of orbiting WMD weapons in space.

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[87] U.S. Department of State.

[88] United Nations General Assembly, "Outer Space Treaty."

[89] United Nations General Assembly.

[90] United Nations General Assembly.

Prior to and after formalization of the Outer Space Treaty, anti-satellite weapons were at the forefront for arms control discussions.

In the 1950s and 1960s, the United States and Soviets made developments in land-based, nuclear-armed missiles for defense against intercontinental ballistic missiles. The development and posturing of these missiles received mixed reviews due to the potential arms race that might result. Ultimately, the United States and Soviet Union decided to agree on limiting anti-ballistic missiles for defense, known as the ABM Treaty. The ABM Treaty was adopted in 1972 as part of discussions during the Strategic Arms Limitations Treaty (SALT) I with the Soviet Union.[91] It prohibited the signatories from "developing, testing, or deploying ABM systems or components that are sea-based, air-based, space-based, or mobile land-based.",[92][93] Additionally, a clause within SALT I and the ABM Treaty stipulated that national technical means would be used as a verification method and therefore could not be interfered with in any manner.[94] This clause furthered the constraints put on what ABM systems could do from the ground. Without this treaty it is likely that the United States and Soviet Union would have been put on a path towards a never-ending arms race trying to balance the actions of one another.

However, the ABM Treaty is no longer in force. Any space weapon employment raises concerns with the strategic arms control and non-proliferation agreements associated with nuclear weapons. As stated above, the ABM Treaty was solidified on the belief that deploying ABM systems would encourage the proliferation of offensive capabilities. Therefore, limiting ABM systems deployments would likely facilitate limitations of

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91 Wade Boese, "U.S. Withdraws from ABM Treaty; Global Response Muted," | Arms Control Association, accessed December 7, 2021, https://www.armscontrol.org/act/2002-07/news/us-withdraws-abm-treaty-global-response-muted.

92 U.S. Department of State, "Anti-Ballistic Missile Treaty (ABM Treaty)," U.S. Department of State, accessed December 7, 2021, //2009-2017.state.gov/t/avc/trty/101888.htm.

93 Arms Control Association, "The Anti-Ballistic Missile (ABM) Treaty at a Glance | Arms Control Association," accessed September 6, 2021, https://www.armscontrol.org/factsheets/abmtreaty.

94 U.S. Department of State, "SALT I," accessed January 5, 2022, https://1997-2001.state.gov/www/global/arms/treaties/salt1.html.

strategic offensive nuclear forces.[95] In 2002, the United States withdrew to protect against developing missile threats, as President Bush stated that "the ABM Treaty hindered the U.S. government's ability to develop ways to protect itself from future attacks."[96] This withdrawal was met with opposition in the international community because of the likely impact to future arms control. The United States withdrawal from the ABM Treaty and subsequent efforts towards space weapons developments caused the international community to look further outward.[97]

During the same era as the ABM Treaty and the Outer Space Treaty, the 1960s-1970s, a variety of kinetic anti-satellite weapon (ASAT) tests were undertaken by the United States and Soviet Union. The United States conducted space weapons testing through Program 437.[98] This program utilized a powerful ballistic missile, Thor, armed with a nuclear warhead that would destroy a target through a nuclear explosion or the electromagnetic pulse that followed the blast. After gathering this information, Defense Secretary McNamara pushed to make such a system operational on Johnston Island as a form of active defense.[99] The Secretary of the Air Force, Eugene B. Zuckert, to whom the Fishbowl and Starfish Prime tests results were sent, believed the system would work, but the tracking and targeting of hostile targets were a limiting factor.[100] Other limiting factors were limited resources and funding shortfalls need for launching the Thor missiles. More so, the climate of Johnston Island did not bode well for the Thor missiles. They were subjected to harsh environmental changes which rendered the missiles incapable of launching. The demise of the program was due to its limited capabilities, the threat of an electromagnetic pulse if the weapons system was ever implemented, and potential nuclear escalation if the Soviet Union misinterpreted the weapon system's use.

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95 Paul H Nitze, "SDI and The ABM Treaty," *United States Department of State*, 1985, 3.

96 James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, Third Edition (Stanford: Stanford University Press, 2019). 269

97 Moltz. 273,274

98 Clayton K S Chun, *Shooting Down a "Star,"* 1999. 9

99 Chun. 10

100 Chun. 16

The Soviet Union was concerned with U.S. missile defense systems, such as Program 437 and Nike-X, which they believed had the potential to support a first strike to Soviet forces.[101] In order to combat such dangers the Soviet Union began testing co-orbital ASATs. These tests took place with Fractional Orbital Bombardment Systems (FOBS) and rendezvous proximity operations with conventional explosives on board a satellite. The FOBS testing inevitably went to the wayside following the Outer Space Treaty and the violations that would come from using such systems. The rendezvous and proximity ASAT tests exhibited similar limitations as the U.S. Program 437 with their tracking and targeting.[102] These rendezvous and proximity tests produced a large quantity of orbital debris because of the explosion of conventional warheads. Soviet testing of co-orbital ASATs continued to take place, putting great concern on the future Soviet intentions.[103] Soviet testing brought U.S. defense analysts together in an effort to decide if a U.S. ASAT would be able to act as a deterrent. Ultimately, it was deemed that such a system for the United States would be suited as potential leverage for future political discussions.[104]

In order to address feared vulnerabilities created by Soviet intercontinental ballistic missiles, the Reagan administration took efforts to continue the research surrounding ballistic missile defense systems. This effort was known as the Strategic Defense Initiative (SDI). This initiative looked at the implementation of space-based defenses to include interceptors and directed-energy weapons.[105] During President Reagan's administration it was believed if the Soviet Union decided to deploy weapons in space without a United States response the balance of world power might be shifted, in favor of the Soviet Union.[106] The United States decided to push towards SDI research and development.

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[101] Moltz, *The Politics of Space Security*. 143-144

[102] Moltz.185

[103] Nicholas L Johnson, *Soviet Military Strategy in Space* (London; New York, N.Y. : Jane's, 1987), https://natlib.govt.nz/records/21558109?search%5Bpath%5D=items. 132

[104] Moltz, *The Politics of Space Security*. 202

[105] Preston et al., *Space Weapons Earth Wars*. 14

[106] Launius, Roger D., ed., *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue*, 1995, http://archive.org/details/nasa_techdoc_19960017728.

However, the space-based missile defenses within SDI would violate the ABM Treaty and Article IV of the Outer Space Treaty, likely causing greater strategic ramifications. The end of the Cold War pushed SDI efforts to the wayside as missile defense shifted from strategic to theatre level defenses, meaning less reliance or focus on space-based weapons capabilities.

The 1980s also saw a change in how kinetic ASAT testing was perceived. Soviet Union policy makers attempted to eliminate all testing or operations of ASATs with a draft treaty.[107] When the United States declined to enter such a treaty, it gave the Soviet Union the opportunity to continue the development of space weapon systems. While the number of public ASAT tests diminished following the proposal by the Soviet Union, a greater concern became apparent: debris. The increase in debris pieces from all the ASAT tests posed security concerns for future U.S. space operations. The increase in debris pieces, however, did not stop the United States from conducting an airborne ASAT test involving an F-15 aircraft that shot a missile at an active satellite.[108] While the test proved to be successful, the generation of debris validated the concern from space analysts that it was a problem. It is highly likely that different viewpoints on ASATs led to a series of discussions among governmental parties on how to approach tests going forward. Ultimately, we see that there were no further debris-producing tests conducted. Although there was no solidified arms control agreement among the United States and Soviet Union, each nation possessed the ability to use their ASATs as leverage for any future tensions.

Another international agreement that could be considered part of space weapons and arms control conversations is the Environmental Modification Convention of 1978. This convention was an international treaty that prohibited military or hostile use of any capabilities that would have widespread or long-term effects on the space environment. The Environmental Modification Convention contains provisions that likely influenced

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[107] Moltz, *The Politics of Space Security*. 196

[108] United States Air Force, "Vought ASM-135A Anti-Satellite Missile," in *National Museum of the United States Air Force™*, accessed January 6, 2022, https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198034/vought-asm-135a-anti-satellite-missile/.

space weapons developments and employments.[109] One example of environmental modifications that might have significant impacts from space weapons is the creation of a debris field to harm satellites. If that debris field was created near a U.S. early-warning satellite or satellite that contributed to missile tracking nuclear escalation would be likely. These environmental modifications remain a critical concern today, but it is highly frowned upon when the creation of debris is done purposefully and not a part of a space mission. A recent example of such modification is from the 2021 Russian ASAT test that created debris which may cause serious implications for the International Space Station and the astronauts aboard.[110] It is interesting to note that United States criticism of the Russian test did not mention the Outer Space Treaty, the Environmental Modification Convention, or the 2007 United Nations debris mitigation guidelines.

Space weapons and arms control conversations are likely something that will never go away. The Limited Test Ban Treaty, Outer Space Treaty, and Environmental Modification Convention are just some of the treaties and agreements that will likely have continued relevance as operations and actors in space grow. Present-day U.S. space activities, while adhering to international treaties and agreements, continue to present complex challenges for U.S. deterrence. Increased technological developments allowed for the creation of new space weapons.

C. NEW PRESSURES AND WEAPON SYSTEMS FOR DETERRENCE

Many satellites launched into orbit by both the United States and the Soviet Union during the Cold War were focused on gaining valuable intelligence of any sort of nuclear proliferation or force posture changes.[111] These satellites provided credibility to the United States or Soviet Union on actions that would need to be taken to deter if an escalation of

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[109] U.S. Department of State, "Environmental Modification Convention," accessed December 10, 2021, //2009-2017.state.gov/t/isn/4783.htm.

[110] Tereza Pultarova, "Space Debris from Russian Anti-Satellite Test Will Be a Safety Threat for Years," Space.com, November 16, 2021, https://www.space.com/russia-anti-satellite-test-space-debris-threat-for-years.

[111] Caroline Dorminey and Eric Gomez, eds., *America's Nuclear Crossroads: A Forward-Looking Anthology* (Washington, DC: Cato Institute, 2019).

force reached a certain threat level. As time passed, the dependency on these satellites increased, thus creating opportunities for offensive and defensive space operations. The influx of satellites for intelligence, surveillance, and reconnaissance contributed to developments, capabilities, vulnerabilities, and opportunities for space weapon use.

Operations in space are neither offensive nor defensive in nature. The U.S. military defines offensive and defensive operations as forms of space control to "ensure freedom of action in space for the United States and its allies and when directed, to deny an adversary freedom of action."[112] This definition creates challenges when it comes to finding the appropriate method to deter adversarial actions. The space domain is significantly different than any other domain. It is increasingly more difficult to determine actors' motives. Although all satellites used in space are in specific orbits and in the field of view of a ground station tracking its movements, there is still difficulty in determining the operational or strategic intent behind them. The feasibility of dual-use satellites contributes to this challenge as a secondary capability, weapon oriented, may be hidden. More actors in space will also increase the potential for greater congestion and disruptive activities, contributing to the difficulty of determining motives. The greater number of actors in space also leads to increased opportunities for space debris generation, which can have cascading effects on satellites in orbit. Disruptive and debris-generating activities threaten the security and stability the United States seeks to maintain in space.

Compounding the matter of stability and security in is the proliferation of counterspace capabilities that adversary countries such as Russia and China possess to disrupt, degrade, deny, or destroy U.S. satellites. Moreover, the fact that many U.S. satellites are interwoven into critical infrastructure means that a moderate to significant amount of interference or disruption may impact other domains for operational or strategic use. These capabilities possessed by adversaries put the ability of the United States to deter

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[112] U.S. Joint Chiefs of Staff, "Joint Publication 3-14: Space Operations," June 26, 2013, https://publicintelligence.net/jcs-space-ops/.

such actions in doubt.[113] Whether the United States can keep up with Russia or China in counterspace capabilities developments remains a concern. Because space is contested and will be even more so in the future, the United States will need to fight or deter to meet the challenges of operating in the domain. Deterrence by denial alone may not contribute enough to affect adversary actions. If the United States is solely focused on strictly deterrence by denial, adversaries may be likely to pursue their objectives without the fear of United States retribution, furthering the chances of conflict. Deterrence by punishment may be necessary for a well-rounded deterrence strategy and space weapons are a potential avenue of approach that should be taken into consideration.

The definition of a space weapon amongst most actors in space is not agreed upon and has remained a topic of debate since the Cold War. In this analyst's eyes, a space weapon is a capability, Earth or space-based, that is designed to disrupt, deny, degrade, or destroy a satellite or its associated terrestrial control sites through kinetic or non-kinetic means. This proposed definition also includes the potential actions of bombardment satellites, directed-energy weapons, or ballistic missiles during the Cold War and beyond. A general framework for categorization on space weapons was created by Harrison, Johnson and Young.[114] This framework has been adapted and is illustrated in Table 1.

Table 1. Adapted Framework for Types of Space Weapons[115]

	KINETIC	NON-KINETIC
EARTH-TO-SPACE	Direct-Ascent ASAT	Uplink Jammer, Laser Dazzler/ Blinder, Cyberattack
SPACE-TO-SPACE	Co-Orbital ASAT, Space-Based Missile Defense Interceptors	Co-orbital Crosslink Jammer, Co-orbital High-Powered Microwaves
SPACE-TO-EARTH	Space-Based Global Strike	Space-Based Downlink Jammer Space-based High-Powered Laser

[113] Todd Harrison, Kaitlyn Johnson, and Makena Young, "Defense Against the Dark Arts In Space," February 2021, 53.

[114] Harrison, Johnson, and Young.

[115] Harrison, Johnson, and Young.

This framework breaks down space weapons by the domain where they originate, their effects and how those effects are achieved.[116] It consists of Earth-to-space, space-to-space, and space-to-Earth weapons that are either kinetic or non-kinetic. The framework provides the ability to interpret and determine where space weapons fall and what is best or worst for U.S. deterrence efforts. This categorization also provides a means to tailor appropriate deterrence measures for strategy. To appropriately incorporate space weapons into a flexible deterrence strategy, it is necessary to analyze the types of space weapons the United States might use for deterrence.

The types of weapons capabilities analyzed for a flexible U.S. deterrence strategy are non-kinetic and kinetic.[117] Each capability presents a separate set of challenges and manners of appropriate response, dependent upon the political and operational space objectives. Non-kinetic space weapons create reversible effects on satellites and ground systems without the occurrence of physical contact. Examples of these types of weapons are jammers, cyber-attack systems, or laser weapons that can dazzle or blind a satellites' optics/sensors and disrupt electronics making the satellite ineffective.[118] These weapons are challenging for the adversary to identify due to the lack of visible evidence. Nuclear detonations do fall within the scope of non-kinetic weapons, however, due to the Limited Test Ban Treaty of 1963 they are barred from use.

Electronic space weapons utilize the electromagnetic spectrum affecting uplink and downlink communications with satellites and ground stations. The most common example of this is a jammer, which the United States, China, Russia, Iran, North Korea, and other countries possess.[119] Like non-kinetic weapons, effects or the source make it difficult to attribute. This capability is reversible, and with the flick of a switch or press of a button it can be turned off.

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[116] Todd Harrison, "International Perspectives on Space Weapons," accessed September 27, 2021, https://www.csis.org/analysis/international-perspectives-space-weapons.

[117] Harrison, Johnson, and Young, "Defense Against The Dark Arts In Space."

[118] Preston et al., *Space Weapons Earth Wars*.

[119] Victoria Samson and Brian Weeden, "Global Counterspace Capabilities: An Open Source Assessment" (Secure World Foundation, April 2020).

While the previous capabilities focus on denying or degrading space systems, cyber-attacks target systems directly to disrupt or destroy satellites from the inside out. These types of attacks are potentially the most effective and dangerous because minimal resources are required, and anyone can perform this type of attack on space systems, assuming they are capable of penetrating military computer networks. Cyber-attacks are likely to be utilized prior to or in conjunction with other attacks, or after alternate space weapon use to best set conditions for follow-on actions.

Kinetic weapons are the more commonly understood weapons we think of that detonate in proximity to a satellite via some sort of projectile, crash into a satellite, or utilize a grappling arm to directly affect satellite components. Examples of such weapons are direct ascent ASATs, as Russia recently tested in November 2021, and co-orbital ASATs. These kinetic weapons can cause irreversible effects to space systems and create debris, which may significantly affect other space systems including those of the attacking nation and space for future use. Kinetic ASATs also pose the greatest risk of catalyzing a conflict in space due to their irreversibility, much like nuclear weapons being all-or-nothing for effects. Each type of space weapon capability is the basis for secondary and tertiary effects space-based actions. Using space weapons capabilities could provide opportunities to strengthen deterrence opportunities.

D. POSSIBLE ADVANTAGES AND DISADVANTAGES OF SPACE WEAPONS

A future proliferated environment will present various challenges in how to approach the type of space weapon the United States would want to use for deterrence. From the framework listed above, there are developed space weapons that fall within the realm of possible use for the United States. Not all space weapons are created equal; some may create beneficial short-term effects, but terrible long-term effects. Some weapons may do the exact opposite. Others might be used for preparatory effects toward a greater strategic objective. To appropriately determine the weapons that will be of best to use and those that will not, a further analysis of kinetic and non-kinetic weapons is necessary.

1. Kinetic Weapons

The first category is kinetic weapons. The two main types of kinetic weapons analyzed are direct ascent ASATs and co-orbital ASATs. A potential appeal of the use of kinetic ASATs as a part of deterrence is likely due to the notion that they can function as a conflict deterrent.[120] If a conflict does arise, adversaries may be less likely to act when the chances of their space assets getting destroyed by a kinetic weapon is greater. Unlike the other weapons for analysis in this chapter, kinetic weapons are relatively easier to attribute because a physical projectile or orbital debris will be seen. So, if such a weapon were to be used, an adversary will be able to see what is going to happen to them. An adversary might also be less likely to act if they believe that the opponent is capable of destructive functions that create orbital debris that may significantly impose upon the military and commercial sectors. In a similar fashion to mutually assured destruction with nuclear weapons, kinetic ASATs provide mutual vulnerability. If both the United States and its adversary degrade each other's capabilities, for example, surrounding nuclear early warning and relays, then both would be defenseless. A caveat is that both country's strategic warning systems and relays must be space-based for this effect to occur. Losing warning systems is an elevated risk that likely neither the United States nor its adversary would be willing to bet on. Kinetic weapons do provide a relatively quick and swift manner to destroy a satellite.

If the United States were to posture kinetic weapons in space, doing so may provide a series of advantages. One such advantage constitutes the minimal response time to any adversary actions, which may further emphasize deterrence by punishment.[121] As the kinetic weapon is already deployed in space, it eliminates the time required to posture or fire when compared to a kinetic weapon employed from the ground. The deployed kinetic weapon provides the United States enhanced opportunities to respond immediately with a

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[120] Talia M. Blatt, "Anti-Satellite Weapons and the Emerging Space Arms Race," in *Harvard International Review*, 2020, https://hir.harvard.edu/anti-satellite-weapons-and-the-emerging-space-arms-race/.

[121] Rebecca Reesman and James R. Wilson, "The Physics of Space War: How Orbital Dynamics Constrain Space-To-Space Engagements | The Aerospace Corporation," Aerospace Corporation, accessed October 28, 2021, https://aerospace.org/paper/physics-space-war-how-orbital-dynamics-constrain-space-space-engagements.

threat to an adversary. Kinetic ASATs could then be used to influence space actions from other countries, like the gunboat diplomacy of Teddy Roosevelt and his "Big Stick" policy. This projection of power through deterrence by punishment could provide the opportunity to influence nations' space actions at any time and location.[122] Continuing along the lines of deterrence by punishment, kinetic ASATs are a requisite capability that sends a message to United States adversaries. Sending such a message, through public or governmental approach of the existence of offensive capabilities, tells adversaries what the United States has and is capable of. In this manner, the United States would lay its cards on the table and leave the adversaries to make the next move. Keeping with the theme of cards, when someone knows your hand, you are more able to predict what your opponent's next move will be. The same could be said for these kinetic ASATs. Once our adversaries would know that we were willing to employ such capabilities, they could become discouraged, because any actions on their end might result in an overwhelming response from the United States. If adversaries still decided to employ space weapons, then the United States might effectively implement kinetic ASATs as a form of punishment.

Due to the fact that co-orbital ASATs are in space, the distance to target them increases when looking at ground-based actions; however, they are in fixed orbits, so the ASATs survivability is diminished. Orbiting ASATs could also be an optimal approach to bolstering strategic objectives as an offensive capability. These orbiting ASATs are difficult to defend against when employed in space because of the high velocity and short flight times of projectiles, pending the amount of fuel on board and location of target.

While these advantages pose promising strategic advantage, their disadvantages and long-term effects provide significant weight as to why the United States may think twice about kinetic ASAT employment. ASAT use is likely to initiate or prolong conflicts. Let's say the United States decides to use ASATs to break through Chinese anti-access area denial defenses. The use of an ASAT, while potentially an effective way to break through and neutralize Chinese capabilities, runs a high chance of escalating actions. If

[122] Deblois, "The Advent of Space Weapons."

Chinese surveillance satellites, go down for a certain period it could be perceived as an action to undermine Chinese actions and likely result in a Chinese response of equal or greater magnitude. On top of the potential to initiate or prolong conflicts, a bigger implication with kinetic ASATs are the increased risks of accumulating debris. Kinetic ASATs create irreversible effects and the debris will endanger satellites and create future collision problems. Examples of such effects from kinetic ASATs are from the 2007 Chinese ASAT test, and, more recently the 2021 Russian ASAT test, both producing large amounts of debris.,[123][124] To put this in perspective, even a single piece of debris can create immense damage, rendering a satellite incapable of completing its mission.

The creation of debris also means that, to best prevent future collisions, new debris must be tracked. As it currently stands, the smallest debris tracked are smaller than 10 cm in size.[125] The countless number of orbital debris unable to be tracked, given their velocity and size, are just as likely to cause damage to commercial and military satellites and their components, likely implicating a response from other space actors as described in the 1972 Liability Convention.[126] The political and economic fallout from future use is likely to be significant, as efforts to mitigate debris in space will only increase. Greater amounts of debris limit the ability for space systems to be used and threaten U.S. critical infrastructure. Kinetic ASAT use is then a double-edged sword for the United States as it would achieve the desired effects against adversaries, however; public opposition or repercussions, political and economic actions, and inadvertently putting one's own satellites at risk do not constitute overall benefits. The United States would weaken its ability to deter long term, sever international ties, and potentially be left out of future space policy conversations, if it were to use such weapons.

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[123] Dr T S Kelso, "Analysis of the 2007 Chinese ASAT Test and the Impact of Its Debris on the Space Environment" (2007 AMOS Conference, 2007), https://celestrak.com/publications/AMOS/2007/AMOS-2007.pdf.

[124] Pultarova, "Space Debris from Russian Anti-Satellite Test Will Be a Safety Threat for Years."

[125] "LeoLabs - Satellite Missions - EoPortal Directory," accessed December 14, 2021, https://directory.eoportal.org/web/eoportal/satellite-missions/l/leolabs.

[126] United Nations, "Convention on International Liability for Damage Caused by Space Objects," September 1972, http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introliability-convention.html.

2. Non-kinetic Weapons

The second category of analysis is non-kinetic space weapons. The types of weapons analyzed within this category are lasers, jammers, and cyber-attack systems. A big appeal to the use of non-kinetic space weapons is the difficulty in attribution and the ability for reversibility, simply by turning the systems off.

a. Laser Weapons

The appeal of using laser weapons may likely stem from such science fiction movies as "Star Wars" with its Death Star and other innovative technologies. Laser beams do not carry momentum or explosive projectiles, but rather energy. This energy can be used to heat an object, inhibiting its ability to perform its primary functions. A laser system does not require a projectile to fire, instead it only requires an electric or other fuel source.[127] The lack of requirement for a projectile shortens reaction times required to fire, therefore increasing a laser systems responsiveness and likely its effectiveness. In this sense, the laser "could be used as both a sensor and a weapon, shortening the sensor-to-shooter timeline," resulting in multiple engagements towards a target.[128] Considering this shorter timeline, laser weapons could also contribute to targeting. These laser weapons would also facilitate new opportunities for strategic operations to disrupt any adversary force power generation or distribution.[129] In turn, these capabilities provide opportunities to use laser weapons as a form of active defense, potentially providing for the means of limited space control, denying adversaries the use of their space assets. In theory these advantages seem to be clear enough to push for the use of laser weapons.

However, as the weapon is a form of energy, there are physical constraints to consider. A laser weapon system is a form of energy that is emitted via a beam path. As the laser propagates the beam width gets wider and wider the farther it travels. When the

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[127] Jeff Hecht, "A 'Star Wars' Sequel? The Allure of Directed Energy for Space Weapons," *Bulletin of the Atomic Scientists* 75, no. 4 (July 4, 2019): 162–70, https://doi.org/10.1080/00963402.2019.1628507.

[128] Andrew Feickert, "U.S. Army Weapons-Related Directed Energy (DE) Programs: Background and Potential Issues for Congress," February 12, 2018, 35.

[129] Feickert.

beam is wider, the desired effects of the laser on a target will take longer. Once the beam is emitted, it is subject to atmospheric effects that can weaken its strength or decrease precision. The longer distance also poses issues as the target will be moving, therefore, tracking and pointing systems for the system are necessary. Depending on the target and the power required to affect it, the weapon system's footprint may increase. If the footprint does increase, it becomes an easier soft target for adversaries to go after. The responsiveness of the laser system is also dependent upon the power requirements and mobility. If there is another significant push for space-based lasers, like the SDI of the Reagan era, they will likely need to be in low Earth orbits to overcome atmospheric effects.

A further complication with the use of lasers, however, is the logistics of refueling or receiving power. Technology has not reached the level of finding a way to refuel satellites in flight, so, like all satellites, this laser system would be constrained to a certain number of engagements. There is also the potential risk of a laser weapon's fuel source or its target's fuel source intentionally or unintentionally exploding in space creating orbital debris. Lasers do not possess the requisite lethality when compared to kinetic weapons. Therefore, if the United States wanted to use a laser weapon in a lethal manner there would need to be proximity between the system and its target. As space is always open and within view from Earth, it is highly likely that an adversary would take evasive or preemptive actions, in the event they determined United States intent. At that point, that use of fuel detracts from future uses for Earth-based effects and an opportunity to deter adversary actions. Based upon the disadvantages and existing physical constraints, laser weapons may be best suited to Earth-based uses to disrupt and degrade adversary space assets. Lasers also offer a preparatory capability to set conditions for strategic level objectives

b. Jamming Capabilities

Satellite Communications (SATCOM) offers tremendous advantages, especially for an expeditionary force of the United States. SATCOM decreases required infrastructure and is easier to set up vice terrestrial networks, depending on where SATCOM operations take place. Satellites can handle large bandwidths, and a transmitted signal can be received by hundreds or even thousands of users in the satellite's footprint. These advantages have caused the United States to become reliant on SATCOM. But increased reliance on SATCOM is a vulnerability that adversaries will likely target. Taking away U.S. SATCOM links provides an adversary the ability to create an asymmetric impact to U.S. operations. SATCOM jamming is attractive approach because it is temporary, reversible in nature, and can slow down decision making processes. Electronic warfare will likely be vital to deterrence in future conflicts.

Jamming interferes with communications from satellite to satellite or satellite to ground by emitting noise within the same frequency spectrum.[130] Jamming provides the ability to functionally neutralize adversary satellites and does not degrade or destroy the systems. Jamming allows for the ability to conduct covert operations on satellites which further hides U.S. strategic intentions, creating greater challenges for adversaries. Intentional interference from jamming takes place in either an uplink or downlink section of the communications chain. Uplink jamming interferes with a signal coming from the Earth to the satellite. Downlink jamming interferes with a signal originating from the satellite going down to a ground or air-based sensor on Earth. Depending upon the mission set and situation at hand, there are associated pros and cons to each of the jamming techniques.

Uplink jamming is beneficial because it uses the same frequency as a targeted satellite, which will limit the satellite's ability to differentiate from the interference signal and the actual signal. Uplink jamming is beneficial as it provides a greater impact in the degradation of signals for all users. Jamming could be especially important when trying to stop or slow down any information from the source prior to dissemination throughout a satellite constellation. The jamming may result in slowing operational or strategic level operations that threaten space. This jamming technique is enhanced when employed on a mobile platform, as its lethality is increased due to the limited power and targeting requirements. The technique also reduces the electromagnetic footprint of the platform, increasing its ability to conduct covert operations under the guise of normal

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[130] Maj Brian Garino and Maj Jane Gibson, "Space System Threats," in *Space Primer*, 2009, https://aerospace.csis.org/wp-content/uploads/2018/09/Space-System-Threats.pdf.

electromagnetic emissions you might expect from a cell phone or television tower. The distance from the targeted ground station/user or satellite drives the power requirements needed for the jamming system. Like laser systems, jamming signals are also subject to atmospheric effects, so further distances require more power for desired effects to be achieved. Higher power requirements lead to a larger footprint and likely a fixed site, limiting the area of denial that the jamming system would have.

Downlink jamming has benefits in that the signal only needs to be as strong as the signal received on the ground for the interference to be effective. This jamming technique provides the ability to use aviation or naval assets for jamming missions. Using such assets also has lower power requirements other than what is necessary for the asset to perform its functions. Given that this technique occurs on the receiving end of a transmission, there is a requirement for the jamming system to be within the field of the view of the receiving ground station/terminal. To achieved desired effects, downlink jamming must be localized. This constraint also limits the amount of time that is present to jam said transmission. The location of desired jamming increases the potential of putting assets at risk if in an area of conflict. There is also the possibility that attempted jamming in an area of conflict could lead to an escalation of adversary actions, unless the escalation is a follow-on attack on the jammer itself. The biggest problem in this analyst's eyes that come with downlink jamming are the configurations of satellite constellations. Unlike uplink jamming, the interference does not occur at the origin of the signal. Current satellite configurations are, distributed, disaggregated, proliferated, and diversified, and this increases the likelihood that the signal is shared amongst multiple satellites and then disseminated to the appropriate actors. The dissemination of data amongst various satellites severely limits the ability to use downlink jamming unless the exact time and location of signal transmission from the satellite is known. Such information could be obtained with cyber-attacks on satellites and their ground stations/terminals.

c. Cyber-attack Capability

While not inherently classified as a space weapon cyber-attacks constitute another section of electronic warfare that employed space weapons can use in space with their various transmitters and antennas. In the digital age, cyber actions are likely able to influence all satellite functionalities from both ground and space. It is important to note that cyber-attacks are difficult when the object is protected by secure communications. A possible way to circumvent this challenge is with the rise of autonomous systems for the future. Autonomous systems, as they continuously learn and evolve, could become a major component in cyber-attacks on satellites. One manner to influence actions is through data corruption or modification.[131] Similar to jamming, cyber-attacks may occur in the uplink or downlink transmission signal. A likely target to corrupt or modify is a satellite's command and control functions. Corrupting or modifying this target could likely lead to an incorrect response from the satellite resulting in a burn into a different orbit making its mission set useless. This corruption or modification could also be used to create a denial of service. Cyber-attacks would deny the use of access to the appropriate resources such as bandwidth, memory, and connectivity aboard the satellite and its associated ground station/ terminal. These attacks would also constrain the ability to gather mission critical data and control the satellite.

Another manner in which cyber-attacks could influence actions is through false identification. In terms of satellites, this involves obtaining the appropriate credentials to potentially pose as a satellite operator. Gaining credentials allows the individual with the false identity to report false information about the satellite or remotely control the satellite to put it at risk of damage and loss of mission. This false identity also allows for the ability to intercept signals and then replay said commands later. A potential action may be to send a command to a satellite to alter its course when it is in the process of performing its mission. The ability to intercept signals may result in gaining valuable information regarding access codes for ground systems. Those access codes provide the means to shut down a ground station/satellite, upload erroneous information, or obtain data. Now, it is likely that the satellites and ground stations have redundancies built in place. So, if any of these actions occur, it is likely that they will not last long, but if in a time-sensitive

[131] CCSDS Secretariat, "Security Threats against Space Missions" (Washington, DC: The Consultative Committee for Space Data Systems, 2015).

environment, the desired effects may be achieved. An adversary may be focused on correcting the erroneous outputs from their systems, which gives the United States an ability to achieve tactical, operational, or strategic objectives.

Cyber-attacks are becoming increasingly common as a part of warfare. The commonality of such attacks also threatens U.S. space assets. Cyber-attacks are a capability that any actor may utilize regardless of whether they an actor in space or not. Although resilient and redundant components exist for satellites, that does not provide a basis to claim satellites are invulnerable to such attacks from adversaries. Many of the satellites that the United States uses for operational or strategic level operations are now considered legacy systems. Legacy systems likely do not possess suitable capabilities to deny or degrade adversary attempts to interfere or access signals as technology has become more modernized. If the United States deems the use of cyber-attacks to be a primary form of deterrence in space, grey zone activities may likely happen. If grey zone activities were to occur in space, the United States is likely to suffer greater losses because space technology is a massive piece of critical infrastructure. It also provides an adversary a multitude of targets to pick at their choosing. Cyber-attacks could be effective as a part of U.S deterrent efforts, but the United States is just as susceptible to these attacks as adversary nations. This concludes the analysis of warfighting functions for each space weapon system. Now we will take a look at just how these space weapons can deter adversary actions.

E. HOW SPACE WEAPONS COULD DETER

The theory of space combat power uses axioms, established rules, principles, or laws, as building blocks like any developed theory. The axioms of space combat power that Air Force Lieutenant Colonel Mantz provides include the way space weapon systems are able to act as a deterrent towards adversaries. "Space systems can deter hostile actions by holding forces, decision making and infrastructure at risk"[132] is a statement that Lieutenant Colonel Mantz makes to illustrate the effectiveness space systems might have

[132] Michael R Mantz, *The New Sword: A Theory of Space Combat Power* (Maxwell Air Force Base, Ala.: Air University Press, 1995).

on deterrence outside of space deterrence. In terms of deterring by holding forces, space weapons provide the threat of an equal or bigger attack in retaliation, ultimately deterring an adversary attack. More so, if a space weapon proves to have formidable uses, the threat of being punished by such a capability could deter aggressive actions.

Proving the formidable use of such weapon could be conducted through demonstrations. Such demonstrations could be performed on stationary, slow moving targets, and dynamic targets. Space weapons that could be used in such a manner are the kinetic ASATs and lasers, as they have the greatest physically illustrative effects. Demonstrations illustrate the precision and lethality of capabilities resulting in greater flexibility for the United States. This kind of demonstration is something we see commonly conducted in the military sector when the United States wants to illustrate the power and capabilities of its military on an international level. More often than not, such demonstrations prove doubters wrong, further establishing credibility and utility moving forward. Furthermore, these space systems can be postured and or employed independently or jointly with one another further complicating adversary forces actions going forward. Posturing or employment of weapons impacts the mindset of the adversary as to whether his actions are worthwhile. This posturing and or employment of independent or joint space weapon systems would significantly impact the decision making of an adversary.

The second area where space weapons could deter is by holding an adversary's decision making at risk. A methodology that falls in line with holding decision making at risk is Command and Control Warfare (C2W). C2W seeks to protect one's own systems while attacking an enemy system.[133] There are five C2W tools that may be utilized: "operational security, military deception, psychological operations, electronic warfare, and physical destruction."[134] These tools are applicable across the various spectrums of conflict. The goal of C2W is to "confuse, deceive, mislead, and delay enemy decision-

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[133] Jerome M. Lynes, "Command and Control Warfare: An Operational Imperative in the Information Age:" (Fort Belvoir, VA: Defense Technical Information Center, January 1, 1997), https://doi.org/10.21236/ADA525174.

[134] Lynes, 18.

making by attacking the sources of his data, how data is passed, processed, and how direction is given and monitored for execution."[135] Space weapons fall within C2W and, more importantly, can deter actions by posing risk to adversary command and control nodes.

Joint Publication 3-53 states that the employment of an element of national power always has a psychological dimension.[136] Space weapons provide the ability to deter with a C2 attack function. The C2 attack function "assails decision making by attacking information and the path of information that travels from sensor to shooter."[137] Within the C2 attack function, space weapons could hold critical adversary C2 capabilities at risk through physical or non-physical destruction. Holding such critical assets at risk could result in fostering unwise decision making among adversary C2 functions, likely leading to indecision and mental paralysis causing disruption in the Observe, Orient, Decide, Act (OODA) loop. Once such an action occurs within adversary communications lines, a greater chance of confusion rises amongst the ranks. The increase in dissidence and disaffection could open the door for the potential internal severing of the adversary command structure from its forces.[138] When the potential of jointly using space weapons is feasible, increased uncertainty could further cloud the mind with decision making and leads to a no-win scenario for them. Much like space weapons providing risk to adversary forces, it is necessary that the threat be credible. The active use of demonstrations, with the weapon capabilities discussed above, will further reinforce the risk that the adversary faces if it decides to make any aggressive actions. To be clear, I am not advocating for live fires tests on employed space systems during peacetime, as there are significant risks to doing so. These tests could be conducted from the Earth to another target on Earth for the United

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[135] Mantz, *The New Sword*. 75

[136] Joint Chiefs of Staff, *Joint Publication 3-53: Doctrine for Joint Psychological Operations*, 2003, https://www.jcs.mil/Doctrine/Joint-Doctrine-Pubs/3-0-Operations-Series/.

[137] Lynes, "Command and Control Warfare." 17

[138] Lynes. 27

States to prove credibility. Additionally, space weapons also pose a threat to adversary infrastructure.

Yet another area where space weapons may be capable of deterring adversary actions is the risk they pose to adversary infrastructure. Infrastructure is an integral component of air, space, and cyber operations.[139] Without a reliable infrastructure in place, readiness or ability to build combat power is significantly reduced. Given that infrastructure is a concern for all leaders any potential threats or risks are likely to be taken seriously. Many of the important communication lines utilize space so there is a crucial reliance built upon assets. As Lieutenant Colonel Sloan and his colleagues discuss, critical infrastructure systems must be developed to be sustainable and resilient, suggesting that currently these systems are vulnerable to attack.[140] Space weapons could exploit this vulnerability. Once proven to work against forces and C2 nodes, space weapons would be effective against infrastructure targets as well. Critical infrastructure needs to be sustainable and resilient, but the level of each is subject to the views of the owners. The assets that contribute to infrastructure could be taken down, although any physical actions to do so would likely be met with swift recourse. Therefore, to appropriately deter aggressive actions from adversaries requires holding such assets at risk with space weapons used in conjunction with one another.

As infrastructure assets are not indestructible, there is a limit to their longevity. Again, with the proven capabilities of U.S. space weapons, this may likely cause an adversary to consider the effects of dealing with multiple weapons at once, when postured on the ground and in space. Space weapons may act as a form of deterrence because the adversary in its national interests will need to keep the infrastructure functioning to maintain its national power. Properly implementing and posturing space weapons will require greater investments, which may then affect the balancing of funds and resources that are available for any potential space activities. The increase in spending may constrain

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[139] Col Joel A Sloan et al., "Infrastructure Truths for Air, Space, and Cyberspace," n.d., 18.

[140] Sloan et al. 23

an adversary to using its funding and resources to only those things within its national interests, diminishing opportunities for aggressive space actions. The investment in development and posture also takes away an important aspect that is critical to space operations; time. The more an adversary focuses on attempting to rectify or bolster their defense, the opportunities for the United States to deter become more plentiful.

Another approach the United States may take with adversary infrastructure assets is with rendezvous and proximity operations. Given the adversary belief in the credibility of a U.S. space-based weapon the United States could maneuver such a weapon within close proximity to the adversary asset. Given that there are no methods to replenish fuel supplies, an adversary would have to weigh the potential of their asset running out of fuel if they move it out of harm's way. In this analysts' eyes, it would be better to have reduced functionality then no functionality at all. The result of such rendezvous and proximity operations would catalyze the degradation of that adversary asset faster than normal expectations. Putting a United States satellite in proximity to an adversary's satellite, means that an adversary will need to put time and resources into adjusting to their maneuver. An action such as this could shift an adversary mindset from an active to passive nature meaning any aggressive actions for the time being are deterred. However, it is important to note that such actions taken by the United States may also encourage adversaries, like China and Russia, to conduct their own rendezvous and proximity operations. In assessing the potential actions of the United States, it is important to remember that the adversary always has a say.

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III. ALLIED CONTRIBUTIONS TO DETERRENCE

One of the four layers of approach for improving U.S. space deterrence is to "Build coalitions to enhance collective security capabilities."[141] Increased space actors will likely lead to greater proliferation of space objects and assets, creating greater challenges in maintaining security in the light of increased threats. Further challenges may come from new or existing space actors seeking to project orbital power. In order to combat these challenges, the United States may benefit from further deepening relationships with allied nations. This chapter will analyze what additional contributions cooperation with allied nations may provide to U.S. deterrence strategy. Key areas of analysis for this chapter are cooperation in space, the complexities of security threats, U.S. and allied space outlooks on deterrence, multinational space operations and systems, and combined contributions to deterrence. Coalitions among allied nations may provide increased opportunities to deter adversary actions and further the development of niche capabilities specific to allied nations. The findings from this chapter will provide U.S. policy makers potential mechanisms to further deepen relationships and strengthen collective deterrence strategies against potential adversaries.

A. COOPERATION IN SPACE

Cooperation has many different definitions depending upon the context intended. As context matters, we are looking at cooperation within space. As such, one could say there are several definitions for cooperation in space: orderly sharing of resources, active help, association for common benefit and association for mutual benefit. These definitions represent the ways in which the United States may cooperate with other space actors, but they do not provide the reason behind the desire to cooperate. Just as there are benefits to cooperation there are also drawbacks. Cooperation is a balancing act that the United States contends with as partnerships continue to impact space operations and in turn deterrence efforts.

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[141] Department of Defense, "DoDD 3100.10."

The predominant motivation for cooperation in space revolves around national interests as Scott Pace, former executive secretary of the National Space Council, alludes to when he says, "cooperation is not an end in itself, but a means of advancing national interests."[142] Perhaps a better way of putting Pace's statement is that countries seek cooperation because it is in their best interest. This cooperation likely stems from a vested self-interest in using space as a means to achieve a specific goal that gives a country an advantage over others. A slight advantage gained over other countries could impact the environment of space, for both good and bad.

To maintain an appropriate level of military space power, a flexible strategy could be implemented to strengthen United States policies and objectives. This strategy, when shared, with other partner nations, through various channels on different sectors of focus may build trust, further reinforcing a country's objective in deterrence. This trust may then be used towards long-term goals such as norm-setting, codes of conduct and treaties to shape the conduct of space operations.

A potential disadvantage to cooperation is that it may be limited to developments that fall within the government. While there is self-interest amongst countries, there are those that may not be willing to provide support to certain projects. Unwillingness to cooperate may be due potential advantages gained by other countries: diplomacy, economy, and national strength. Countries could hesitate about sharing information and technology if deemed detrimental to their overall strengths. Hesitation and unwillingness to share information or technology with cooperating nations may leave gaps in defenses, resulting in fewer deterrence opportunities against potential adversary actions. Any sharing of information and technology could also result in increased competition amongst cooperating countries. A nation could unknowingly foster the growth of its industrial competitors which may damage the competitiveness of its own domestic industry and

[142] Scott Pace, "Align U.S. Space Policy with National Interests," SpaceNews, March 26, 2015, https://spacenews.com/op-ed-align-u-s-space-policy-with-national-interests/.

abilities to deter.[143] Transactional costs requirements needed to coordinate with international partners, such as additional work needed to ensure inter-operability. Initially, this could increase costs of building a system, but long-term there could be savings later on. Military developments are primarily contracted to industry partners, so the costs to develop and employ satellites could increase. Depending upon the budget between partners, one partner may need to pay a bigger fee. Based on the United States partner, this may force the U.S. to provide a majority of the funding, like what happened with the International Space Station. Pending the mission of the military contract this might hurt the United States pocketbook with unexpected costs that were planned for a different use.

One could say that it is easier to cooperate than attempt to succeed alone. Cooperation is not a panacea that gives all the answers on steps to take in space, but self-interest drives cooperation to meet political and/or strategic objectives and goals.

B. SPACE SECURITY AND COMPLEXITIES

Over the last several decades the primary area for space security has primarily fallen at the national level for space actors.[144] The Cold War saw the hostile relationship between the United States and the Soviet Union. Although there were agreements made during this period to prevent mutually assured destruction, measures for the future of space security were not considered. As expected, two nations that have a hostile relationship will likely avoid cooperation, which is what the United States and Soviet Union did. Post-Cold War, we saw the United States dominate space. While the United States maintained this dominance in space for just over a decade, other countries, China and once again Russia, started to rise as space powers. The rise of these countries as space actors brought about new concerns with space security.

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[143] Christopher Johnson, "Policy And Law Aspects Of International Cooperation In Space," *International Institute of Space Law*, 2011, 8.

[144] Moltz, "Coalition Building in Space."

It is no secret that the United States and Soviet competition during the Cold War spurred the development and creation of the United States space program.[145] While the capabilities pushed out by the United States thrived for the following decades, the U.S. presence in space caused cooperative challenges even with allies.[146] A major challenge that has presented itself since the Cold War is sharing advanced military capabilities with allied nations, due to sovereignty and security considerations on both parties.[147] The U.S. reluctance to share technology might have impeded allied development of space capabilities. space capabilities.

Larger-scale security concerns came about with the United States Global Positioning System (GPS), as the fears of losing a strategic advantage prevented the sharing of data with Europe.[148] The September 11, 2001, attacks in New York, however, shifted the mindset of space actors in favor of a transatlantic security alliance.[149] The attacks of 9/11 resulted in a greater demand for satellites to support military operations. Greater demands on satellites for military operations also meant sharing military space assets for information gathering and dissemination. Operations Iraqi Freedom and Enduring Freedom saw multilateral capabilities put to use in order to support joint military forces. Given that joint forces were either co-located or falling under the same commander, the ability to use the same space assets was highly likely. Combined capabilities, Intelligence, Surveillance, and Reconnaissance (ISR) and Advanced Extremely High Frequency (AEHF) could have been useful to the conduct of combined operations. The use of joint force space capabilities provided forces with greater operational flexibility. Although Operations Enduring

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[145] Roger D. Launius, "Historical Dimensions of the Space Age," in *Space Politics and Policy: An Evolutionary Perspective*, ed. Eligar Sadeh, Space Regulations Library Series (Dordrecht: Springer Netherlands, 2004), 3–25, https://doi.org/10.1007/0-306-48413-7_1.

[146] Stephen Ganote et al., *Reenergizing Transatlantic Space Cooperation: Opportunities in Security & Beyond*, 2019, https://atlanticcouncil.org/wp-content/uploads/2019/09/Transatlantic-Space-Cooperation-Report-REDO-FIN-web-092419.pdf.

[147] Sheng-Chih Wang, *Transatlantic Space Politics: Competition and Cooperation Above the Clouds* (Routledge, 2013), https://www.routledge.com/Transatlantic-Space-Politics-Competition-and-Cooperation-Above-the-Clouds/Wang/p/book/9780415827973.

[148] Ganote et al., *Reenergizing Transatlantic Space Cooperation*, 6.

[149] Wang, *Transatlantic Space Politics*.

Freedom and Iraqi Freedom are completed, countries still share an interest in stabilizing the Middle East.

The need for combined space capabilities, through operational necessity, also lead to national security arrangements with military space capabilities. The United States Wideband Global Satellite Communications (WGS) network received investments from Australia, Canada, Denmark, Luxembourg and New Zealand to receive data and capacity.[150] Data sharing through USSTRATCOM SSA program was established and includes such alliance partners as Denmark, United Kingdom, France, Canada, Italy, Spain, Germany, Norway, Japan, the ROK, Australia and the European Space Agency.[151]

C. UNITED STATES AND ALLIED NATIONS DETERRENCE OUTLOOKS

The U.S. Defense Space Strategy, released by the Trump administration in 2020, looks to use the Department of Defense to establish a secure, stable, and accessible space domain where the U.S. and allied use of space benefits from their collective military strengths.[152] The document focuses on two lines of effort for military space operations: "a comprehensive military advantage in space and integrating military space power into national, joint and combined operations."[153] The second line of effort on "integrating military space power into national, joint, and combined operations" sets the tone for a military advantage against threats in space. Furthermore, the establishment of United States Space Command provides an ability to focus on the integration and employment of military space capabilities that will contribute to deterrence. The United States also sees military space power as a way to shape the strategic environment. The United States identifies that integration of space capabilities with allies in space may be essential to securing a military advantage against threats in space, providing increased deterrence opportunities.[154] The

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[150] Ganote et al., *Reenergizing Transatlantic Space Cooperation*, 6.

[151] Ganote et al., 6.

[152] Department of Defense, "2020 Defense Space Strategy Summary."

[153] Department of Defense, 6.

[154] Department of Defense, 7.

integration of space systems between the United States and allies could then allow for proactive discussions on space security interests that could further contribute to combined space deterrence.

The NATO space policy includes themes analogous to those of the United States military strategy. NATO acknowledges that space is becoming more contested, congested, and competitive with alliance space assets a likely target for adversaries. They further allude this vulnerability by discussing space related threats primarily from adversary counterspace capabilities developments and usage. Surprisingly, outside of the debris generated from space weapons, there is no further mention of efforts to mitigate or get rid of debris. This may be a result of the technological developments to do so being at a stage of infancy. The NATO policy identifies key roles in keeping with individual countries space policy, integration, sharing information, support and effects to operations, and development of compatibility and interoperability amongst space services.[155] One of the lines of effort that NATO seeks to take to meet the key roles is deterrence, defense, and resilience. Under this line of effort NATO acknowledges that the allied nations that make it up view space as integral to the deterrence and defense of all allied nations. This line of effort also brings up increasing the collective understanding of space concepts across the organization and space being a key enabler for all domains. In this analyst's eyes what sticks out the most is the fourth element within this line of effort. The fourth element effectively states that while resiliency and survivability are typically national responsibilities NATO will look to exploit force-multiplying redundancies in allied space capabilities.[156] A statement like this alludes to the use of multinational space systems for deterring adversary actions and stabilizing space security.

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[155] NATO, "NATO's Overarching Space Policy," NATO, accessed January 19, 2022, https://www.nato.int/cps/en/natohq/official_texts_190862.htm.

[156] NATO.

D. MULTINATIONAL SPACE OPERATIONS

A multinational space system, as defined by this writer, is a space capability earth-based or space-based that allows for the command and control of said system to be utilized by more than one country. Joint use of space systems opens the door to new and unique opportunities to further strengthen relationships and in turn prioritize strategic objectives. Multinational space operations are a step in the right direction toward capabilities development and enhanced deterrence through international cooperation. Prime examples are data sharing with WGS and USSTRATCOM SSA. Furthermore, the continued evolution and development of new counterspace technologies by adversaries intensifies the need for increased deterrence mechanisms. There have been various approaches to leverage the number of deterrence opportunities amongst allied nations including the Combined Space Operations Center (CSpOC), Operation Olympic Defender, and sharing of SSA information.

The CSpOC is a U.S.-led multinational space operations center that provides control for U.S. Space Command Forces.[157] Current participants within CSpOC are the United States, Australia, Canada, United Kingdom, France, Germany, and New Zealand.[158] The CSpOC is broken down into six different elements covering all aspects of space operations that seek to achieve theater and global objectives. The inclusion of international partners within the CSpOC provides increased opportunities for allied nations to share a wealth of knowledge and technical capabilities with one another. Through the sharing of such information advancements may be made. This also bodes well for deterrence, as nations can funnel information through the CSpOC and then to their proper space operations channels. However, the fact that the CSpOC is a one-of-kind joint space operations center could make it a primary target for adversaries with their counterspace capabilities.

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[157] USSPACECOM, "USSPACECOM Expands Key Allied Space Partnerships through Multi-Nation Operations," United States Space Force, accessed January 11, 2022, https://www.spaceforce.mil/News/Article/2047797/usspacecom-expands-key-allied-space-partnerships-through-multi-nation-operations/.

[158] USSPACECOM.

Operation Olympic Defender, a USSPACECOM-led endeavor, focuses on deterring adversary actions alongside allied partners.[159] This operation concerns itself with the problem of debris as adversary space actor's counterspace and debris-creating capabilities increase in numbers. Through this operation, the synchronization of allied space operations could allow for a collective response from those participating. In the event a collective response occurs, cooperation and relationships amongst those participating could strengthen. Long-term effects would further inhibit adversaries from taking actions when a multinational response, such as economic sanctions or employing counterspace capabilities, could be highly likely to occur. The sharing of SSA may be a critical component to the future of this operation because it provides a major impact to the tracking and identification of debris. An opportunity that arises with the use of multinational space systems in operations, like Olympic Defender, is the ability to expand and improve networks and capabilities.

Expanding and improving networks and capabilities with multinational systems could improve systems that are geographically dispersed. Doing so this might allow for the enhancement of capabilities at strategic locations. A large area where effects would be evident is in SSA. Diversifying a set of geographically distributed sensors can create higher accuracy to the point of completely capturing an operational environment.[160] Multiple nations are then able to have persistent surveillance and coverage of debris and other satellites as a collective. More so, the vast location of ground stations or terminals across the globe prevent the possibility of a single point of failure. The timing of information dissemination may also be streamlined, resulting in faster actions or responses, when necessary, that could be critical to deterrence efforts. The potential coverage and shortened time for action could be especially useful for the identification of adversary counterspace threats. The use of radar or optical telescopes spread around the Earth could be something

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[159] Defense Brief Editorial, "US Space Command Authorizes Its First Multinational Space Operation," *Defense Brief* (blog), May 21, 2020, https://defbrief.com/2020/05/21/us-space-command-authorizes-its-first-multinational-space-operation/.

[160] Robert S Wilson, Colleen Stover, and Steven R Jordan Tomaszewski, "Defense Space Partnerships: A Strategic Priority," 2020, 11.

that acts as a valuable tool for the United States and allies in information gathering. The capabilities spread around the globe open the potential for an allied space network.

An allied space network is a means to allow multinational systems to flourish. A network like this could allow for the ability to reduce vulnerabilities that are inherent with space systems. The reduction of single points of failure and creating new forms of space deterrence by raising the stakes is an interesting consideration.[161] Such a network allows for the development of inter-operable and redundant networks of satellites, lessening vulnerabilities that implicate adversary actions in space. It is also possible that such a development sways efforts away from space weapons developments. However, in the event a response is needed from the United States or its allies, space weapons still pose a threat, when credibility has been established. Regardless, this allied network of multinational systems could be capable of strengthening space security and relationships with allies. Specific areas where an allied network could prove impactful are with ISR, Position, Navigation, and Timing (PNT), launch, and counterspace.

More often than not with the U.S. military, the level of authorities for satellite use falls under different military organizations. An allied space network could make it so that there is a sole authority that streamlines the process of requesting and using a satellite for the specific mission set. First, looking at ISR satellites, a network could provide the means to develop a repository of information that the United States and its allies may use to gain knowledge and be on the same page regarding adversary activities. A repository created from this network may also catalyze discussions for combined military operations in different warfighting domains, where satellites might provide greater support.

PNT is critical to the modern world and ranges from transportation to military operations, to timing for the internet to banking. Technological advances have become more sophisticated, such that PNT satellites are now threatened. With military operations, PNT is crucial to ensuring targets for fires are in the correct locations. Furthermore, the counterspace capabilities of adversaries in the Indo-Pacific region have forced the United

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[161] Moltz, "Coalition Building in Space."

States to use a myriad of multi-sensor technologies to circumvent any loss in PNT.[162] A space network with PNT capabilities could be a big step in the right direction to combat a global loss of PNT, in the event an adversary decides to target GPS satellites. Currently, there are technologies that are capable of addressing threat conditions up to regional PNT outages, but not global outages.[163] The United States could look towards Europe's Galileo, Japan's Quasi-Zenith, and other allied PNT or GPS-enhancement systems to potentially address global outage concerns. An allied network could provide opportunities for a collective effort to address global PNT outages in a contested environment.

An allied space network could also bolster the ability to conduct launches. The network would provide for constant communication among members with the notification of planned launches and what capabilities may or may not still need to be addressed. These notifications may then lead to further discussions among members of the network regarding the provision of rocket use, inclusion of different payloads, and technologies to improve overall launch parameters. Essentially, this could make every member knowledgeable of what launch is happening and where and how it could perhaps assist. The network would also allow for allies to hold each other accountable, when members are all notified, in the event there is a time-sensitive deadline. This may also allow for the ability to reconstitute space assets if high-value launch sites are taken down by adversary attacks.

An allied network may also provide significant impact to counterspace capabilities developments and employments. During the development stages, the sharing of information among allies could shorten the timeline typically required for development and testing. A shorter timeline may result in faster employment and deterrence opportunities. Furthermore, the network could allow for allies to pool their counterspace capabilities together and use multiple capabilities on one satellite or spread load the capabilities across a variety of satellites. The flexibility that the pooling of counterspace capabilities provides

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[162] Mark Johnson, "A Positioning, Navigation, and Timing (PNT) Threat Environment Model for Military and Civilian Use," *Collins Aerospace*, 2019, 9.

[163] Johnson, 5.

could also make adversary countries reactive vice proactive, as their level of uncertainty rises.

Relationships within an allied network provide a means to share financial burdens of operating in space. The United States could put a payload on an allied countries space system which would save them millions in dollars and provide opportunities to leverage capabilities, like how a Norway satellite hosted a U.S. military payload. In the event the United States decides to not put a payload on an ally's system, the United States could contribute financially to the cost of said system. Burden sharing such as this might open the door to further opportunities for multinational approaches in policy, strategy and operations.[164] It is also important to note that the context of this network is not limited to solely space, but also the ground control stations on Earth. The ability of an allied network utilized terrestrially could enhance the efficiency of information flow and dissemination. Increased information flow and dissemination can also further the opportunities to have a collective outlook with space security.

Multinational space systems and allied networks provide opportunities for the United States and allied nations to converge on space security matters. Both of these formats could promote future discussions surrounding scenarios dealing with threats and conflicts. Discussion could be on the topics of how conflicts might emerge, how allies may contribute, capabilities to pursue in advance, and actions that constitute crossing of a threshold for response.[165] These discussions provide the means for the United States to leverage its alliances and partnerships for the future. This would not be the first time that such efforts have been made. United States international partners participate in space exercises Space Flag, Global Sentinel, and the Schriever Wargame.[166] Outside of these

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[164] Department of Defense, "2020 Defense Space Strategy Summary."

[165] Wilson, Stover, and Tomaszewski, "Defense Space Partnerships: A Strategic Priority."

[166] U.S. Strategic Command, "USSTRATCOM Hosts Fourth SSA Experiment with International Partners," U.S. Strategic Command, accessed February 2, 2022, https://www.stratcom.mil/Media/News/News-Article-View/Article/1340856/usstratcom-hosts-fourth-ssa-experiment-with-international-partners/.

exercises, there have also been efforts with Five Eyes nations, the United States, Australia, Canada, New Zealand and the United Kingdom towards combined space operations.[167]

Ultimately, a shared understanding amongst allied countries on potential threats and conflicts in space may be best for decision-making surrounding deterrence, but the classification of specific information could be why this has yet to happen. If actions are understood between the United States and its allied partners, it is feasible that support among countries in space and different domains could be fostered. Such support may also be beneficial to maintaining peacetime operations, which would include deterrence operations.

E. COMBINED CONTRIBUTIONS TO DETERRENCE

The most significant potential of multinational space systems is their ability to increase deterrence opportunities. Partnerships with other countries would be beneficial to satellite networks and ground infrastructure, as these are critical to space operations and daily life on Earth, along with a flexible deterrence strategy. The implementation and integration of multinational systems could cause adversaries to reassess their motives or chances of success.

Benefits that could come from integration and implementation of allied and partner space systems include resilience and mission assurance. Resilience and mission assurance could prevent an adversary from achieving an objective or limiting the benefit of taking action.[168] Resiliency and mission assurance would then convey the futility in conducting aggressive actions therefore, enhancing deterrence by denial.

The commercial sector might be helpful in supporting deterrence with multinational systems. The commercial sector could provide a diverse set of launch capabilities enhancing the ability to employ satellites, provide the ability to reroute communications

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[167] Air Force Space Command, "Multinational Statement for Combined Space Operations," Air Force Space Command (Archived), accessed February 2, 2022, https://www.afspc.af.mil/News/Article-Display/Article/1810793/multinational-statement-for-combined-space-operations/.

[168] John J. Klein, "The Influence of Commercial Space Capabilities on Deterrence," March 25, 2019, https://www.cnas.org/publications/reports/the-influence-of-commercial-space-capabilities-on-deterrence.

channels, improve SSA, and a support a transparent attribution process.[169] Commercial involvement with multinational systems might be necessary to avoid any gaps in capabilities with adversaries, like China, having the government sector dominate space developments and space operations.[170]

Greater involvement of partners, like commercial companies, with multinational systems provides the flexibility to possess "passive" defensive systems. Passive defenses are capabilities used to negate effective adversary attacks, through resiliency or hardening.[171] There are three different categories that fall within passive defenses: architectural, technical, and operational.

While discussion will primarily be concerned with defensive uses in space for deterrence with multinational systems, multinational systems could also be used offensively. Offensive uses for multinational systems could be jamming or spoofing, dazzling or blinding, the ability to shoot back or even the physical seizure of an adversary satellite. Jamming and spoofing could be conducted to disrupt sensors as a way to dodge kinetic attacks or deceive adversary Space Domain Awareness (SDA) capabilities. Dazzling or blinding could be used to affect adversary optical or infrared sensors to prevent imaging of a satellite, which may then frustrate adversary SDA efforts. The ability to shoot back with multinational space systems provides the means to have an immediate response to an ASAT attack against the satellite. Options for immediate response could be orbital lasers, like France is currently developing, the physical seizure of an adversary satellite, which could be moved or have pieces manipulated, or combined jamming on adversary critical infrastructure satellites. While each of these offensive capabilities offer benefits, a potential drawback is the increased weight and size of satellite design, which would likely drive up the cost and limit the number of satellites that could be used within a constellation.

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[169] Klein.

[170] Kevin Pollpeter, "China's Role in Making Outer Space More Congested, Contested, and Competitive," September 27, 2021, https://www.airuniversity.af.edu/CASI/Display/Article/2789413/chinas-role-in-making-outer-space-more-congested-contested-and-competitive/.

[171] Harrison, Johnson, and Young, "Defense Against The Dark Arts In Space."

In terms of deterrence, multinational satellites with offensive capabilities embedded in one of the constellation configurations could be a huge step in increasing deterrence opportunities. The inclusion of offensive satellites with passive defense satellites could increase the level of uncertainty for adversaries. Adversaries would have to go with being concerned about solely passive defensive multinational systems within a constellation to defensive and offensive systems. It would provide greater flexibility with where and when satellites might conduct their mission sets without potential interference from an adversary. The possible existence of offensive capabilities within constellations might make adversaries think twice about the potential ramifications of their actions. The employment of multinational systems with offensive capabilities, however, is easier said than done. For this to happen it would take partners or at least some allies to come to a consensus on what offensive capabilities to use. Furthermore, international views on satellites possessing an offensive capability as a part of its dual use may not end well, especially if orbital debris are likely.

The first category of passive defense that could contribute to deterrence by denial is architecture. The primary method contributing to deterrence in an architecture is the configuration of a constellation of satellites. The different configurations for constellations take into consideration the mission set of the satellites, any command-and-control functionality that is required, and any need to cover the entire earth via different orbits.

The architectures of satellite constellations have different designs that could work in deterring adversary actions. "Disaggregated" constellations provide the means to separate satellites by mission sets. The separation of mission sets could deter an adversary from taking action. This ability to deter would be based upon the notion that an adversary would need to be explicit about the capabilities it would target in an attack.[172] In turn, a disaggregated constellation could minimize unintentional escalation as there would only be one mission set aboard the satellite, further contributing to deterrence.

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[172] Dorminey and Gomez, *America's Nuclear Crossroads*.

"Distributed" constellations provide the opportunity to have one or a variety of nodes working in unison or as a single entity. This constellation's organization could deter adversary actions because any one of the satellites could act as a node if another satellite is destroyed. If an adversary wants to achieve the desired effects, it would need to attack a majority of the satellites within the constellation at the same time. A good example to give some perspective is looking at GPS satellites. If one satellite is taken out, the other satellites in the constellation can adjust their orbit to ensure there is still coverage of the globe. The same can be said for "proliferated" constellations, where a large number of satellites are spread out in orbits all conducting the same mission set. If one or multiple satellites get taken out, new satellites could be launched or satellites that were "extra" in the constellation could maneuver to fill the gap. The number and resources required by the adversary for such an attack would be bountiful, and even then, that does not mean an attack results in success. With a distributed architecture, the cost vs benefit ratio could be significantly raised for the adversary, which might deter them away from such actions as not to throw away money and resources that could provoke the United States and its partners. The concern of orbital debris might also come into play. In the event that an adversary decided to attack, the creation of numerous orbital debris would further strain international views of adversary space actors.

Yet another architectural design for multinational systems is "diversified." In this type of constellation satellites could be spread out into different orbits contributing to the same mission set. It is possible that the satellites in different orbits may not have the same subsystems aboard, allowing for flexible contributions to air, land, sea, cyber, and space domains. The diversification of multinational systems in different orbits could deter adversary actions because of the overlap. If an adversary did attack a satellite in an orbit, the effects would be moot, as another satellite could fulfill the role of the satellite destroyed. If the adversary decided to attack satellites in higher orbits, high earth orbits and geostationary or geosynchronous orbits, the United States and its partners' chances of identifying the attacker could increase. If a low-earth orbit satellite were to be attacked, the chances of identifying the attacker may not be affected. However, regardless of what orbit could be attacked, one risk that cannot be avoided is the likelihood of orbital debris. Orbital debris would be dependent upon the methods an adversary would use for an attack, but in the event that orbital debris are produced, diplomatic and economic sanctions could be a result, which may steer an adversary away from taking action.

The “technical” defense category could contribute the greatest amount of deterrence with multinational systems. Technical surrounds the variety of technologies that could be incorporated into multinational systems improving resiliency and thus deterrence by denial. The ability and effectiveness of a multinational system, much like a national system is dependent upon the technology aboard the satellite. Technology shared amongst the United States and its partners could enhance or enable opportunities to identify, assess, interdict, and deter adversary actions.

Arguably the biggest area where multinational systems could contribute the most to deterrence in the technical category is with SDA. SDA may be defined as the “capability to detect, track, identify, and characterize space objects and the space environment, aimed at supporting space activity in terms of safety, security, and sustainability.”[173] Essentially, SDA is a means to gather an overarching view of all operations in space. The definition of SDA may seem very similar to SSA, keeping track of objects in orbit and predicting their course over time, but the fundamental difference is that SDA focuses more heavily on the military and governmental side of space operations. This means that diplomacy could be critical to deterrence actions.

SDA is one area that NATO takes seriously and encompasses the functional areas of: SSA, ISR, PNT, SATCOM, weather, and early warning.[174] The United States, being a major actor in space, has numerous satellites that are capable of gathering information across the space domain. However, gathering and disseminating large quantities of information in a timely manner remains challenging. To achieve an effective and autonomous capability for SDA, cooperation would be beneficial. Creating a multinational

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[173] Alessio Capt Di Mare, “The Role of Space Domain Awareness,” in *Joint Air Power Competence Centre* (Joint Air & Space Power Conference 2021, Italian Air Staff, 2021), 8, https://www.japcc.org/the-role-of-space-domain-awareness/.

[174] NATO, “NATO’s Overarching Space Policy.”

constellation of SDA systems could benefit the alliance and all nations with ties to the alliance. The creation of a constellation could create an allied network that could fill an intelligence gap amongst nations. Over the years, the intelligence community has viewed space as a tool for information, but now that space has been declared a warfighting domain the requirement for intelligence is extremely high.[175]

A constellation of multinational SDA satellites could fill in the potential gap within the intelligence community. By having a constellation focused on SDA and creating an allied network, uncertainty and "fog of war" could be minimized, which may result in higher quality information. The increase in the quality of information gathered through this network could also allow the United States and its partners to create greater transparency with space operations and the environment. In terms of deterrence, transparency of space operations could deter adversary actions because of the SDA constellation's ability to gain greater attribution and put any action within public international view. The gray zone, covert, activities adversaries could conduct could be diminished. Any actions that an adversary may take would be in the public view.

The creation of a multinational SDA constellation and subsequent network could also provide the push for NATO to be a leader with SDA. We know that NATO does not have or operate any space assets, but it could become a coordinator of the SDA satellites to properly integrate and disseminate information to the appropriate actors. The integration and dissemination of information could also allow NATO not to violate the independence of nations. NATO as an SDA coordinator would also allow for allied nations to remain independent actors in space. NATO acting as a coordinator could provide strategic-level opportunities to deter. NATO could also provide the means to draw the United States away from capabilities-based development and planning that has been dominant for the last 30 years.[176] With NATO in the coordination role, efforts on modernizing strategic level space

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175 Boyce, "Twenty-First Century Deterrence in the Space War-Fighting Domain."

176 Terri Moon Cronk, "DOD Must Rethink, Prioritize Strategic Deterrence," U.S. Department of Defense, October 21, 2020, https://www.defense.gov/News/News-Stories/Article/Article/2389931/dod-must-rethink-prioritize-strategic-deterrence/.

assets may be taken. This coordination role would be especially tricky in the Pacific region where a conflict is likely. The Republic of Korea, Japan, and Australia are not a part of NATO; however, they have worked with the United States in space operations. Perhaps the dominate presence of U.S. military in the region would allow the United States to be a coordinator among the allied nations in the Pacific. The modernization of such strategic assets could provide increased opportunities to deter across the tactical, operational, and strategic levels with the domain of space being a synapse rather than tool. The coupling of space and strategic assets through a multinational SDA constellation could further bolster the diplomatic, information, military and economic sectors leading to deterrence in other domains.

SDA and the allied network may also open the doors to operational methods that contribute to deterrence. The rapid deployment and reconstitution of multinational satellites could address the problem of attrition from conventional warfare to space operations. The sheer number and ability to replace satellites within a constellation could deter adversaries from taking actions as it would be a waste of resources and create orbital debris. Decoy satellites could also be an operational method that contributes to deterrence.

A good historical example that shows the impact decoys may have had with General Patton's fake army during World War II.[177] During the stages leading up to the beach invasion of Normandy, decoys of tanks, camps and other military capabilities were created to deceive the Germans about where Allied forces were staging. The actions taken by Allied forces caused Hitler and his commanders to focus on other matters allowing Allied forces to focus on their battle plans. Although it is not explicit, the deception acted as a form of deterrence, because the Germans were disinformed and Allied forces plans were concealed allowing for greater flexibility with the changing weather conditions prior to the invasion of Normandy.[178]

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[177] William B. Breuer, *Hoodwinking Hitler: The Normandy Deception* (Westport, CT: Prager Publisher, 1993).

[178] Breuer, 190.

Decoys as a part of multinational space constellations could provide the same effects. By employing decoys and actively sharing information on their capabilities, it is possible that adversaries may focus their efforts on the decoys. With adversaries' efforts focused on decoys that look like satellites and mimic satellite behaviors, and electromagnetic spectrum emissions, the United States and its partners may further enhance resiliency of critical space assets. In the event that an adversary decides to attack a decoy unknowingly, it could provide the grounds for an international response. As far as orbital debris go, they may or may not be influential. The effects of such debris are dependent upon the orbit that the decoys are placed in. Although such an option exists, it is probable that the United States and its partners would not venture to employ decoys. The benefits gained from decoys may not be immediate or exist at all when compared to satellites with given mission sets. Some other potential results that might steer away the use of decoys would be an increase in orbital debris and taking up space in limited orbital slots.

In terms of deterrence, multinational satellites with offensive capabilities embedded in one of the constellation configurations could be a huge step in increasing deterrence opportunities. The inclusion of offensive satellites with passive defense satellites could increase the level of uncertainty for adversaries. Adversaries would have to go with being concerned about solely passive defensive multinational systems within a constellation to defensive and offensive systems. It provides greater flexibility with where and when satellites may conduct their mission sets without potential interference from an adversary. The possible existence of offensive capabilities within constellations might make adversaries think twice about the potential ramifications of their actions. The employment of multinational systems with offensive capabilities is easier said than done. For this to happen it would take partners to come to a consensus on what offensive capabilities to use. Furthermore, international views on satellites possessing an offensive capability as a part of its dual use may not end well, especially if orbital debris are likely.

Overall, there are a variety of approaches that the United States and its allies could pursue with multinational systems. Each of the approaches offer a different variety to space operations, but the end state remains the same, deterring adversary actions. Multinational systems with defensive capabilities could increase the resiliency and mission assurance through denial. Multinational systems may have the same effects, but with a mix of deterrence by denial and punishment. However, the term “offensive” when associated with satellites could be a concern when it comes to partnerships and agreements between those partnered. Future space operations may likely pose a variety of security concerns for the United States. Deterrence through multinational systems is a mechanism for mitigating those concerns.

IV. CONTRIBUTIONS BY NORMS, CODES OF CONDUCT, AND TREATIES TO DETERRENCE

Norms, codes of conduct, and treaties may be crucial to the conduct of space operations and space actors' decisions in a proliferated environment. The presence or lack of diplomatic mechanisms would significantly impact the ability for the United States military and other allied partners to achieve strategic objectives, including deterrence operations. This chapter will discuss the importance of norms, codes of conduct, and treaties to space, historical and contemporary efforts, and, most significantly how they could contribute to deterrence. The uniqueness of the space domain could present a variety of opportunities for the future, especially as more space actors employ capabilities. If norms, codes of conduct, and treaties are implemented and adhered to there may be important positive effects on security and deterrence thus making major conflict in space, less likely.

A. NORMS, CODES OF CONDUCT, AND TREATIES IMPORTANCE TO SPACE

Norms, codes of conduct, and treaties are means that could be used to shape actions in space and deter adversaries from taking any aggressive actions. To better understand the context for norms, codes of conduct, and treaties, it is important to define each and point out their importance. A norm could be an expectation that steers behaviors amongst a society or group of members. Simply put, norms are those rules that shape thinking and behavior. In the context of outer space, norms are viewed as ways to inform the international space community on best practices for space operations.[179] Norms as a part of space operations may have a significant impact on the safety and sustainability of space. Without norms in space, without some sort of traffic management, it is likely there would be a variety of collisions between satellites, resulting in increased orbital debris. It could have a compounding effect on the protection of valuable orbital regimes for those countries

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[179] Audrey M. Schaffer, "The Role of Space Norms in Protection and Defense," *Joint Force Quarterly*, 87, no. 4 (2017): 5.

that rely on space for critical infrastructure. The establishment of norms makes it easier to identify behaviors that are not in keeping with those norms, which could provide early warning and potentially protection from any space threats.

A code of conduct is like a norm, but a significant difference between the two is that a code of conduct is a policy. Codes of conduct are an important means for compliance as they outline repercussions in the event an action is taken that goes against policy. The importance behind codes of conduct in space is that they serve as reference points for space actors to make appropriate decisions on daily space operations. A code of conduct is essential when used in a cooperation with a variety of people from different national backgrounds, because it impacts functions, daily conduct, and how people interact with one another. Therefore, you could see how important codes of conduct would be in space. The emplacement of codes of conduct in space could provide structure and deter any actions are that are inappropriate. Given the legal complexity of determining which laws apply in space and which do not, codes of conduct present an opportunity that could fill the gap while legalities get sorted out.

Treaties have had a significant impact on the development of space throughout the years. Unlike norms and codes of conduct, treaties are formed when a group or individual members agree to terms that are formally established via a written document that has been ratified by their respective national legislatures. The formalities surrounding treaties have been integral to shaping the space environment. To date there have been five international treaties and subsequent principles that have shaped space operations.[180] While treaties are the ultimate way to shape space operations, they can take a considerable amount of time to negotiate and ratify. However, once treaties are ratified, they can establish both norms and codes of conduct by explicitly defining what is right and wrong. This does not mean that actors in space could not challenge these treaties or skirt along the lines to see what they could get away with. The likelihood of space actors flirting with limits is something that makes the need for norms and codes of conduct to support treaties necessity for the future.

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[180] United Nations, “Space Law Treaties and Principles,” accessed February 25, 2022, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html.

B. HISTORICAL AND CONTEMPORARY EFFORTS

Establishing rules and norms regarding responsible behavior for space operations has been a complicated matter over the years. The primary focus on the establishment of rules and norms has been the security and safety of space. However, both the security and safety of space have not been held on equal terms historically.[181] The Cold War conflict is where initial approaches to norms and rules in space started. Initial efforts on drafting international law in space were triggered by the issue of Soviet Union testing.

The testing of nuclear weapons in the 1960s in LEO, the Limited Test Ban Treaty of 1963 and UN resolutions passed in 1963 bolstered the opportunity to build on pre-existing guidelines for space. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies provided most of the text for the Outer Space Treaty, signed in 1967.[182] The Outer Space Treaty is considered the foundation of modern international space law as it provides a basic set of rules for space behavior.[183] The Outer Space Treaty of 1967, however, does have some areas where broad language creates gray areas. Article IV discusses nuclear weapons and weapons of mass destruction not being allowed in orbit, but does not clarify in further detail, leaving the article open to interpretation on how other space weapon capabilities may be employed.

Outside of the Outer Space Treaty, other major treaties impacting space behaviors and officially signed by several nations are the Rescue and Return Agreement of 1968, the Liability Convention of 1972, the Registration Convention of 1975, the Moon Treaty of 1979 and the ABM Treaty.[184] The limited number of treaties dedicated to space could be a result of the increasing number of actors that all have different interests, making a

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[181] Bruce McClintock et al., "Responsible Space Behavior for the New Space Era: Preserving the Province of Humanity," RAND Corporation, Perspective: Expert Insights on a Timely Policy Issue (2021): 50.

[182] United Nations General Assembly, "Outer Space Treaty."

[183] McClintock et al., "Responsible Space Behavior for the New Space Era: Preserving the Province of Humanity." 6.

[184] McClintock et al. 7.

consensus even more challenging. A lack of consensus has not stopped the creation of draft proposals. However, some proposals have been accepted through voluntary agreements from participating nations.

One proposal that centered around space is known as the International Code of Conduct (ICOC). This proposal builds off the Outer Space Treaty and attempts to set standards by which participating nations would conduct themselves with space operations.[185] To countries that see security and stability as necessary for the future of the space environment, this proposal might have done just that. Given that the ICOC would establish rules of the road, it might have possessed the ability to deter countries from taking any questionable approaches to space operations when held accountable. The trouble with proposals and their acceptance as a part of space behavior is the need for consensus, which is difficult when actors have their own ideas on how space should be utilized. The proposal was eventually halted after backlash from procedural issues and security concerns with inclusion of the right to self-defense.[186]

One area where there has been significant traction in building norms in space is through transparency and confidence-building measures (TCBMs). TCBMs have been primarily focused on information sharing about space operations for long-term sustainability of the space environment. However, when a mechanism to measure compliance is not in place, it can be difficult to measure the benefit of TCBMs. The difficulties presented did not stop the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) from adopting guidelines for the Long-Term Sustainability of Outer Space Activities (LTS) in 2019.[187] The LTS is a voluntary measure. However, it was a shift in a different direction when compared to the Outer Space Treaty and the not adopted Treaty on Prevention of the Placement of Weapons in Outer Space and of Threat or Use of Force Against Outer Space Objects (PPWT). The LTS focuses on the full range

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[185] Moltz, *The Politics of Space Security*, 331.

[186] Moltz, 331.

[187] COPOUS, "Guidelines for the Long-Term Sustainability of Outer Space Activities" (Vienna, Austria: United Nations, 2021), https://spacesustainability.unoosa.org/content/the_guidelines.

of human interactions that play a role in the development of space as a domain instead of only self-defense or armament. As technology and actors increase within the space domain the LTS should evolve as well.

The PPWT concept focused on armament and self-defense. The proposal catered more towards the likelihood of an arms race in space, instead of the overall protection and security of space. The proposal's attempt to mitigate the threat of force on objects in space ended up receiving significant criticism because of the ambiguities on the testing of weapons and difficulty of verification.[188] Furthermore, the ambiguities from the PPWT did not promote confidence in mitigating developing technologies that would threaten space assets. The narrow scope of the PPWT around an arms race and the ambiguities within the text did not receive much international support.

The rapid nature of technological advances with space operations threatens the ability of treaties and voluntary agreements to maintain long-term. These limitations exist because in the initial stages of space operations there was not much concern for space traffic or debris, because the primary concerns were sending and receiving communications for intelligence or command and control. Now that space has become more congested, an emphasis on safety has risen to the forefront for satellites conducting missions. A likely reason countries' may not have taken long-term safety into account in space was due to doubts that other countries would gain the capabilities to use the space domain.

This historical short-sightedness about the use of space has also shaped the U.S. military's outlook. Because the U.S. military initially used space as a means, military leaders have sometimes overlooked the future role space could play with respect to deterrence and conflicts. This could be why the Kessler Syndrome, posed in 1978 by NASA scientist Donald Kessler, did not generate greater concern with the United States up until 1985 when the United States adopted debris mitigation as a goal.[189] The Kessler Syndrome was a study illustrating that the number of orbital debris would exponentially

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[188] Moltz, *The Politics of Space Security*, 310.

[189] Moltz, 202.

increase over time even if space operations were to stop. Orbital Debris Mitigation Standard Practices were released in 2001 and updated in 2019 to "to limit the generation of new, long-lived debris by the control of debris released during normal operations, minimizing debris generated by accidental explosions, the selection of safe flight profile and operational configuration to minimize accidental collisions, and post mission disposal of space structures."[190] Debris management could become a critical component to norms, codes of conduct and treaties in the near and distant futures for space operations. Space activities take place within a shared-resource system, so any independent actions contrary to the common good may affect all actors conducting operations, taking away opportunities for deterrence.

Before deterrence through norms, codes of conduct and treaties could take place, one of the most critical areas of concern are the establishment of some universal definitions regarding safety. The development of definitions on safety would then impact the space security outlooks. To deter appropriately across the military spectrum, a fundamental understanding of what is responsible and irresponsible. Definitions provide substance and a backbone to tactical, operational, and strategic level decision-making that could shape how deterrence operations are conducted. The terms safety and security to many in the military sphere are synonymous with one another; without one you cannot have the other. While this is true and there are many overlaps between the two terms, the overlaps are a potential cause of lack of consensus when it comes to treaties.

The United Kingdom Resolution "Reducing Space Threats through Norms, Rules, and Principles of Responsible Behaviours" is a contemporary effort that seeks to outline and define how a space actor should appropriately conduct operations.[191] The participating members of this resolution identified that the rapid increase and diversity in number of space actors raised new concerns for space security and an arms race in outer space. The

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[190] U.S. Government, "Orbital Debris Mitigation Standard Practices, November 2019 Update" (U.S. Government, November 2019), https://orbitaldebris.jsc.nasa.gov/mitigation/.

[191] *Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours*, United Nations Disarmament Yearbook 76/77 (United Nations, 2021), https://doi.org/10.18356/9789210056700c009.

contents of this resolution focus on existing and potential future threats to space systems, the characterization of actions or activities that may be considered responsible or irresponsible, and future ideas to develop and implement norms, rules, and principles to reduce security risks.[192] The existing proposal encompasses building awareness and facilitates alignment among space nations. This resolution has received strong international support and has succeeded in creating the 2022–2023 Open Ended Working Group (OEWG).[193] The creation of this working group may now develop and implementing norms, rules, and principles of responsible behavior, which would favor U.S. deterrence efforts.

Another contemporary effort on norms, codes of conduct, and treaties focuses on banning kinetic ASAT testing. The proposal was drafted by the Outer Space Institute (OSI), a network of space experts drawn from various professions to the United Nations General Assembly President. This proposal expressed the need for an ASAT test ban treaty due to orbital debris and upcoming mega-constellations from commercial space actors.[194] Furthermore, this proposal builds off the General Assembly resolution "Reducing Space Threats through Norms, Rules, and Principles of Responsible Behaviours" section that encouraged members to study existing and potential security risks. The members of the OSI provided a list of countries, adversary and allied, that have expressed a consensus that kinetic ASAT testing should be avoided. No countries in this list brought up kinetic ASAT testing as appropriate or internationally legal in their responses to the UK resolution.[195] Ironically, however, a few of the countries that oppose the use of kinetic ASAT testing are ones that conducted recent tests, contradicting their own viewpoints.[196] OSI identified the strong possibility that momentum behind a test ban treaty is growing, given continued risks

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[192] *Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours*, 5–17.

[193] Douglas Loverro et al., "The ASAT Prisoner's Dilemma," *Center for Strategic and International Studies*, Aerospace Security, January 11, 2022, 6.

[194] The Outer Space Institute, "Kinetic ASAT Test Ban Treaty" (The Outer Space Institute, September 2, 2021), http://outerspaceinstitute.ca/docs/OSI_International_Open_Letter_ASATs_PUBLIC.pdf.

[195] *Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours*. 19-105.

[196] Loverro et al., "The ASAT Prisoner's Dilemma," 3.

from kinetic ASAT testing. Since the publication of the proposal in September 2021, there has been an additional roundtable meeting among signatories, United States, Canada, Australia, Japan and other allied nations, further discussing regulation of ASAT systems and discussions on political involvement with restraints.[197] The proposal for the ban on kinetic ASAT testing remains active and seeks additional signatures, China and Russia. Future efforts surrounding norms, codes of conduct and treaties could focus on SSA, debris mitigation, rendezvous, and proximity operations, ASATs, and maintaining safety and security of space. These efforts could exhibit a mixture of self-defense and long-term humanity aspects. Such a mixture makes sense with modern technologies, new space actors, and the asymmetric tendencies of space. Broader areas to address means potentially having efforts inclusive to one another. The areas to address mean nothing if there is a lack of awareness on the issue.

The mindset regarding debris in the early space era was one that displayed little concern. Of course, this mindset was not surprising given the primary actors were the Soviet Union and the United States. Space was also vast and uncongested. The influx of more space actors has effectively proven that mindset to be faulty. As an active member in the United States military and observer of policy changes, inaction exists, where we talk about the future, but we wait until something happens before doing anything to prevent or deter an action.

The different interests among space stakeholders are a challenge on reaching an overarching focus. An increase in the number of space actors means that more players have a say in how space should be used. If many differences exist, collective thinking cannot prosper. Collective thinking is crucial to successfully develop norms, codes of conducts, and treaties. The Outer Space Treaty failed to establish the common benefit for space and its actors.[198] The lack of clear common benefit might stem from concerns with self-defense. The Cold War illustrated just how important self-defense was with the threat of

[197] University of St Andrews, *CGLG Roundtable - Banning Space Weapons?*, 2021, https://www.youtube.com/watch?v=4904ubML-Mo.

[198] United Nations General Assembly, "Outer Space Treaty."

nuclear weapons and making it the top priority. The United States, China, and Russia have all explicitly stated that space is important to their overall strategic operations, meaning space is important to self-defense. To enhance the importance of space for self-defense the United States 2020 Defense Space Strategy illustrates the desire to maintain space superiority to deter and defeat a hostile adversary in space.[199]

The lack of norms, codes of conduct, and treaties presents challenges to substantial progress of hard law and a comprehensive space governance system. Treaties, outside of the Liability Convention and claims processes, comprising space law do not incorporate any measures to constrain or punish behavior outside the scope of treaties or customary international law. The lack of an enforcement mechanism may limit the ability to prevent, deter or punish actions outside of customary international law. The absence of an enforcement system is likely the result of customary international law focused on sovereignty, whereas space law must deal with non-sovereignty. Furthermore, the language within the treaties making up space law is often vague and ambiguous, which leads to arbitrary applications by the signing members of the treaties.[200] The non-existence of lexicon for the characterization of key definitions, space weapons, space debris, space objects, and many more, allows for individual actors to define them as they see fit. The lack of an agreed-upon lexicon regarding space takes away from the collective thinking that leads to norms, codes of conduct, and treaties.

C. NORMS, CODES OF CONDUCT, AND TREATIES CONTRIBUTIONS TO DETERRENCE

Although challenges present themselves with respect to space law, there are still approaches the United States military could take to catalyze norms, codes of conduct or treaty discussions that would have the effect of deterring future space operations. The catalysis of norms and codes of conduct could lead to treaties, deterring adversary actions that may be aggressive or questionable for the betterment of space. Approaches that may

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[199] Department of Defense, "2020 Defense Space Strategy Summary."

[200] McClintock et al., "Responsible Space Behavior for the New Space Era: Preserving the Province of Humanity," 24.

contribute to deterrence with norms, codes of conduct, and treaties would be test bans, increased communication, increased transparency, achievable demonstrations, and addressing safety concerns.

Test bans are one approach that the United States has recently taken to strengthen deterrence.[201] The United States has declared a ban of direct-ascent ASAT testing unilaterally. The premise of this ban focuses on any direct-ascent ASAT tests that would destroy satellites in orbit creating orbital debris. The result of the ban would limit the creation of debris. This proposal is an effort on our part to promote the further development of responsible behavior by other countries in their space operations as well. Vice President Harris has discussed that "without clear norms we face unnecessary risk in space" and "testing increases the risk of armed conflict."[202] Because the focus of the ban is centered around the space environment, it is a sustainability approach towards appropriate space behaviors. The semantics surrounding sustainability may be better received by the international community. The focal point of sustainability also aligns with the UK resolution and may bolster international support to further shape norms and codes of conduct for space operations. Furthermore, this ban could be very minimal in cost if other space actors decided to follow suit with the U.S. The unilateral ban could have a significant positive impact on the employment of mega-constellations from various space actors, as the concern for orbital debris affecting satellites could be mitigated. The users of these constellations may support this ban with its benefit to promoting a stronger international norm and facilitating safer space operations.

Unilateral action may seem inappropriate to some, but given historical experience, a unilateral move like this may be what is needed to start the ball rolling. For example, back in 1991 Mikhail Gorbachev unilaterally declared a ban on Soviet nuclear weapons testing.[203] A brief time later the United States passed its own ban, followed by the U.N.

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[201] Sandra Erwin, "U.S. Declares Ban on Anti-Satellite Missile Tests, Calls for Other Nations to Join," *Space News*, April 19, 2022, https://spacenews.com/u-s-declares-ban-on-anti-satellite-missile-tests-calls-for-other-nations-to-join/.

[202] Erwin.

[203] Loverro et al., "The ASAT Prisoner's Dilemma," 4.

negotiation of an eventual treaty. Unilateral action with this space ban could provide the United States further opportunities to foster credibility and leadership within the international community. Proposing this ban unilaterally illustrates our commitment to sustaining the space environment. Although this ban is for a specific use case, other space actors may take further declarations. The narrower scope of our ban could be the catalyst towards broader bans on ASATs in the future, which would contribute to U.S deterrent efforts.

The knowledge level of space policy within the military community is high, however, it could be argued that a lack of awareness exists among the lower-level leadership and the public on the vital role that space fills in daily life. This lack of awareness may be detrimental to the development of norms, codes of conduct, treaties, and deterrence. Much like a politician or someone running for a higher level of leadership within a community, the level of awareness from those voting impacts the person running for office. The same can be said for the development of norms, codes of conduct, and treaties. A proactive and coordinated global campaign would build awareness on the importance of space and facilitate nations to pursue alignment.

The military would play a critical role in increasing the level of awareness. The proven operational experience in space and expertise on space capabilities may be a catalyst to the development of norms and codes of conduct. The number of years that the military has participated successfully in space is something that members outside of the space policy community could recognize and see as an appropriate approach for the future. Furthermore, providing obtainable policy documentation may further bolster support for broader application of a military ruleset for space operations. The military working with commercial space actors would also prove impactful. The military could function as a reference for commercial actors on what is and what is not appropriate for space operations. Through such actions the U.S. military would be shaping the thinking of commercial actors towards safety within space. In the same fashion, commercial actors may be a reference for the military when it comes to the daily conduct of space operations. The shift in thinking may then lead to developing norms and codes of conduct for space operations across an extensive range of space actors both military and commercial.

Scientists from commercial and military sectors could also have a key role. Scientists' knowledge on the physics of the space environment and technologies could function as advisors to policy makers on what norms and codes of conduct are feasible for daily space operations. The increased number of space actors involved in norms and codes of conduct may then lead to shorter timelines to establish treaties because of greater pressure. However, it is also important to note that there is just as much of a possibility that timelines could take longer because of an increased number of differing interests.

An increase in awareness would also increase the need for transparency. Historically, questionable actions in space have been difficult to detect or attribute because of the struggle to maintain SSA transparency.[204] Although we could call for full transparency in all space operations, there is a need to maintain national security. Increasing U.S. reporting related to objects in space and sharing that data to other space nations would illustrate the willingness of the United States to be a leader for the security and safety of space. This may be critical to the development of norms and codes of conduct, because failing to contribute to transparency may undermine the credibility of the United States while still pushing for transparency. The willingness to share information will lead to a unified SSA system to fill gaps and increase transparency. In the commercial sector we see companies such as LeoLabs and ExoAnalytics that have been disseminating SSA information with positive impacts. The United States could look to combine efforts with these companies and either develop its own capability to share information or increase the commercial companies' capabilities. Doing either of these would allow for increased credibility on U.S. efforts. If the United States wants to further influence behaviors in space, it is essential to be at the front of transparency efforts, which would lead to norm and code of conduct developments.

Greater norm and code of conduct developments, with treaties being a long-term goal, in the context of transparency, would enhance overall deterrence towards adversaries. Shared SSA information across various space actors could increase the ability to detect and

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[204] McClintock et al., "Responsible Space Behavior for the New Space Era: Preserving the Province of Humanity," 27.

attribute adversary space operations. Furthermore, this implicates an adversary's abilities to conduct space operations that would further its strategic objectives in space. Covert space operations might turn into overt operations with multiple space actors having a watchful eye over all activities in space. Norms and codes of conduct, among multiple space actors, with transparency, may even make it harder for adversaries to play dumb or deny that they do not know what is appropriate and what is not in space. Transparency here will hold adversaries accountable, especially when there are state and non-state actors, including commercial, contributing to agree upon behavior.

The fastest way to initiate awareness and transparency with space operations may be through quick and achievable demonstrations. The previously few successful attempts, via UN proposals, suggest that approaches to norms, codes of conducts, and treaties will either fail or stall in negotiations for years. This may be due to United States competition with other major powers, which may take away the effectiveness of the UN, because of possible vetoes by China and Russia. The current competition with Russia and China may pose issues with pushing any worthwhile proposals through negotiations.

An initial movement conducted by like-minded allies, consisting of NGOs, scientists, and the commercial sector, on norms and codes of conduct could be the key to speeding up the process for creating a more formal space environment. A more regulated space environment, instead of the wild west we have seen, would be pivotal to deterrence. Increased formalities leave less wiggle room for getting away with anything questionable when rules are either explicitly written, like treaties, or there is a traditional approach that while not written into law is adhered to by all actors, such as norms and codes of conduct. Formalities are something that we have seen with land, sea, and air domains over time, which have proved impactful to deterring adversary actions. A good starting point to look at with developing standards and formalities is Defense Advanced Research Project Agency (DARPA). DARPA has been working to develop rendezvous and proximity operations guidelines, NASA developed debris-mitigation standards and other countries' industry developed their own guidelines.[205] Developments such as these could lead to faster backing from U.S. policy makers at which point the U.S. could present these during the OEWG meetings to gain international support.

Initial movements conducted by the alliance members may allow for the inclusion of other like-minded personnel to come together on space security and safety. Depending on the number and level of inclusion, standards may be developed faster and pushed out to a wider audience. The tricky part for the United States with movements is also setting rules for ourselves and not just adversaries. The concept of transparency comes back into play here. If the United States wants greater transparency for space operations, we must also be willing to resolve internal debates on what the collective approach towards norms, codes of conduct, and treaties would need to be.

A potential key behind the value of initial movements, conducted by like-minded groups, is the measuring of compliance. The best guidelines, practices, and rules can exist, but without the ability to observe and enforce those measures, guidelines, practices, and rules will not be effective. A lack of motivation may result in countries only adhering to the best measures when the benefit is greater than the cost to itself. The best guidelines, practices, and rules emerging along within a compliance method would function as a cost-benefit system. Within this system, benefits may be given to space actors that comply with the best measures for space and take away from those actors that do not comply. An established compliance method would also function as a deterrence mechanism because any space actor acting outside of compliance measures would suffer some sort of cost, potentially across the diplomatic, information, military, or economic sectors.

A compliance method could act similarly to the FAA's enforcement and monitoring of commercial space transportation. The compliance method with the FAA covers pre-operational activities, operational activities, and post-operational activities.[206] A space compliance method could focus on operational and post-operational activities. Pre-

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[205] McClintock et al., 29.

[206] Federal Aviation Association, "Compliance, Enforcement & Mishap," template, accessed April 20, 2022, https://www.faa.gov/space/compliance_enforcement_mishap/.

operational activities could be retained by the FAA as any launches would have to transit through airspace. In a similar fashion to aviation, when the spacecraft enters space, a handoff of authorities could take place from the FAA to the appropriate space professional managers to enforce and manage operational and post-operational activities. Any violations of operational or post-operational activities outlined in the compliance method, once identified by the space professional managers, could be passed to the appropriate legal space authority to deem if remediation or sanctions may be necessary.

A compliance method with this design would also need an appropriate authority to oversee any actions. An international committee of space professionals designed like the UN may be the best suited candidate as an authority. One of the key roles of this committee could be serving as a consultant for political-military consultations on the development of legal and behavioral norms.[207] An international committee of space professionals could function as a consultant for political-military activities and, most importantly, an overarching body ensuring space operations and activities are within the bounds of appropriate behavior. An international committee of space professionals could be a good selling point for all space actors' interests. Additionally, an international committee could be a bridge to the UN that could further aide in the development of space behaviors and legalities.

To make the most of the ability for norms, codes of conduct, and treaties to contribute to deterrence, terminology should be considered as the most important priority. Established definitions regarding safety in space could drive the development of norms and codes of conduct, which may be inclusive of terminology that limits freedom of movement with offensive and defensive space operations. Terminology on safety could function along the same lines as the Limited Test Ban Treaty, in that a ban could be put in place to prevent debris-creating testing during peacetime operations, which in turn would benefit everyone's space-based assets. If the terms on safety in space are defined in such a manner, consensus agreements on security may become easier to get to. This could offer massive

[207] NATO, "NATO's Overarching Space Policy."

benefit among the space actors cooperating with one another that seek to deter adversaries, because it could provide credibility to future outlooks on the use of space. The credibility could bolster long-term plans for friendly actors and limit plans for adversaries, shaping the environment in a way aligned with friendly space actors' intent and deterring adversary intentions.

Again, the tricky part with these definitions, if they are made, is that they do not have a firmly solidified place to reside. The lack of a governmental framework for space and the difference between space law and the law of armed conflict, as well as with other laws, are existing gaps that may take away opportunities to deter adversary space operations in a future proliferated environment. Achieving agreed-upon terminology for responsible and irresponsible space behaviors will rely on increased awareness and transparency. An increase in awareness and transparency may also then drive developments with a space governmental framework and space law. Greater involvement leads to higher chances for the development of norms, codes of conduct, and treaties to contribute to deterrence.

The context of space operations has drastically shifted since the ratification of the Outer Space Treaty in 1967. The space domain now consists of numerous space actors, sectors of government, and the commercial sector that are all intrinsically linked to terrestrial actions. Increased actors and critical space assets have driven the need to maintain safety and security in space. Norms, codes of conduct, and treaties are means to maintain safety and security. Maintaining safety and security through those means also provides the ability to deter adversary space activities. Awareness, transparency, achievable demonstrations, and definitions could all help the development of norms, codes of conduct, and treaties that contribute to deterrence. The Russian ASAT test in November of 2021 has created consensus among international members pushing for responsible behavior in space. The current conflict in Ukraine may allow for further cohesion between U.S. and allied nations on defining what responsible and irresponsible behaviors are in space. The current climate in international relations has increased opportunities to build consensus to further shape space operations. It is up to us to act and be at the forefront of appropriate decision-making regarding space behaviors to maintain security and safety.

V. CONCLUSION

The environment of space has drastically changed since the launch of Sputnik, and it is rapidly changing each passing year as more actors employ space capabilities. Deterrence in a space environment with increasing technology and capabilities will impact multi-domain activities.[208] Due to the nature of space, and lack of territorial boundaries in accordance with space law, the challenges associated with deterrence will be significantly higher.

Military space operations will be critical in deterring adversary actions and maintaining the security and safety of operations in space. Areas of contribution to deterrence the military should seek to further include as a part of space strategy are space weapons, allied contributions, and norms, codes of conduct and treaties. Furthermore, the recommendations listed below for each area of contribution would give the United States more opportunities to build greater flexibility in its deterrence strategies.

A. RECOMMENDATIONS

1. Space Weapons

The expected proliferation of space activity in the years to come highlights the need for the United States to have a space weapon capability at its disposal to use for deterrent purposes. While some may disagree with this conclusion, until there is some formal agreement or policy banning the use of weapons in space, it will be necessary for the United States to develop them. To really drive this point home, if the United States decided not to deploy space weapons as a part of its deterrence strategy, it would open the door for adversaries. What could happen is that an adversary would be more willing to use space weapons and to exploit them to the fullest potential to negatively impact the United States. From a deterrence perspective, not developing at least certain kinds of space weapons could take away the U.S. ability to hold adversary forces, decision-making, and infrastructure at

[208] Executive Office of the President, "Weapons Of Mass Destruction."

risk. A lack of space weapons could take away opportunities to influence the adversary psychologically when a proven credible capability has been demonstrated. Following the research conducted for this thesis, it is concluded that the electronic warfare techniques of jamming and cyber-attack are the best approach for U.S. deterrence with space weapons.

a. Kinetic Weapons

Kinetic space weapons are not suitable for U.S. deterrence strategy, because of debris. Kinetic weapons will cause debris when tested against space objects or used offensively, increasing congestion in a contested and competitive environment. Increased congestion in space will likely limit the number of launches and capabilities that the United States can use. Greater congestion and contested space only behoove adversaries, such as China, to use such conditions as a method for their space strategy.[209] Of greater concern, United States posturing of kinetic weapons to hold adversary capabilities at risk would likely result in increased tensions with the commercial sector, allied nations, and adversary nations. A severe implication would be allied nations severing ties with the United States, which would undermine the advancement of science, international commercial cooperation, military space cooperation, and space exploration. Severing ties would have far greater implications on a global scale, primarily with diplomatic or economic sanctions being a possibility. Also, depending upon the timing and current state of relationships, the use of a kinetic weapon by the United States may start or escalate a space conflict. A conflict would undermine efforts outlined within the Defense Space Strategy.[210] There is also a strong chance that the United States would lose the respect of many other nations, including up-and-coming space actors. These nations may see the United States as turning its back on others and looking out for its own best interests, especially as it was a leader in past agreements and conversations on debris mitigation.

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[209] Pollpeter, "China's Role in Making Outer Space More Congested, Contested, and Competitive."

[210] Department of Defense, "2020 Defense Space Strategy Summary."

b. Laser Weapons

Laser space weapons do provide a means for the United States to implement its deterrence strategy, but only to a certain degree. These laser weapon systems, unlike kinetic weapons, significantly mitigate the likelihood of producing debris, although debris are still likely depending upon the power output and location of satellite. The ability for the United States to establish limited space control is a crucial factor for the consideration of implementation into strategy.[211] Space control, if unchallenged, may impact the balance of military forces and the conduct of future conflicts, favoring the United States. However, with international views agreeing that all nations should have access to space, there is a chance that controversy may arise. In terms of the United States and space's relationship with nuclear deterrence, lasers also constitute another possible measure for missile defense. While missile defense with lasers may be effective initially, the potential proliferation of laser weapons by a variety of actors in space could reignite an arms race. Discussions on arms control may be a bad thing for the United States because they could take away capabilities to deter adversaries and constrain the United States from possessing a flexible strategy.

Physical constraints drive the proposal for only limited use of laser systems. A physical constraint of laser weapon systems is presented by the atmospheric effects that weaken the power of the emitted beam. To get the most bang for its buck, the United States should consider using such systems against low earth orbit or medium earth orbit satellites from the ground. The use of lasers systems at such orbits mitigates the size, power, and cost requirements for the type of laser systems needed. However, the orbits for laser system use also limit the ability to impact adversary strategic level assets. As it stands right now, if the United States were to use a laser system on a satellite in high earth orbit or a geostationary/geosynchronous orbit, it would likely take multiple beams to achieve the desired effects. Multiple beams would increase the chance that an adversary could detect and determine United States intentions with said satellite. Detection then potentially would

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[211] Feickert, "U.S. Army Weapons-Related Directed Energy (DE) Programs: Background and Potential Issues for Congress."

lead to adversary counteractions of equal or greater effects. Therefore, the orbits closer to earth will be a more appropriate venue for laser weapon deterrent efforts.

The optimal scenario is to position these laser weapons within the continental United States, overseas aboard military bases, and in allied nations. Posturing weapons in these different locations would allow for multiple opportunities to engage any orbital objects, whether in response to an adversary action or to set conditions for friendly space operations. By doing so, these lasers provide some risk to adversary capabilities, likely altering any potential courses of action that may result in a major conflict. In that sense, laser weapons would be greatly beneficial to deterrent efforts; however, one cannot simply outweigh the environmental effects that may result. It is a slippery slope that the United States would have to address, and the outcome would be dictated by the desired effects and end state.

c. Jamming

The electronic warfare techniques of uplink and downlink jamming would be the best space weapon capability to implement into a U.S. deterrence strategy. First, these electronic warfare techniques are reversible and do not cause any damage to satellites. Second, because they fall within the electromagnetic spectrum, a variety of frequencies are capable of use. The difficulty in attributing the origin of a signal further enhances the United States ability to deter in land, air, sea, or space domains. The ability to target different segments of a transmission signal gives the United States the ability to impact actions at various levels. For example, the United States can position systems capable of performing electronic warfare techniques in the field of view of an operational satellite. This jamming system could then radiate for an extended period, for testing or demonstration purposes. If an adversary catches on to such actions, it will be less likely to use said satellite for their actions. Depending on the orbit and number of satellites within that orbit, the United States could prevent any adversary actions to upload or download information. Also, given our knowledge about the physics of orbits, the likelihood of additional jamming in the same orbit may force adversaries to change the course of their satellites, potentially implicating the amount of future adversary space operations. While the satellite is moving to a new area, the time for an adversary to take potential action is further extended. The ability to impact actions at different levels of signal transmission across a wide spectrum of frequencies provides the greatest number of opportunities to deter adversaries.

A counterpoint to this recommendation might be that jamming systems are easily attainable, and these systems have the same constraints with respect to a laser system. While it is true that such systems are attainable, when compared to a laser system, jamming systems do not need to be as precise for effects, just within the field of view of the signal they want to interfere with. In addition to the opportunities that will be presented to the United States, jamming is less likely to constrain international relations or cause conflicts. Again, since the effects are reversible in nature, any moment when an adversary raises alarm, the jamming system can be turned off, lowering the escalation level for potential actions.

d. Cyber-Attacks

Cyber-attack capabilities may be best suited to combine with the jamming capabilities. These attacks in conjunction with jamming may impact the psyches of adversaries because they will not be able to determine whether there is a problem with their space systems. Cyber-attacks and jamming would constrain adversaries' ability to take actions. The United States could deny adversaries the ability to conduct actions while simultaneously compromising their capabilities, rendering them useless. The posturing of cyber-attack capabilities along with jamming capabilities would remind adversaries that any action on their part would be met with a dual response. Posturing holds adversary decision-making at risk because a potentially important asset may no longer be usable. Depending on the strategy of the adversary in said conflict, this could be devastating to their objectives. The lack of ability to achieve objectives may force an adversary to go back to the drawing board with their space strategy.

While adversaries would have to reconsolidate and determine the best way forward, the United States could continue evolving its deterrence strategy. Reconsolidation will leave an adversary in a reactive state vice a proactive state, enhancing the United States ability to deter within other domains and outpace adversaries' OODA loops. In a comparable manner to jamming systems, cyber-attack systems, are less likely to impact international relations and create debris in space. If cyber-attack systems target adversary strategic-level assets, there is a risk of escalation and response, but the scale of that cyber operation would require considerable resources and manpower. A cyber-attack of such a scale is likely to feasible in the future, given rapid technological advancements, but exactly when, we do not know.

Electronic warfare techniques present the best approaches to pursue for U.S. deterrence strategy. These techniques are reversible, have no physical effects to space systems, do not produce debris, and are the least likely to raise international tensions or significantly impact the security and stability of space. The posturing of such systems may also be less evident to adversaries when part of a multi-purpose ground station or satellite, making them better suited for continuous deterrence operations. The higher level of difficulty in tracking paths of interference with these systems will further enhance deterrence opportunities for the future. Kinetic weapons and laser weapons are additional areas of approach; however, their long-term effects do not bode well for future international relations or the environment of space.

2. Combined Space Systems

Cooperation will be necessary with future space actors for successful space operations. The security and stability of space and its operations will be a continuous and evolving area of interest for the United States. Given the previous discussion, the best approach for the United States to take in the preservation of space security and deterrence is using multinational space systems. These multinational space systems provide the flexibility to not only the United States, but also to partner nations. Furthermore, an approach that involves the United States using multinational systems meshes well with NATO policy and its approach to cooperation and deterrence. Multinational systems used for SDA is an approach the United States must take for deterrence strategy.

Multinational space operations are nothing new, as evident by Operation Olympic Defender. This operation, however, restricts itself to only a certain sector of space security concern, debris. While this operation is limited, it could be the kickstart that is needed for further space cooperation and integration. The sharing of technology and implementation of said technology into sophisticated satellites could further bolster deterrence opportunities and flexibility. Moreover, the joint ownership of these satellites could be a way to bridge diplomatic and economic sectors amongst nations. Within the economic sector, commercial actors could also play a key role with developments and employment of constellations.

The overall goal with multinational space systems, in this context, is the capabilities they can provide for deterrence in space operations. Cooperation via multinational space systems is a method that the United States and its allies need. Multinational satellite constellations offer one method of deterring adversary actions. However, the cost and development of such satellites may be time consuming. Furthermore, spreading decision making authorities could muddle the already complicated "operations management" side of space activities. This may lead to indecision among the United States and its partners, especially if there is not a consensus on who has the ultimate authority. Perhaps by having NATO act as a coordinator for space operations management, allied nations within NATO and working with the United States could avoid such an issue. This would leave Japan, the Republic of Korea and Australia out of the loop. If the United States decided to pursue such a route with NATO, relationships may be negatively affected with these countries. At the same time, the more parties involved in deciding, the harder the decision may be to achieve. It is also important to remember that the potential for increased orbital debris may be a result with greater congestion in space.

Multinational space systems for SDA are the primary mechanism that the United States and its partners should pursue as a part of deterrence strategy. SDA with multinational systems enhances opportunities for the United States and its partners to increase the transparency of space operations. An increase in transparency will make it harder for adversary countries to play dumb or act as if they are unaware of what is happening. This transparency will increase the accountability that space actors can hold one another to. Accountability will be an integral part of deterring future aggressive or questionable acts in space because a space actor may no longer be able to get away with such action. Coupling transparency with the different configurations of satellite constellations also provides flexibility with deterrence. The focus on SDA could be an overarching catalyst for additional cooperation in the functional areas of ISR, communications, and launch capabilities between the United States and its partners. Combined ISR, communications, and launch capabilities will only help in enhancing flexibility within a deterrence strategy.

The offensive capabilities of combined space systems are a potential approach that should be considered going forward. However, the employment of multinational systems with offensive capabilities is easier said than done. For this to happen, it would take partners coming to a consensus on what offensive capabilities to use. International views on multinational offensive satellites will likely be frowned upon, especially when orbital debris are a likely result of offensive actions. In that regard, discussions on combined offensive space systems are necessary, but should be focused on in terms of an appropriate response to not ruffle international relationships or unknowingly start a space conflict.

3. Norms, Codes of Conduct, and Treaties

Norms, codes of conduct, and treaties will arguably be the most difficult contributions to realize for a deterrence strategy. The definitions for norms, codes of conduct, and treaties inherently require some level of consensus for establishment and implementation. The establishment and implementation will be critical for appropriate levels of deterrence to achieve effects. The differences between space law versus more general international law are a major constraint to the further development of norms, codes of conduct, and treaties.

The U.S. should focus efforts to increase the awareness and transparency of security and safety with space operations. The strong track record of successful space operations by the U.S. could act as a catalyst for a consensus on the appropriate ways to conduct space operations. The U.S. should also look towards the commercial sector to gather what its best practices are. Once commercial best practices are gathered, they may be selling point to the international community and be better received than U.S. military practices. The recent U.S. unilateral ban on direct-ascent ASAT testing, however, provides credibility in support to the U.S. willingness to establish and maintain appropriate behavior with its own space operations. The U.S. military could demonstrate the applicability of these commercial best practices to prove that they may be adopted outside of just the commercial sector. The U.S. military could then spread awareness about these best practices to partners. This would allow the U.S. to further act as an ambassador in the conduct of appropriate behavior during space operations. Possessing an ambassador role could provide increased opportunities to have foreign space actors align with U.S. space strategy across the strategic level. Additionally, greater concerns about safety from foreign space actors could result in greater deterrence opportunities. Norms, codes of conduct, and treaties could become more widespread in legal regimes, which would further bolster deterrence in space operations.

To fully achieve awareness, the U.S. also needs to have greater transparency as a feature of its space operations. The level and quality of information that we can obtain with satellites is something that should be shared to our partners. When information is shared to our partners, it shows that the United States is serious about security and safety of space operations. An increase in the level of our credibility could go a long way, as other partners may then look to the United States for advice or guidance with their space operations, which would allow us to shape their way of thinking and behaviors. If we can influence their way of thinking and behaviors in space by being transparent, then discussions on norms and legal matters would surely follow at some point. An even better potential result is that the flow of information among partners is continuous, and that the information gives a bigger picture to the conduct of space operations. A bigger picture could mean more information on adversary actions, minimizing covert space operations resulting in more opportunities to deter an adversary.

For the U.S. to increase the level of awareness and transparency with security and safety with space operations, there is inherent risk. Risk is something that the military discusses frequently in every facet of operations. The space domain presents a lot of unknowns but, given historical and legal outcomes from previous conflicts and events, it is imperative that the United States and its partners take risks to be leaders before space becomes unusable.

B. FUTURE AREAS OF RESEARCH

The research conducted in this thesis opens the door to different areas of future research on military deterrence in space operations. One area where further research could be conducted is looking for specific locations and types of electronic warfare systems to employ. This thesis focused on the types of space weapons that would be best to implement as a part of deterrence strategy, so researching appropriate locations and types of electronic warfare systems to implement could be a useful next step. The establishment of rules of engagement within space operations could provide some direction on where, what, when, and why to employ the various set of space weapons. A better direction on how to employ these capabilities in accordance with a rules of engagement framework could aid in maintaining the security and safety of space.

Another area of future research could focus on multinational systems. This thesis gives a broad analysis on how multinational systems could be configured in a constellation and the effectiveness of that constellation towards deterrence. Future research may want to investigate different partners that could make multinational systems a reality. A researcher could also investigate different partners' space capabilities, on a technical scale, and recommend the best components that would work for multinational systems. An investigation could take a different approach and pursue this topic of multinational systems from the commercial sector over the military and see how commercial multinational systems compare to those of the military regarding deterrence.

Future areas of research surrounding norms, codes of conduct, and treaties could focus on specific ways that the U.S. could increase awareness and safety with space operations. Perhaps one area to look at would be the type of information that should be shared, and the pros and cons of sharing that information across both military and commercial sectors. Another area of analysis could be the types of demonstrations or activities the U.S. could take to initiate norms, codes of conduct, and treaty discussions. An investigation could also analyze the troubles that may result in the future if a general framework for space operations continues to remain absent.

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