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THESIS

**CAN THE OUTER SPACE TREATY PREVENT
CONFLICTS IN ORBIT IN THE 21ST CENTURY?**

by

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June 2018

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**CAN THE OUTER SPACE TREATY PREVENT CONFLICTS IN ORBIT IN THE
21ST CENTURY?**

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ABSTRACT

The rapid increase of space activity in the 21st century has raised questions about the adequacy of the 1967 Outer Space Treaty (OST) to govern orbital activities and prevent future international conflicts. This thesis analyzes the OST's ability to address critical emerging problems across three issue areas: orbital space debris, the weaponization of space, and asteroid and Moon mining. It concludes by arguing that the language within the OST does not adequately address these emerging problems, which could lead to possible conflicts in each of these issue-areas. This thesis offers several possible policy recommendations for consideration by U.S. decision makers to promote a future framework of stability and longevity in the use of space: 1) transfer responsibility for tracking non-military satellites and space debris in low earth orbit (LEO) from the military to commercial space companies; 2) review the current 25-year guideline for de-orbiting satellites for adequacy; 3) propose a moratorium to China and Russia on further anti-satellite weapons (ASAT) testing; 4) prohibit nefarious behavior in space, rather than trying to prohibit dual-use technologies; 5) initiate talks with Russia and China to reevaluate and discuss the Moon Treaty; and 6) reach out to interested State Parties in the OST to coordinate future space mining legislation.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABM	Anti-Ballistic Missile
ACSC	Air Force Air Command and Staff College
AIDA	Asteroid Impact and Deflection Assessment
AIM	Asteroid Impact Mission
ARM	Asteroid Redirect Mission
ASAT	Anti-Satellite Weapon
ASEAN	Association of Southeast Asian Nations
ASRA	American Space Renaissance Act
BLITS	Ball Lens in The Space
CD	Conference of Disarmament
COPUOS	Committee on Peaceful Uses of Outer Space
CSIS	Center for Strategic and International Studies
DSC	Defensive Space Control
DSI	Deep Space Industries
DoD	Department of Defense
EMP	Electromagnetic Pulse
ESA	European Space Agency
EU	European Union
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
GA	General Assembly
GPS	Global Positioning System
IADC	Inter-Agency Space Debris Coordination Committee
ICBM	Intercontinental Ballistic Missile
IHLS	Israeli Homeland Security
IPIE	Institute for Precision Instrument Engineering
ISS	International Space Station
JSpOC	Joint Space Operations Center
LEO	Low Earth Orbit
LTS	Long-term Sustainability

MHV	Miniature Home Vehicle
NASA	National Aeronautics and Space Administration
NEA	Near-Earth Asteroid
NMD	National Missile Defense System
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Aerospace Defense
NSDC	National Space Defense Center
OSC	Offensive Space Control
OSIRIS-REx	Origins, Spectral Interpretation, Resource Identification, Security, and Regolith Explorer
OST	Outer Space Treaty
PAROS	Prevention of an armed race in outer space
PDSA	Principal Department of Defense space adviser
PPWT	Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects
PTBT	Partial (or Limited) Test Ban Treaty
SAFE	Securing America's Future Energy
SALT	Strategic Arms Limitation Talks
SATCOM	Satellite Communications
SDI	Strategic Defense Initiative
SPACE Act	Spurring Private Aerospace Competitiveness and Entrepreneurship
SSA	Space Situational Awareness
TMD	Theater Missile Defense
UAE	United Arab Emirates
UN	United Nations
USSR	Union of Soviet Socialist Republics
WMD	Weapons of Mass Destruction

EXECUTIVE SUMMARY

The 1967 Outer Space Treaty (OST) is the “constitution of outer space”¹ for 105 countries across the world.² With the advance of technology and the continuance of activities in space, the question arises as to whether the language within the OST designed to address international needs of the 1960s can sufficiently govern a domain that has undergone significant transformation due to advances in technology and expanding national interests in the 21st century. In this context, the OST needs to be examined and reevaluated to address its ability to handle emerging problems caused by several recent developments: the significant growth of orbital space debris, the possibility of the weaponization of space, and the potential for asteroid and Moon mining. Each of these issues poses potential conflicts well outside the existing tenets of the OST. The question this thesis evaluates is: can the Outer Space Treaty prevent conflicts in orbit in the 21st century?

Three case studies were selected, which represent some of the critical current and emerging concerns in the 21st century. The case studies are: space debris, weaponization of space, and asteroid and Moon mining. The language within the OST does not directly address a range of emerging problems which could lead to possible conflicts in each of these issue-areas. The first case study presents the hypothesis: if the current amount of space debris continues to expand, endangering space-based assets, it is likely there will be conjunctions that could cause international conflicts in the foreseeable future that the OST cannot prevent. The second case study presents the hypothesis: if countries continue to go forward weaponizing space without further legal agreements, the current OST will not be able to adequately prevent conflict. If space-faring nations begin to weaponize space or use space weapons against adversaries without new international legal agreements, it could create political instability and wars in space and on Earth, putting millions of people in danger. The third case study presents the hypothesis: if the current technological advances in both the commercial and military sectors regarding asteroid and Moon mining continue to move

¹ Jill Stuart, “The Outer Space Treaty Has Been Successful – But Is it Fit for the Modern Age?,” Space.com, February 19, 2017, <https://www.space.com/35758-outer-space-treaty-success-modern-assessment.html>.

² Ibid.

forward without further legal agreements, the OST as it stands will not be able to prevent conflict. The analysis of the OST's capability to aid in the challenges posed by the 21st century concerns determined that even though certain articles could cover these identified issues, they are not specific enough to address all the possible scenarios that could in theory occur in space.

Analysis of the OST indicates that the terms are insufficient to address the emerging concerns of the 21st century. Policy recommendations for each case study provide short-term recommendations, with the hope that in the long term, the future of space activities will find a global solution because “any considerable effort to close the existing gaps in international space law must include measures to build confidence and transparency among states.”³ For space debris, two policy recommendations were offered: first, the United States could begin transferring the responsibility of tracking non-military space debris in low earth orbit (LEO) from the military to commercial space companies; second, the United States should support a review of the current 25-year guideline for de-orbiting satellites to determine if more rapid de-orbiting is required for certain types of satellites. For weaponization of space, the policy recommendations focus on the United States providing positive solutions rather than just criticism (i.e., to propose new concepts to strengthen existing proposals and/or to offer new regulations aimed at the prevention of weaponization). Space mining most likely will not be realized until 2030.⁴ With that in mind, the United States might be well served to get ahead of the process and instigate talks with Russia and China to re-evaluate and discuss the Moon Treaty. In the short term, these countries could adopt certain principles from the treaty to help establish initial norms for mining. Additionally, the United States should reach out to State Parties in the OST and begin initiating discussions, recommending that interested countries enact mirroring commercial space mining legislation, in order to promote the development of best practices. Currently, without further legal agreements to elaborate on these identified concerns the OST as it stands will not be able to adequately prevent conflict in the future. Therefore, the time for creative approaches and positive U.S. engagement is now.

³ Nayef Al-Rodhan, “Preventing Future Conflicts in Outer Space,” The CSS Blog Network, March 14, 2018, <https://isnblog.ethz.ch/security/preventing-future-conflicts-in-outer-space>.

⁴ Charles Kieck, as quoted in Lynsey Chutel, “NASA’s latest mission will show if asteroid mining will be a real threat to the global platinum industry,” QUARTZ: Africa, September 9, 2016, <https://qz.com/776894/nasas-latest-mission-will-be-a-real-threat-to-the-global-platinum-industry/>.

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I. INTRODUCTION TO THE OUTER SPACE TREATY

A. INTRODUCTION

For more than 50 years, “international treaties and agreements, which have been in place have established the foundations for the exploration and use of outer space.”⁵ On January 27, 2017, one of the most important space treaties celebrated its 50th anniversary—”The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.”⁶ This treaty which we refer to by its nickname—the Outer Space Treaty (OST)—⁷ signed in 1967, was agreed upon among members of the United Nations, and today it currently “remains the constitution of outer space for 105 countries across the world.”⁸ The treaty has worked thus far, but the challenges that the 21st century presents could create future conflict in space. Is the OST adequate as it stands for conflict prevention in the 21st century? This thesis analyzes the OST and evaluates its future ability to prevent conflict in areas such as space debris, asteroid and Moon mining, and the weaponization of space. For over 50 years, the treaty has represented the foundation for how countries should act in space and ensured explorations remain peaceful, but it may not be able to handle the future issues, problems, or threats to space.⁹

Henry Hertzfeld, a research professor of space policy and international affairs at George Washington University, explains that “the OST is only seventeen articles in length; by comparison, the Law of the Sea Treaty spans hundreds of articles.”¹⁰ Therefore, he

⁵ Jill Stuart, “The Outer Space Treaty Has Been Successful – But Is it Fit for the Modern Age?,” Space.com, February 19, 2017, <https://www.space.com/35758-outer-space-treaty-success-modern-assessment.html>.

⁶ Ibid.

⁷ Ibid.

⁸ Ibid.

⁹ Loren Grush, “How an International Treaty Signed 50 Years Ago Became The Backbone For Space Law,” The Verge, January 27, 2017, <https://www.theverge.com/2017/1/27/14398492/outer-space-treaty-50-anniversary-exploration-guidelines>.

¹⁰ Henry Hertzfeld, as quoted in Ibid.

believes it is likely that the OST cannot address every issue or concern.¹¹ The OST was established when space technology was still in the development phase and the race to space involved only two nations, the United States and Soviet Union Russia.¹² Today, as discussed by U.S. representative Jim Bridenstine, the majority of nations on Earth depend on the services their space assets provide to both their military and commercial sectors; but this reliance comes with risks.¹³ Recently, the International Astronautical Congress 2017 addressed the increased presence in space and the need for global governance of space activities. It discussed:

as more actors, including states, intergovernmental and non-governmental entities, as well as industry and private sector, increasingly engage in space activities, there will be an increasing need to protect the space environment and enhance the safety of space operations, the security of space assets, space systems and critical infrastructures, and the sustainability of outer space activities.¹⁴

Although much has changed in 50 years, the treaty is still used when discussing additional space legislation.¹⁵ This thesis evaluates current concerns we are facing in the 21st century and, if necessary, propose policies to address the gaps that may not be covered by the OST to prevent future conflict.

¹¹ Ibid.

¹² Grush, “How an International Treaty Signed 50 Years Ago Became The Backbone For Space Law.”

¹³ Jim Bridenstine, as cited in Krause, “The Outer Space Treaty Turns 50. Can It Survive a New Space Race?,” *ABA Journal*, (April 2017): http://www.abajournal.com/magazine/article/outer_space_treaty; article originally appeared in the April 2017 issue of ABA Journal with headline: “Rocket Law.”

¹⁴ General Conference Overview, “The 50th Anniversary of the Outer Space Treaty: Global Governance for Space Activities.” International Astronautical Federation, September 27, 2017, accessed November 22, 2017, <http://www.iafastro.org/events/iac/iac-2017/global-networking-forum/the-50th-anniversary-of-the-outer-space-treaty-global-governance-for-space-activities/>.

¹⁵ Grush, “How an International Treaty Signed 50 Years Ago Became The Backbone For Space Law.”

B. SIGNIFICANCE OF OST ANALYSIS IN THE 21ST CENTURY

While the principles within the OST are extremely important “to the peaceful use of outer space,”¹⁶ significant issues could potentially cause conflict in the 21st century.¹⁷ As the world continues to technologically advance in and embrace space,¹⁸ the OST needs to be examined and reevaluated to address the pace and development of the weaponization of space, the significant growth of space debris, and the potential for asteroid and Moon mining. Each of these issues pose potential conflicts well outside the existing tenets of the OST. We do not want a war in space; therefore, these research questions on the evaluation of the OST are essential to prevent these issues from resulting in future struggles.

The 50-year span since the creation of the OST is significant. The OST represented a momentous accomplishment for space law.¹⁹ It was responsible for laying down “the foundations for international regulation of space and established the framework of the present legal regime for outer space and the celestial bodies.”²⁰ For 50 years, the treaty has helped prevent major conflict from occurring in outer space. But can the treaty continue to prevent conflict as new 21st century threats emerge? First, to analyze the significance of the OST, it is important to discuss the history and reasons behind the formation of the OST.

C. HISTORY OF THE OUTER SPACE TREATY

Immediately following World War II, the Cold War began in 1945, and between the years of 1957–58, both the United States and the Soviet Union had acquired a sizable stockpile of “hydrogen bombs of unbelievable destructive power.”²¹ At the same time,

¹⁶ Duncan Blake and Steven Freeland, “As the World Embraces Space, the 50-year-old Outer Space Treaty Needs Adaptation,” Space.com, July 17, 2017, <https://www.space.com/37500-outer-space-treaty-needs-adaptation.html>.

¹⁷ Ibid.

¹⁸ Ibid.

¹⁹ Vladimir Kopal, “Introductory Note: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies,” United Nations Audiovisual Library of International Law, December 19, 1966, accessed November 22, 2017, <http://legal.un.org/avl/ha/tos/tos.html>.

²⁰ Ibid.

²¹ Helen Caldicott and Craig R. Eisendrath. *War in Heaven: The Arms Race in Outer Space* (New York: The New Press, 2007), xi.

both nations were racing to develop intercontinental ballistic missiles (ICBM), which “were designed to exit the earth’s atmosphere before raining death and destruction down”²² on selected targets.²³ This marked “the first instance of the use of outer space for military purposes and, once this threshold had been crossed, military planners realized space itself could be weaponized.”²⁴ While the military had been dreaming about future wars in space, others were imagining the many ways by which space could benefit and provide for humanity in the future.²⁵ Outer space was an exciting new frontier, and many felt it should be preserved and utilized to benefit the entire human species.²⁶ But, due to Cold War political rivalry, a race to space had begun between the United States and the Soviet Union.

In October 1957, the Soviet Union launched *Sputnik*, the first orbiting spacecraft.²⁷ On January 31, 1958, at the National Press Club, Chief of Staff of the Air Force Thomas Dresser White discussed a new space policy in response to *Sputnik*, arguing that the Soviet Union had one-upped the United States and that our homeland was in danger.²⁸ The United States answered the Soviet Union with *Explorer I*, which put the United States back into the space race.²⁹ Shortly after, White discovered that the capability to possess total control on the ground was equivalent to the ability to control space.³⁰ Therefore, the need to formalize an international legal agreement for space was paramount.

According to Vladimir Kopal, professor of International Law at West Bohemian University, “the creation of a special regime for outer space and the celestial bodies was

²² Ibid., xi-xii.

²³ Ibid.

²⁴ Ibid., xii.

²⁵ Ibid., xiii.

²⁶ Ibid.

²⁷ Henry R. Hertzfeld, “Developing Issues in the Law of Outer Space,” *Penn Undergraduate Law Journal* 3, no. 1 (Fall 2015): 1–15, <https://spi.elliott.gwu.edu/sites/g/files/zaxdzs2251/f/downloads/Articles/Hertzfeld%20Developing%20Issues%20in%20the%20Law%20of%20Outer%20Space.pdf>, 2.

²⁸ Chief of Staff of the Air Force Thomas Dresser White, as quoted in Caldicott and Eisendrath, *War in Heaven*, 3.

²⁹ Caldicott and Eisendrath, *War in Heaven*, 4.

³⁰ Chief of Staff of the Air Force Thomas Dresser White, as quoted by in Ibid.

necessitated by the commencement of space activities and the rapid development of rocket technology.”³¹ As Hertzfeld writes, “under the auspices of the United Nations in 1959, 18 nations formed the Committee on Peaceful Uses of Outer Space (COPUOS) beginning the process of negotiations that led to a set of space treaties.”³² COPUOS understood that its role would be to develop with the international community a treaty for the use of outer space.³³ Human activity in outer space was a new arena and it was essential any international agreements would have to be adopted and implemented by consensus.³⁴ COPUOS began this discussion by utilizing the framework provided by the Antarctic Treaty and adapting it for regulation of space activities.³⁵

1. Antarctic Treaty—Precursor to the OST

In 1959, “COPUOS was tasked to develop specific proposals concerning the development of international cooperation, conduct in outer space, and space exploration for peaceful purposes.”³⁶ Prior to 1960, a substantial amount of discussions had occurred addressing the conduct in outer space.³⁷ One of the major questions was whether a nation could claim sovereignty over celestial bodies in space.³⁸ An additional concern questioned whether existing laws could support such claims as legal.³⁹ The United Nations “suggested that some form of international administration over celestial bodies should be adopted.”⁴⁰

³¹ Kopal, “Introductory Note.”

³² Hertzfeld, “Developing Issues in the Law of Outer Space,” 2.

³³ Kopal, “Introductory Note.”

³⁴ Ibid.

³⁵ Ibid.

³⁶ Ibid.

³⁷ Paul G. Dembling and Daniel M. Arons, “The Evolution of the Outer Space Treaty,” *The Journal of Air Law and Commerce* 33, no. 3 (1967): 419–456, <http://libproxy.nps.edu/login?url=https://search.proquest.com/libproxy.nps.edu/docview/1296599846?accountid=12702>. 420.

³⁸ Ibid.

³⁹ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 421; Lipson and Katzenbach, *Report to the National Aeronautics and Space Administration on the Law of Outer Space*, A.B.A. FOUND. 22(a) (1960).

⁴⁰ Ibid., 420–421.

Shortly after the UN suggestion, on September 22, 1960, President Eisenhower proposed guidelines regarding sovereignty in space.⁴¹ President Eisenhower said:

Side by side with these startling changes, technology is also in revolution. It has brought forth terrifying weapons of destruction, which for the future of civilization, must be brought under control through a workable system of disarmament. And it has also opened up a new world of outer space--a celestial world filled with both bewildering problems and dazzling promise.⁴²

In his speech, President Eisenhower continued to address the issues confronting the United States in outer space. He made it clear that it was our choice to make whether this would become the focus for another arms race or international cooperation to maintain space for peaceful purposes.⁴³ He stated:

the nations of the world have recently united in declaring the continent of Antarctica “off limits” to military preparations. We could extend this principle to an even more important sphere. National vested interests have not yet been developed in space or in celestial bodies. We must not lose the chance to control the future of outer space.⁴⁴

Twelve countries that had been active in and around Antarctica during the years 1957–58 signed the Antarctic Treaty in Washington on December 1, 1959.⁴⁵ It “entered into force on June 23, 1961.”⁴⁶ The treaty laid binding regulations and guidelines for the international community regarding scientific exploration in Antarctica.⁴⁷ Some of the principles of the treaty included the following: “it demilitarized the Antarctic continent, provided for its cooperative exploration and future use, and served as a model for later non-

⁴¹ Ibid.

⁴² “Dwight D. Eisenhower: Address Before the 15th General Assembly of the United Nations, New York City – September 22, 1960,” The American Presidency Project, September 22, 1960, accessed November 22, 2017, <http://www.presidency.ucsb.edu/ws/?pid=11954>.

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ “Narrative of the “Antarctic Treaty,”” U.S. Department of State, Signed at Washington December 1, 1959, Entered into force June 23, 1961, accessed November 22, 2017, <https://www.state.gov/t/avc/trty/193967.htm>.

⁴⁶ Ibid.

⁴⁷ Ibid.

armament treaties such as the exclusion of weapons of mass destruction from outer space.”⁴⁸ The acceleration of space activities and development, combined with the political tensions and pressures, created momentum to create a demilitarized zone in space. At this time, COPUOS was the principal organization dedicated to bringing about recommendations on cooperative space programs and initiatives.⁴⁹

The Antarctic Treaty and the guidelines proposed by President Eisenhower played a significant role in shaping the OST. Specifically, the similarities in the Antarctic and the OST include the concepts of peaceful purposes, freedom to pursue scientific research and investigations, and prohibiting nations from making additional claims of sovereignty.⁵⁰ President Eisenhower proposed four agreements that would enable future generations to peacefully and scientifically explore space without fear of an arms race.⁵¹ These agreements were:

We agree that celestial bodies are not subject to national appropriation by any claims of sovereignty; we agree that the nations of the world shall not engage in warlike activities on these bodies; we agree, subject to appropriate verification, that no nation will put into orbit or station in outer space weapons of mass destruction. All launchings of space craft should be verified in advance by the United Nations; we press forward with a program of international cooperation for constructive peaceful uses of outer space under the United Nations. Better weather forecasting, improved world-wide communications, and more effective exploration not only of outer space but of our own earth - these are but a few of the benefits of such cooperation.⁵²

After President Eisenhower proposed his space guidelines, COPUOS finally regrouped as it had not met for several years due to a Soviet protest regarding membership and voting.⁵³ COPUOS met in November-December 1961, discussed the President’s proposals, and

⁴⁸ Ibid.

⁴⁹ Kopal, “Introductory Note.”

⁵⁰ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 423.

⁵¹ The American Presidency Project, “Dwight D. Eisenhower.”

⁵² Ibid.

⁵³ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 424.

adopted the principles regarding international law.⁵⁴ COPUOS, to the UN, “proposed that international law be applied to outer space and celestial bodies.”⁵⁵ It further suggested that states could explore and use space only as long as such exploration conformed to international law and excluded national appropriation.⁵⁶ The Antarctic treaty and proposals made by President Eisenhower were the starting point for proposed space regulations, but additional treaties were used as well in the later creation of the OST.

2. First Draft of Outer Space Treaty

In the spring of 1962, the Union of Soviet Socialist Republics submitted to the Legal Subcommittee “a draft Declaration of the Basic Principles Governing the Activities of States Pertaining to the Exploration and Use of Outer Space.”⁵⁷ Initially, numerous member States of COPUOS did not support it, but “the idea gained ground, and in 1963, the Declaration (UN General Assembly Resolution 1962) was successfully negotiated”⁵⁸ and unanimously adopted at the United Nations on December 13, 1963.⁵⁹ This “declaration included a set of general principles which characterized the legal status of outer space and celestial bodies and outlined the scope of legality for activities of States in the space environment.”⁶⁰

3. Additional Treaties/Resolutions used in Creation of the Outer Space Treaty

The OST also later incorporated precedents from the Limited Nuclear Test Ban Treaty (August 5, 1963).⁶¹ It “prohibited the testing of nuclear weapons in outer space,

⁵⁴ Ibid.

⁵⁵ Ibid.

⁵⁶ Ibid.

⁵⁷ Kopal, “Introductory Note.”

⁵⁸ Ibid.

⁵⁹ Ibid.

⁶⁰ Ibid.

⁶¹ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 423.

underwater, or in the atmosphere.”⁶² The Limited Nuclear Test Ban Treaty, a product of the Cold War, addressed the concerns regarding the harmful environmental/health effects of nuclear testing and helped to deter a potential nuclear war between the United States and the Soviet Union.⁶³ President John F. Kennedy was determined to put an end to the testing of nuclear weapons and staunchly supported the treaty.⁶⁴ President Kennedy felt his support for this treaty would prevent nuclear weapons from being obtained by other countries in the future.⁶⁵ President Kennedy played a significant role in gaining support for the treaty by convincing fearful American citizens and a weary Senate to agree to the terms set forth.⁶⁶ In the fall, UN Resolution 1884, adopted by the General Assembly on October 17, 1963, “called for a ban on orbiting any weapons of mass destruction in space,”⁶⁷ passed the United Nations.⁶⁸

In 1964 and 1965, the primary concerns included “assistance to and return of astronauts and space objects”⁶⁹ as well as “liability for damages caused by space vehicles.”⁷⁰ Additionally, COPUOS and its Legal Subcommittees continued to further their guidelines governing Moon exploration activities.⁷¹ The international community felt a sense of urgency as the race between the United States and the Soviet Union continued to the Moon.⁷² This urgency called “for an international agreement on the exploration of

⁶² Ibid., 432.

⁶³ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 424.

⁶⁴ “Nuclear Test Ban Treaty,” John F. Kennedy Presidential Library and Museum, accessed January 9, 2018, <https://www.jfklibrary.org/JFK/JFK-in-History/Nuclear-Test-Ban-Treaty.aspx>.

⁶⁵ Ibid.

⁶⁶ Ibid.

⁶⁷ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 433; A/RES/18/1884 (XVIII), United Nations 18th Session (1963), accessed January 25, 2017, <http://www.un-documents.net/a18r1884.htm>.

⁶⁸ Ibid.

⁶⁹ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 425.

⁷⁰ Ibid.

⁷¹ Ibid.

⁷² Ibid.

the Moon and other celestial bodies”⁷³ and was reiterated by President Lyndon B. Johnson on May 7, 1966.⁷⁴ President Johnson emphasized the importance of space to the future of mankind and the need for international law to be created in support of exploration for peaceful purposes and scientific investigations.⁷⁵ President Johnson proposed a few principles to be considered in an international agreement. The agreements proposed were as follows:

The moon and other celestial bodies should be free for exploration and use by all countries. No country should be permitted to advance a claim of sovereignty; There should be freedom of scientific investigation, and all countries should cooperate in scientific activities relating to celestial bodies; Studies should be made to avoid harmful contamination. Astronauts of one country should give any necessary help to astronauts of another country; No country should be permitted to station weapons of mass destruction on a celestial body. Weapons tests and military maneuvers should be forbidden.⁷⁶

President Johnson wanted to ensure that the United States acted quickly regarding the use of space “not only for his generation, but for future generations”⁷⁷ to prevent political and military conflicts from arising because of space activities.⁷⁸

4. Finalization of the Outer Space Treaty

In 1966, U.S. Ambassador to the United Nations Arthur J. Goldberg wrote a letter to Dr. Kurt Waldheim of Austria, the Chairman of the COPUOS, requesting the Legal Subcommittee to consider meeting earlier to address the principles proposed by President Johnson for consideration as an international treaty.⁷⁹ The committee met on the July 12,

⁷³ Ibid.

⁷⁴ Ibid.

⁷⁵ President Lyndon B. Johnson, as quoted in Ibid., 425–426.

⁷⁶ “Lyndon B. Johnson: Statement by the President on the Need for a Treaty Governing Exploration of Celestial Bodies – May 7, 1966,” The American Presidency Project, May 7, 1966, accessed November 22, 2017, <http://www.presidency.ucsb.edu/ws/?pid=27581>.

⁷⁷ Ibid.

⁷⁸ Ibid.

⁷⁹ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 426.

1966, and began discussions on the principles that would make up the OST.⁸⁰ The committee utilized the current situation and conflicts to help mold the “Treaty on Principles Governing the Activities of States in the Exploration and use of Outer Space including the Moon and Other Celestial Bodies.”⁸¹ Additionally, the treaty included rhetoric from proposals made by President Eisenhower, President Kennedy, and President Johnson, as well as previous treaties and resolutions. On December 8, 1966, “an agreement had been achieved among the members of twenty-eight-nation United Nations Outer Space Committee on a treaty that would establish principles governing the activities of states in the exploration and use of outer space, the Moon, and other celestial bodies.”⁸² Of note, the OST repeated the 1963 UN space resolutions with additional language added to cover the activities regarding the Moon. The United Nations General Assembly finally approved the Treaty on December 19, 1966 and opened for signatures on January 27, 1967.⁸³

5. Post Outer Space Treaty Era

After the ratification of the OST, President Johnson cautioned that “in diplomacy of space and as technology increases, it is essential to note that interim achievements not be mistaken for final success.”⁸⁴ Despite the treaty’s approval, the principles were generic and subject to interpretation.⁸⁵ Additionally, President Johnson advised policymakers to remember that this “treaty is a first step, but a long step toward assuring the peace essential for the longer journey.”⁸⁶ 50 years later, we must look at the first steps taken and apply them to the issues in the 21st century that are causing contention and begin to address the second step toward the continuing assurance of peace in space.

⁸⁰ Ibid., 427.

⁸¹ Ibid., 427.

⁸² Ibid., 419.

⁸³ Ibid., 455.

⁸⁴ President Lyndon B. Johnson, as quoted in Ibid., 455–456.

⁸⁵ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 456.

⁸⁶ President Lyndon B. Johnson, as quoted by Ibid.

6. Additional Space Policy, Legislation, and Treaties since the Outer Space Treaty

The OST was the first big step in the defining the legal status of outer space.

The OST was followed by the 1968 Agreement on the Rescue of Astronauts, the 1972 Convention on International Liability for Damage Caused by Space Objects, the 1975 Convention on Registration of Objects Launched into Outer Space, and the 1979 Agreement Governing the Activities on the Moon and Other Celestial Bodies.⁸⁷

The 1979 Moon Agreement (also known as the Moon Treaty) has not been ratified by any major space-faring powers and therefore, is now considered latent.⁸⁸ In addition, non-binding guidelines and resolutions for the international community were proposed and adopted by the General Assembly.⁸⁹ These included:

the 1982 Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting, the 1986 Principles Relating to Remote Sensing of the Earth from Outer Space, the 1992 Principles Relevant to the Use of Nuclear Power Sources In Outer Space, and the 1996 Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries.⁹⁰

More recently, on November 25, 2015, H.R.2262—U.S Commercial Space Launch Competitiveness Act or Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE Act of 2015) became public law.⁹¹ It was introduced on May 12, 2015 by Representative Kevin McCarthy (Rep-California).⁹² The primary goal of H.R.2262 is to

⁸⁷ Matthew J. Kleiman, “Space Law 101: An Introduction to Space Law,” Young Lawyers Division: American Bar Association,” https://www.americanbar.org/groups/young_lawyers/publications/the_101_201_practice_series/space_law_101_an_introduction_to_space_law.html.

⁸⁸ Kleiman, “Space Law 101: An Introduction to Space Law,” Young Lawyers Division: American Bar Association.”

⁸⁹ Ibid.

⁹⁰ Ibid.

⁹¹ H.R.2262 – U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114–90, 114th Congress (2015-2016), <https://www.congress.gov/bill/114th-congress/house-bill/2262/text>.

⁹² Ibid.

promote continued growth within the commercial space environment.⁹³ Additionally, the “American Space Renaissance Act,”⁹⁴ was introduced to the House by Representative Jim Bridenstine (Rep-Oklahoma) on April 14, 2016, and on September 30, 2016, it was referred to the Subcommittee on Space.⁹⁵ Within the provisions of this act, the President is directed to develop:

a doctrine for the Armed Forces and the intelligence community governing the U.S. response to efforts by state and non-state actors deliberately to deny the United States or its allies or partners access to space or space operations or degrade or destroy any of their government or commercial space assets; and a doctrine for the Armed Forces with respect to the rules of engagement for space forces.⁹⁶

Additionally, this bill requires that the DoD appoint a qualified official to become the Principal Department of Defense Space Advisor (PDSA) to the President on any and all matters regarding space activities.⁹⁷ But, in December of 2017, President Donald Trump signed the “2018 defense authorization bill,”⁹⁸ which officially terminated the position of PDSA.⁹⁹

7. Emerging Concerns

In regards to international space law, the OST, represents one of the most significant treaties developed and adopted by the United Nations.¹⁰⁰ But space is becoming a big business for the private and commercial sectors which are placing new pressures on

⁹³ Summary Text of H.R.2262, as quoted in Ibid.

⁹⁴ H.R.4945 – American Space Renaissance Act, Referred to Subcommittee on Space 30 September, 2016, 114th Congress (2015-2016), <https://www.congress.gov/bill/114th-congress/house-bill/4945>.

⁹⁵ Ibid.

⁹⁶ Summary Text of H.R.4945, as quoted in Ibid.

⁹⁷ Ibid.

⁹⁸ Valerie Insinna, “The Pentagon no longer has a leader on space programs. What does that mean?,” DefenseNews, January 18, 2018, <https://www.defensenews.com/space/2018/01/18/the-pentagon-no-longer-has-a-leader-on-space-programs-what-does-that-mean/>.

⁹⁹ Ibid.

¹⁰⁰ Kopal, “Introductory Note.”

the laws and regulations of outer space.¹⁰¹ Space activity is still largely driven by national space agencies and military agencies, but private interests in space are rapidly increasing.¹⁰² According to Krause, “nearly 50 years after the U.S. beat the USSR to land the first humans on the Moon, a new 21st century space race is underway.”¹⁰³ Can the Outer Space Treaty stand up to the challenges presented in this new race to space? This thesis evaluates the significance of the OST and whether it can adequately handle the current 21st century conflicts. The concerns faced during the creation of the OST do not necessarily mirror the issues of the 21st century. The research questions proposed in this thesis address three current 21st century issues and evaluate whether the OST is still able to prevent conflict in space.

D. LITERATURE REVIEW

Given the recent anniversary of the OST, an increased amount of information has been published regarding the adequacy of the treaty. The OST has been subject to debate by various scholars regarding its successes, failures, gaps/limitations, and the benefits of either amending the treaty or enacting new laws/agreements. Additionally, research has identified recommendations and policies to address the gaps in space law, specifically the OST. This literature review assesses those perspectives to lay out the background information necessary to address the research question. This literature review will incorporate different perspectives regarding the OST. These sources will address the viewpoints on whether to amend the treaty, enact new laws/agreements, or do nothing, as well as highlight some of the gaps/limitations in the OST.

First, it is important to address the literature that completely supports the OST to further guide space activities. Supporters argue the OST, just like the U.S. Constitution, is rooted with basic values that are fundamental and applicable in any age.¹⁰⁴ An example

¹⁰¹ Jason Krause, “The Outer Space Treaty turns 50. Can it survive a new space race?,” *ABA Journal* 103, no. 4 (April 2017), http://www.abajournal.com/magazine/article/outer_space_treaty.

¹⁰² Ibid.

¹⁰³ Ibid.

¹⁰⁴ Ibid.

provided by Joanne Gabrynowicz, professor emerita at the University of Mississippi School of Law and editor-in-chief emerita of the *Journal of Space Law*, states “the OST proposed that space should be used for peaceful purposes; that’s the principle. It’s no less ambiguous than due process or other fundamental principles.”¹⁰⁵ Other support for leaving the treaty as it is has come from the results of May 23, 2017, hearing of the Senate Commerce Committee’s space subcommittee. During this hearing, an examination of the OST was conducted to see if it should be updated.¹⁰⁶ Those in support of an update felt the OST did not sufficiently regulate the commercial space sector activities nor would it suffice against future conflicts that may emerge.¹⁰⁷ However, others argued “that although the treaty is not ‘self-executing’—that is, its provisions are not binding without federal laws to implement them—any regulatory gaps could be addressed without changing the treaty itself.”¹⁰⁸ Even the co-director of space, cyber, and telecommunications law program at the University of Nebraska College of Law, Matthew Schaefer, concurred with the previous statement, discussing the advantages the OST provides to commercial U.S. companies due to the “minimally burdensome”¹⁰⁹ provisions, allowing for multiple interpretations.¹¹⁰ Additionally, Bob Richards, chief executive of Moon Express, expressed his opinion of the OST in response to the hearing. He stated,

while the Outer Space Treaty may appear antiquated, in some ways it is a remarkably visionary document with profound principles that have served the world for decades and our time and energy are better spent continuing to interpret the Outer Space Treaty in favor of international collaboration without constraining the rights, benefits, and the freedoms of U.S. commercial enterprise.¹¹¹

¹⁰⁵ Joanne Gabrynowicz, as quoted in Ibid.

¹⁰⁶ Jeff Foust, “Companies, lawyers argue against changing Outer Space Treaty,” Spacenews.com, May 26, 2017, <http://spacenews.com/companies-lawyers-argue-against-changing-outer-space-treaty/>.

¹⁰⁷ Ibid.

¹⁰⁸ Witnesses at May 23 hearing of the Senate Commerce Committee, as quoted by in Ibid.

¹⁰⁹ Matthew Schaefer, as quoted in Foust, “Companies, lawyers argue against changing Outer Space Treaty.”

¹¹⁰ Ibid.

¹¹¹ Bob Richards, as quoted in Foust, “Companies, lawyers argue against changing Outer Space Treaty.”

The current debate in the U.S. Congress is whether the United States should amend, enact new laws/agreements, or withdraw from the OST.¹¹² Literature collected and reviewed shows a range of perspectives: support and explore amending, enacting new laws/agreements, or completely withdrawing from the treaty. Additionally, some sources provide differing perspectives within their documents regarding their stance on the OST.

Dr. James Vedda, senior analyst at Aerospace, wrote a policy paper addressing differing possibilities on the handling of the OST. Vedda provides us with an interesting perspective supporting the revision of the OST and then turns around and details the risks associated with opening a long-standing international agreement.¹¹³ In terms of revising the OST, Vedda discusses two topics that might be targeted for possible added guidelines.¹¹⁴ The first topic is remediation and mitigation of orbital debris and the second is the “issue of property rights in space”¹¹⁵ having the potential to hinder commercial space activities.¹¹⁶ Vedda suggests that if the United States decides to go the route of amending the treaty, it also comes with risks.¹¹⁷ One of the risks suggested involves the treaty’s amendment process and the challenging aspect of opening an international agreement of this magnitude.¹¹⁸ Additionally, Vedda states “it would require a considerable amount of time and effort, without a guarantee that the result would be better than what is already in place.”¹¹⁹ Michael J. Listner, graduate of the Regent University School of Law, also discusses the pros and cons of amending the OST to try and shape the treaty more in line

¹¹² Dianna Ramirez, “Aerospace policy paper examines Outer Space Treaty | The Aerospace Corporation,” Aerospace, June 29, 2017, <http://www.aerospace.org/news/pressreleases/aerospace-policy-paper-examines-outer-space-treaty/>.

¹¹³ James A. Vedda, “The Outer Space Treaty: Assessing its Relevance at the 50-Year Mark,” Center for Space Policy and Strategy Policy Paper for Aerospace Cooperation, June 2017, pgs. 1–7, <http://aerospace.wpengine.netdna-cdn.com/wp-content/uploads/2017/06/OuterSpaceTreaty.pdf>, 1–7.

¹¹⁴ Ibid., 3.

¹¹⁵ Ibid.

¹¹⁶ Ibid.

¹¹⁷ James Vedda, as quoted in Ramirez, “Aerospace policy paper examines Outer Space Treaty | The Aerospace Corporation.”

¹¹⁸ Ibid.

¹¹⁹ Ibid.

with the present-day global concerns.¹²⁰ Listner highlights areas regarding national security, property rights, and commercialization of space.¹²¹ However, like Vedda he believes that each nation has its own objectives and stakes in space and therefore it would be very challenging to gain support among the signatories.¹²² Plus, Vedda says any one of those nations has the right to “bring up its own amendments, which could be objectionable to the major stakeholders.”¹²³

While scholars agree that the OST has been the forefront for space law, many are realizing the inadequacy of the treaty to stand up to current space law issues. One scholar previously mentioned, Joanne Gabrynowiz, argues both in support and in need for upgrading or creating additional legislation to the OST. Gabrynowiz states “space law is still rooted in 20th century international conventions, that begun with the OST.”¹²⁴ Additionally, she offers her belief that the OST is outdated and in need of an upgrade.¹²⁵ She suggests “that new legislation and regulation is the only plausible avenue for modernizing the legal framework in outer space right now.”¹²⁶ As 21st-century challenges arise, she says Congress must define a legal framework that can support orbital debris mitigation, weaponization of space, asteroid and Moon mining, commercial space activities, and other future concerns.¹²⁷ Not only are academic professionals illustrating the need for new legislation but also politicians as well. Senator Ted Cruz (R-Texas), chairman of the Senate’s space subcommittee, stated his concerns during the May 23, 2017,

¹²⁰ Michael J. Listner, “It’s time to rethink international space law,” TheSpaceReview.com, May 31, 2005, <http://www.thespacereview.com/article/381/1>.

¹²¹ Ibid.

¹²² Ibid; James Vedda, as quoted in Ramirez, “Aerospace policy paper examines Outer Space Treaty | The Aerospace Corporation.”

¹²³ James Vedda, as quoted in Ramirez, “Aerospace policy paper examines Outer Space Treaty | The Aerospace Corporation.”

¹²⁴ Joanne Gabrynowiz, as quoted by Krause, “The Outer Space Treaty turns 50.”

¹²⁵ Ibid.

¹²⁶ Ibid.

¹²⁷ Ibid.

hearing on the OST.¹²⁸ Senator Cruz was worried that the OST did “not reflect the needs and interests of emerging commercial space companies.”¹²⁹ Senator Cruz felt it necessary, regarding commercial prospects in space, to enact new policy and legislation that was not covered adequately in the OST.¹³⁰

Space Foundation Research Analyst G. Ryan Faith states “Americans tend to think of space exploration in terms of science, not strategy or war, but other nations don’t always make that distinction—and the laws guiding militaries in space are sorely outdated.”¹³¹ In Faith’s article, he explores the relevancy of the treaty and discusses the parts of the treaty that are relics of the Cold War that ought to be discarded.¹³² Faith believes the OST has been successful thus far in terms of preventing additional competitions within space-faring nations but argues that exploration of space is changing and becoming a new realm of possibilities.¹³³ This new realm “includes a full spectrum of human activity, including everything from property rights to deterrence structures.”¹³⁴ He advocates, much like Vedda, Gabrynowiz, and Listner, that a new space era has dawned and the challenges that were faced in the initial creation of the OST do not correlate with “21st century issues ranging from new defense applications, dual-use technologies, and growing accumulations of space debris.”¹³⁵

The literature discussing the OST addresses concerns that space law and the treaty contain gaps and limitations that are very problematic. The solutions to these problems directly correlate with the literature that supports the argument to enact new laws or agreements into space policy. Specific guidelines for commercial activities in space are

¹²⁸ Jeff Foust, “Cruz to hold hearings on updating the Outer Space Treaty,” SpaceNews.com, May 17, 2017, <http://spacenews.com/cruz-to-hold-hearing-on-updating-the-outer-space-treaty/>.

¹²⁹ Ibid.

¹³⁰ Foust, “Cruz to hold hearings on updating the Outer Space Treaty.”

¹³¹ G. Ryan Faith, “The Future of Space: Trouble on the Final Frontier,” *World Affairs*, September/October 2012, www.worldaffairsjournal.org/article/future-space-trouble-final-frontier.

¹³² Ibid.

¹³³ Ibid.

¹³⁴ Ibid.

¹³⁵ Ibid.

one of the main gaps in the OST and constitute the main problem for many of those who support the proposal of new laws and agreements, rather than just amending the treaty. At the May 23 hearing of the Senate Commerce Committee, some “commercial space companies and space law experts recommended against any changes to the OST, arguing that regulatory issues could better be addressed by enacting new national laws and regulations.”¹³⁶ In 2015, Congress passed “the Spurring Private Aerospace Competitiveness and Entrepreneurship Act (SPACE Act),”¹³⁷ which permitted mining of asteroids by U.S. commercial companies.¹³⁸ The act also gave “U.S. commercial companies exclusive rights to the resources that they collected from the asteroids.”¹³⁹ But the passage of this act has also brought up scrutiny regarding property rights in space.¹⁴⁰ This act was intended to promote the exploitation of resources by the U.S. private space industries.¹⁴¹ The OST clearly prohibits countries from making territorial claims, but “the SPACE Act assumes that commercial exploration and use of celestial objects such as asteroids or the Moon is legal, which is not universal law or opinion.”¹⁴² Article II of the OST states “that outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.”¹⁴³ Amir Siraj with the *Harvard Political Review*, suggested that the SPACE Act could be considered a violation of Article II because it “gives American companies property rights to any natural resources collected from celestial bodies.”¹⁴⁴ Jill Stuart, Department of Government,

¹³⁶ Foust, “Companies, Lawyers argue against changing Outer Space Treaty.”

¹³⁷ Krause, “The Outer Space Treaty turns 50.”

¹³⁸ Ibid.

¹³⁹ Ibid.

¹⁴⁰ Ibid.

¹⁴¹ Ibid.

¹⁴² Ibid.

¹⁴³ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies (Outer Space Treaty), U.S. Department of State, Signed at Washington, London, Moscow on January 27, 1967, Entered into force October 10, 1967, Accessed on February 18, 2018, <https://www.state.gov/t/isn/5181.htm>.

¹⁴⁴ Amir Siraj, “Why Congress Must Act Quickly to Reform U.S. Space Law,” *Harvard Political Review*, September 28, 2017, <http://harvardpolitics.com/united-states/the-dangers-of-stagnancy-and-the-need-for-norms-in-u-s-space-law/>.

London School of Economics and Political Science, weighs in on this debate suggesting that,

although the SPACE Act of 2015 seems to be undermining the space treaty's ban on anyone owning celestial territory, the act itself has a clause stating, in simple terms, that the U.S. does not lay claim to, or own, any such thing.¹⁴⁵

Stuart discusses the importance of OST, but clearly believes it is failing in the modern era due to its primary focus on countries only and little consideration for commercial interests in space.¹⁴⁶ These issues and challenges addressed could cause potential international conflict in the 21st century, which is why this thesis will address asteroid and moon mining as a case study. Additionally, U.S. Representative Jim Bridenstine (R-Oklahoma) believes that it is necessary to perform a complete space law reform.¹⁴⁷ He provides recent examples to support a reform, such as the U.S. weather satellite being hacked by the Chinese and major advances in technology both in the military and commercial sectors.¹⁴⁸ Additionally, he proposed the "H.R. 4945 American Space Renaissance Act (ASRA) to permanently secure the United States as the preeminent spacefaring nation and bring about significant changes in the nation's commercial space policies."¹⁴⁹

The OST "is not anomalous or unusual area of law"¹⁵⁰ and, according to Jason Krause, "it is very similar to maritime law."¹⁵¹ But, in application, "the treaty is like the Antarctic Treaty System, which called for a non-militarized environment and put off claims

¹⁴⁵ Jill Stuart, "The Outer Space Treaty Has Been Successful – But Is it Fit for the Modern Age?," Space.com, February 19, 2017, <https://www.space.com/35758-outer-space-treaty-success-modern-assessment.html>.

¹⁴⁶ Ibid.

¹⁴⁷ U.S. Representative Jim Bridenstine, as quoted by Krause, "The Outer Space Treaty turns 50. Can it survive a new space race?."

¹⁴⁸ Ibid.

¹⁴⁹ Jim Bridenstine (Rep.-Oklahoma), "A Time for Space Leadership," SpaceRenaissanceact.com, accessed December 02, 2017, <https://spacerenaissanceact.com/>.

¹⁵⁰ Krause, "The Outer Space Treaty turns 50."

¹⁵¹ Ibid.

of sovereignty in Antarctica.”¹⁵² One of the problems that he addresses is direct attribution, meaning space-faring nations are responsible for their actions in outer space.¹⁵³ Article VI provides the legal basis for regulations regarding commercial space activity.¹⁵⁴ Specifically, this provision “makes states responsible for the activities of all nongovernmental entities based in their countries, requiring ‘authorization and continuing supervision’ of commercial space activities by their respective national governments.”¹⁵⁵ Additionally, a space law advisor for the Secure World Foundation, Chris Johnson, argues that when the OST was being formalized, commercial interests were not included and therefore must be supplemented using new legal agreements or proposals.¹⁵⁶ Direct attribution will be discussed in this thesis in regards to asteroid and Moon mining. This thesis intends on analyzing asteroid and Moon mining in the 21st century, applying relevant issues to the OST, and discussing in depth whether the treaty can prevent conflict in this area.

An additional gap in the OST that has been highlighted in the literature, space debris mitigation directly correlates to one of the case studies this thesis will evaluate. Vedda points out that “the treaty does not directly address orbital debris mitigation and remediation or enable salvage in space.”¹⁵⁷ He states that orbital debris was not a significant issue in 1967 and, therefore, the treaty did not adequately cover the issue.¹⁵⁸ Currently, the required technology for space debris removal is within reach and the need for regulation has become even more pressing.¹⁵⁹ Vedda says “as space operations become more sophisticated and debris concern increase, reconsideration of the space salvage may

¹⁵² Ibid.

¹⁵³ Ibid.

¹⁵⁴ Ibid.

¹⁵⁵ Ibid.

¹⁵⁶ Chris Johnson, as quoted in Krause, “The Outer Space Treaty turns 50.”

¹⁵⁷ James Vedda, as quoted in Ramirez, “Aerospace policy paper examines Outer Space Treaty | The Aerospace Corporation.”

¹⁵⁸ Vedda, “The Outer Space Treaty: Assessing its Relevance at the 50-Year Mark,” 3.

¹⁵⁹ Ibid.

become a priority.”¹⁶⁰ Additionally, Vedda offers one possible solution to debris mitigation.¹⁶¹ He suggests a new amendment to the OST that is new rhetoric yet incorporates already existing debris mitigation norms.¹⁶² This thesis will address space debris mitigation in the political, military, and commercial sectors and determine whether the OST could prevent conflict in those areas.

One of the more alarming gaps in the OST regards the concept of weaponizing space. The existing literature shows perspectives that are for and against the weaponization of space. Articles III and IV of the OST are responsible for providing guidelines, often considered extremely restrictive, on military activity in space.¹⁶³ Specifically, Article IV “prohibits placing nuclear weapons or any other kinds of weapons of mass destruction into orbit or permanently affixing them to a celestial body.”¹⁶⁴ Jinyuan Su, faculty of Law at McGill University, discusses the potential uncertainties to international peace and security due to the current inadequacy of existing international law to prevent an arms race in outer space.¹⁶⁵ He “believes that the destabilizing effect of space weapons and their potential devastating threat to the benign space environment make them one of the most serious challenges to the peaceful exploration and use of outer space.”¹⁶⁶ Although, the OST prohibits certain categories of space weapons, Jinyuan Su is adamant that preventing the weaponization of space should be considered high priority in regards to enacting new laws/agreements.¹⁶⁷ Similar arguments are made by Alexander Chanock, a graduate of the UCLA School of Law. He discusses the main problem associated with weaponizing space

¹⁶⁰ Ibid.

¹⁶¹ Ibid.

¹⁶² Ibid.

¹⁶³ Adam E. Frey, “Defense of U.S. space assets: a legal perspective,” *Air & Space Power Journal* 22, no. 4 (December 22, 2008), <https://www.thefreelibrary.com/Defense+of+US+space+assets%3a+a+legal+perspective.-a0193084346>.

¹⁶⁴ Outer Space Treaty, as quoted in Frey, “Defense of U.S. space assets: a legal perspective.”

¹⁶⁵ Jinyuan Su, “Space Arms Control: Lex Lata and currently active proposals,” *Asian Journal of International Law* 7, no. 1 (January 1, 2017).

¹⁶⁶ Ibid.

¹⁶⁷ Ibid.

is the likelihood of an arms race.¹⁶⁸ He believes that an arms race could have severe destabilizing effects on “the international system and make the world more vulnerable to war.”¹⁶⁹ Peter Kamocsai, a graduate in space policy at George Washington University, suggests a differing viewpoint than that of Jinyuan Su. He advocates space faring nations are interpreting the OST in a way that gives them the opportunity to weaponize space.¹⁷⁰ He believes that United States should lead the charge in space weaponization because, if we do not deploy space weapons now, we risk falling behind in space.¹⁷¹ Additionally, Alexander Chanock provides two valid reasons for the United States to ignore discussions on the banning of weapons in space and moving toward a weaponized outer space. The two “reasons include the inevitability of the weaponization of space and the vulnerability of U.S. space assets.”¹⁷²

The inevitability theory of space weaponization stems from the notion that the international community will develop weapons for space just as it has for every other frontier.¹⁷³

Chanock identifies the OST “as the only international framework that specifically addresses the problem of space weaponization,”¹⁷⁴ but notes that the treaty was signed over fifty years ago and “contains many ambiguous provisions that prevent it from effectively dealing with the proliferation of space weapons in the 21st century.”¹⁷⁵ This thesis analyzes potential conflicts in-depth that could arise due to the ambiguity of the space weaponization in the OST.

¹⁶⁸ Alexander Chanock, “The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century,” *Journal of Air Law and Commerce*, Volume 78 (2013), pgs. 691–710, Accessed January 10, 2018, <http://scholar.smu.edu/cgi/viewcontent.cgi?article=1327&context=jalc>.

¹⁶⁹ Ibid., 708.

¹⁷⁰ Peter Kamocsai, “Op-Ed: Why the U.S. Should Be a Leader in Space Weaponization,” SpaceNews, January 10, 2015, <http://spacenews.com/commentary-why-the-u-s-should-be-a-leader-in-space-weaponization/>.

¹⁷¹ Ibid.

¹⁷² Chanock, “The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century,” 698.

¹⁷³ Ibid.

¹⁷⁴ Ibid., 700.

¹⁷⁵ Ibid.

One limitation surrounding the OST is the interpretation of the treaty. The way one country interprets the treaty could be very different from another country. Some scholars are concerned that interpretation of the treaty could cause significant issues regarding space activities. Professor Henry R. Hertzfeld notes that all UN treaties have to be translated into six different languages, which means the OST has been translated into six official versions.¹⁷⁶ Hertzfeld provides an additional two perspectives regarding the limits of the OST. First, he discusses, the concern with the treaty's focus solely on that of "human activities in space"¹⁷⁷ and the gross disregard to define space itself.¹⁷⁸ Second, he says, the treaty does not provide adequate definitions for terms "such as celestial body or peaceful purposes,"¹⁷⁹ leaving room for various interpretations.¹⁸⁰ Additionally, Professor David Koplow, a Georgetown law professor, discusses his opinion on how the international community should interpret the 50-year-old text.¹⁸¹ He proposes that scholars, lawyers, nations, politicians, etc., should avoid any further debates and arguments over the OST and move on to negotiating new treaty that addresses the current 21st century issues.¹⁸² Both of these distinguished professors, present a perspective on the OST that shows that the provisions of the treaty can be interpreted and implemented based on the reader's interests or translation, which limits the treaty and causes potential space activities to fall within the cracks of the OST. This thesis will address whether such activities could cause conflict in the 21st century.

The final perspective regarding the OST, is for the United States to withdraw from the treaty. Both Vedda and Listner offer their views on withdrawing from the OST as a possible solution, but, they agree that this is not a wise option. Listner offers what he deems

¹⁷⁶ Hertzfeld, "Developing Issues in the Law of Outer Space," 5.

¹⁷⁷ Ibid.

¹⁷⁸ Ibid.

¹⁷⁹ Ibid.

¹⁸⁰ Ibid.

¹⁸¹ Robert Dalton, David Koplow, and Steve Mirima, "What Laws Govern Outer Space? Three Professors Share Their Thoughts," Vimeo video, 1:20:46, posted by Georgetown Law, February 9, 2017, accessed November 22, 2017, <https://vimeo.com/gulc/review/202851292/8bc5edc353>.

¹⁸² Ibid.

is “the fastest and most efficient solution, which is to withdraw from the OST,¹⁸³” which would eliminate the problems associated with the OST.¹⁸⁴ But both Vedda and Listner believe that while withdrawing from the treaty may eliminate initial problems, the political fallout would be great.¹⁸⁵ Additionally, Vedda mentions “that it is difficult to identify any significant or enduring benefits that could occur from the nation’s withdrawal.”¹⁸⁶ An issue that could occur if the United States withdrew from the treaty is “if the United States tried to claim sovereignty over extraterrestrial real estate, other space-faring nations—all of which are treaty signatories—could refuse to recognize the claim.”¹⁸⁷ This issue could then result in a domino effect, as other countries could withdraw, starting an all-out free-for-all of nations beginning to claim sovereignty over areas in space.¹⁸⁸ Back in 2007, John Hickman, associate professor in the Department of Government and International Studies at Berry College, wrote an article in response to the 40th anniversary of the OST regarding his case for withdrawal from the treaty. His argument for withdrawal stems from the idea that due to the treaty it “has discouraged more energetic space exploration and development.”¹⁸⁹ Hickman argues that the OST is outdated and is keeping humanity from spreading out into the cosmos.¹⁹⁰ Hickman is not alone in his opinions that the OST has prevented the Americans from embracing advancements in outer space. Dr. Everett C. Dolman, Professor of Comparative Military Studies at the U.S. Air Force’s Air Command and Staff College (ACSC), discusses in his book *Astropolitik: Classical Geopolitics in the Space Age* “the idea that nation-states can utilize space to enhance their own power.”¹⁹¹ Similar to Hickman, Dolman proposes a policy that the U.S. should withdraw from the

¹⁸³ Listner, “It’s time to rethink international space law.”

¹⁸⁴ Ibid.

¹⁸⁵ Ibid; Vedda, “The Outer Space Treaty: Assessing its Relevance at the 50-Year Mark,” 5–6.

¹⁸⁶ Vedda, “The Outer Space Treaty: Assessing its Relevance at the 50-Year Mark,” 5.

¹⁸⁷ Ibid.

¹⁸⁸ Vedda, “The Outer Space Treaty: Assessing its Relevance at the 50-Year Mark,” 5.

¹⁸⁹ John Hickman, “Still crazy after four decades: The case for withdrawing from the 1967 Outer Space Treaty,” TheSpaceReview.com, September 24, 2007, www.thespacereview.com/article/960/1.

¹⁹⁰ Ibid.

¹⁹¹ Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age*, (London: Frank Cass, 2002), 3.

OST and “announce that it is establishing a principal of free market sovereignty in space because he believes that the OST has had negative effects on the commercial and military development in space.”¹⁹² Dolman goes even further to suggest that once the U.S. has withdrawn from the OST, “it should endeavor to seize military control of Low Earth Orbit (LEO) to stop a space arms race, safeguarding the peaceful use of space for all nations.”¹⁹³ Finally, Dolman suggests coordination on future space projects between commercial, civilian, and military sectors lead by a newly created national space coordination agency.¹⁹⁴

This thesis, alongside the research that has already been conducted, offers a perspective on current challenges the space community is facing. The primary focus is to highlight the OST’s ability or inability to prevent military, commercial, or political conflict in the 21st century. Utilizing the gaps and limitations identified by various scholars within the space law community, this thesis plans to expand on their knowledge by providing a more detailed discussion on the conflicts that could potentially occur regarding space debris mitigation, asteroid and Moon mining, and the weaponization of space if the OST is not adequate as it stands to prevent conflict in those areas.

E. EXPLANATIONS AND REASONS FOR CASE STUDY SELECTIONS

For 50 years, the OST has helped prevent major conflicts from occurring in space, most importantly, to include preventing belligerent nations from putting weapons of mass destruction in space.¹⁹⁵ But space has changed drastically in 50 years; new threats have emerged that could cause potential future conflict if not addressed adequately. This thesis provides three hypotheses that will be used to evaluate three emerging threats via case studies. The case studies are space debris mitigation, asteroid and Moon mining, and the weaponization of space. Each of the problem areas has the potential to create conflict in

¹⁹² Everett C. Dolman, as quoted in Taylor Dinerman, “Review: *Astropolitik: Classical Geopolitics in the Space Age*,” TheSpaceReview.com, October 3, 2005, www.thespacereview.com/article/465/1.

¹⁹³ Ibid.

¹⁹⁴ Ibid.

¹⁹⁵ Vedda, “The Outer Space Treaty: Assessing its Relevance at the 50-Year Mark,” 1–7.

the 21st century. Prior to discussing these hypotheses, it is important to explain the significance behind these case studies.

Space is becoming a growing business venture, and commercial companies' interests are applying additional pressures on the current laws for outer space activities.¹⁹⁶ Therefore, this evaluation will examine whether the conflict can be prevented and controlled by existing language and mechanisms in the OST. Evaluation will be conducted based on a comparison and analysis of the articles in the OST to the selected 21st century threats. If the OST does not provide guidance on the selected case studies, further analyses will be conducted to determine what potential conflict, if any, could occur in the military, political, and commercial sectors. Additionally, policy recommendations to the OST will be addressed in those areas where the OST may not have adequate language or mechanisms to prevent probable future conflicts.

1. Space Debris Mitigation

Space debris experts suggest that there are “more than 750,000 pieces of debris orbiting Earth,”¹⁹⁷ each piece having the potential to put the future of spaceflight at risk.¹⁹⁸ Dr. Holger Krag, Head of the European Space Agency's (ESA) debris office, states “in orbit, these objects have tremendous relative velocities, faster than a bullet, and can damage or destroy functioning space infrastructure.”¹⁹⁹ Additionally, he discusses the threat to modern society if space debris collide with operational satellites.²⁰⁰ Brigitte Zypries, German Federal Minister for Economic Affairs and Energy, adds her perspective on the significance of losing satellites.²⁰¹ She says, “this is a global issue that affects all space-

¹⁹⁶ Krause, “The Outer Space Treaty turns 50.”

¹⁹⁷ Sarah Knapton, “750,000 pieces of debris orbiting Earth threaten future of spaceflight, warn experts,” *The Telegraph: Science*, April 21, 2017, www.telegraph.co.uk/science/2017/04/21/750000-pieces-debris-orbiting-earth-threaten-future-spaceflight/.

¹⁹⁸ Ibid.

¹⁹⁹ Dr. Holger Krag, as quoted in Ibid.

²⁰⁰ Ibid.

²⁰¹ Brigitte Zypries, as quoted in Ibid.

faring nations from delivering critical services to their citizens.”²⁰² Without a “global solution,”²⁰³ space debris will continue to present as a risk to nation’s space assets.²⁰⁴ If space debris is not addressed the ability to provide services for citizens and continued innovation in space technology will not be possible. That is why the evaluation of the OST to prevent conflict regarding space debris mitigation is essential “to sustaining the dream of future exploration in space” as mentioned by the ESA Director General Jan Woerner.²⁰⁵

2. Weaponization of Space

The weaponization of space is inevitable and is likely to occur in the next decade, “unless it is hindered by organized, effective international opposition or major-space faring nations, to include U.S., China, and Russia, are willing to cancel their projects dedicated to weaponizing space.”²⁰⁶ The OST specifically “bans the placing of nuclear weapons and other weapons of mass destruction in space, but in regards to military use of outer space, the treaty does not explicitly ban such activities.”²⁰⁷ Although space is considered a place for peaceful purposes and scientific exploration, current international concerns suggest weaponizing space is inevitable reality.²⁰⁸ But what does weaponization entail or mean? Several definitions have been offered, but there has been no accepted definition. The “updated 2014 Chinese-Russian Treaty on Prevention of the Placement of Weapons in

²⁰² Ibid.

²⁰³ Ibid.

²⁰⁴ Ibid.

²⁰⁵ General Jan Woerner, as quoted in Knapton, “750,000 pieces of debris orbiting Earth threaten future of spaceflight, warn experts.”

²⁰⁶ “International Legal Agreements Relevant to Space Weapons,” Union of Concerned Scientists: Science for a healthy planet and safer world, February 4, 2011. http://www.ucsusa.org/nuclear-weapons/space-weapons/international-legal-agreements#.WicL0UxFw_5.

²⁰⁷ “Weaponization of Space,” NuclearFiles.org: Project of the Nuclear Age Peace Foundation, Accessed January 9, 2017, www.nuclearfiles.org/menu/key-issues/space-weapons/basics/introduction-weaponization-space.htm.

²⁰⁸ Union of Concerned Scientists: Science for a healthy planet and safer world, “International Legal Agreements Relevant to Space Weapons.”

Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT)”²⁰⁹ defines the term ‘weapon in outer space’ as:

Any outer space object (device placed in outer space and designed for operating therein) or its component produced or converted to eliminate, damage, or disrupt normal functioning of objects in outer space, on the Earth’s surface or in the air, as well as to eliminate population, components of biosphere important to human existence, or to inflict damage to them by using any principles of physics.²¹⁰

The U.S. considers this definition to be flawed, “lacking any guidelines or restrictions on the development a stockpiling of anti-satellite (ASAT) weapons on the ground or any other ground-based counterspace capabilities.”²¹¹ According to Doug Lamborn (R-Colo.), “both China and Russia have openly admitted that they are developing counterspace capabilities, to include jamming of GPS and satellite communications, blinding or damaging our satellites with ground-based lasers, and destroying a satellite with a missile.”²¹² Although, the prior threats mentioned do not necessarily equate to weapons placed in space or weaponization of space, they can still directly affect and inhibit the use of space therefore will be treated as the weaponization of space. These threats are taken very seriously by the United States.²¹³ The United States reserves the right to self-defense and if necessary will respond accordingly to defend ourselves and our allies.²¹⁴ Currently, with no agreed-upon or legally binding proposals on weaponizing space and the significance of space to both the civilian and military populations, the probability of conflict increases. Therefore, an

²⁰⁹ 2014 PPWT, as quoted in Michael Listner and Rajeswari Pillai Rajagopalan, “The 2014 PPWT: a new draft with the same and different problems,” The Space Review, August 11, 2014, www.thespacereview.com/article/2575/1.

²¹⁰ Ibid.

²¹¹ Ambassador Robert Wood, as quoted in Jeff Foust, “U.S. Dismisses Space Weapons Treaty Proposal As ‘Fundamentally Flawed,’” SpaceNews, September 11, 2014, <http://spacenews.com/41842us-dismisses-space-weapons-treaty-proposal-as-fundamentally-flawed/>.

²¹² Doug Lamborn (R-Colo), “Time to get serious about space threats,” The Hill, May 14, 2015, <http://thehill.com/opinion/op-ed/241933-time-to-get-serious-about-space-threats>.

²¹³ Ibid.

²¹⁴ Ibid.

evaluation of the OST to prevent conflict regarding the weaponization of space is essential to preventing a future war in space.

3. Asteroid and Moon Mining

As the world continues to celebrate *Apollo 11*'s success to the Moon, the attraction and desire to explore and exploit celestial bodies for possible resources has become a concern.²¹⁵ Currently, "it is unclear who can extract and profit from the Moon's resources, leading to debates within scientific, commercial, and policy circles—debates that have been made more lively and complicated by the changing actors and stakeholders in space."²¹⁶ Governmental agencies are no longer the only ones involved in space and lunar exploration.²¹⁷ Likewise, "asteroids are also objects of interest for profit-seeking space enterprise."²¹⁸ At a national level, the OST adds an additional complication to the legality of space mining.²¹⁹ For example, article VI of the OST "requires countries to perform 'authorization and supervision' of activities in space by non-government entities under their jurisdiction."²²⁰ Asteroid and Moon mining as well as other commercial activities, such as lunar landings, having no clear licensing authority, and thus fall within the gaps and limitations of the OST.²²¹ Therefore, an evaluation of the OST to prevent conflict in asteroid and Moon mining is essential to ensure that the benefits acquired from space can be utilized by all mankind.

²¹⁵ David Leonard, "Mining the Moon? Space Property Rights Still Unclear, Experts Say," Space.com, July 25, 2014, <https://www.space.com/26644-moon-asteroids-resources-space-law.html>.

²¹⁶ Ibid.

²¹⁷ Ibid.

²¹⁸ Ibid.

²¹⁹ Jeff Foust, "Mining issues in space law," The Space Review, May 9, 2016. www.thespacereview.com/article/2981/1.

²²⁰ Outer Space Treaty, as quoted in Ibid.

²²¹ Foust, "Mining issues in space law."

F. CASE STUDY HYPOTHESIS

1. Case Study #1 Hypotheses: Space Debris Mitigation

Space debris could potentially cause conflict in the future; therefore, an examination of the OST needs to be conducted. According to Joanne Wheeler, the OST's provisions "are too generic to deal with the complex issues of space debris with any certainty"²²² and this could create military, political, or commercial sector conflicts. Over the past decade, space debris has become a high priority and significant efforts have been made to formally define the concept and address the concerns debris play in the space environment.²²³ Unfortunately, despite best efforts, there is still no agreed upon definition among the international community and that is one reason why this thesis has selected this issue as a case study.²²⁴

The hypothesis for this thesis case study on space debris is: If the current amount of space debris continues to expand, endangering space-based assets, it is likely there will be conjunctions that could cause conflict in the foreseeable future that the OST cannot prevent.

2. Case Study #2 Hypotheses: Weaponization of Space

Weaponization of space could cause conflict in the future; therefore, the OST needs to be examined. In the United Nations Conference on Disarmament, "there has been a strong and almost unanimous opposition to weaponization of space."²²⁵ China and Russia have made efforts to promote and "draft a treaty to ban space weapons but the United States has refused to enter negotiations on such a treaty."²²⁶ Meanwhile, China and Russia—along with several other nations effectively killed a European proposal for an international

²²² Joanne Wheeler, "Space debris: The legal issues," Royal Aeronautical Society, January 3, 2014, <https://www.aerosociety.com/news/space-debris-the-legal-issues/>.

²²³ Ibid.

²²⁴ Ibid.

²²⁵ Union of Concerned Scientists: Science for a healthy planet and safer world, "International Legal Agreements Relevant to Space Weapons."

²²⁶ Ibid.

space code of conduct, which might have limited space's weaponization.²²⁷ With no comprehensive treaty regarding space weapons in place, we are left to rely on the legal framework the OST provides regarding weaponization.²²⁸

The hypothesis for this thesis case study on the weaponization in space is: If countries continue to go forward weaponizing space without further legal agreements, the current OST will not be able to adequately prevent conflict.

3. Case Study #3 Hypotheses: Asteroid and Moon Mining

Asteroid and Moon mining could cause conflict in the future; therefore, an examination of the OST needs to be conducted. Since the OST was created over fifty years ago and space mining was not a realistic capability, its provisions are unclear regarding its legality.²²⁹ With technological advances making this possible in the future, it has the potential to threaten the peaceful exploration of space, if commercial conflicts spill into the military or political realm.

The hypothesis for this thesis case study on asteroid and Moon mining is: If the current technological advances in both the commercial and military sectors regarding asteroid and Moon mining continue to rapidly increase without further legal agreements, the OST as it stands will not be able to prevent conflict.

G. RESEARCH DESIGN

As Delwyn Goodrick explains, “comparative case studies involve the analysis and synthesis of the similarities, differences, and patterns across two or more cases that share

²²⁷ Michael J. Listner, “The International Code of Conduct: Comments on changes in the latest draft and post mortem thoughts,” The Space Review, October 26, 2015, www.thespacereview.com/article/2851/1.

²²⁸ Union of Concerned Scientists: Science for a healthy planet and safer world, “International Legal Agreements Relevant to Space Weapons..”

²²⁹ Mark Kaufman, “Luxembourg’s Asteroid Mining is Legal Says Space Law Expert,” Inverse Innovation, August 1, 2017, <https://www.inverse.com/article/34935-luxembourg-s-asteroid-mining-is-legal-says-space-law-expert>.

a common focus or goal.”²³⁰ This thesis will conduct a comparative case study approach using three case studies that share a common goal of evaluating the adequateness of the OST to prevent conflict in the 21st century. Specific case studies linked to the future challenges are testing the OST’s ability to maintain space for peaceful purposes. The case studies selected represent threats to the space frontier. As it is the 50-year anniversary of the treaty, this thesis has the opportunity to draw from various resources being published regarding the OST. Research and resources include but are not limited to information from law journals, space policy papers, dialogues from recent conferences (33rd Space Symposium and International Astronautical Congress September 2017), news-related sources (CNN, SpaceNews, SpaceDaily, etc.), and books covering topics such as the militarization of space, politics of space security, space strategy, and war in space. Additionally, this thesis will use a historical process-tracing method to conduct analysis on the major research questions.²³¹ To understand the importance of the threats selected for the case studies, this thesis must present a historical context to the new threat. The threats and concerns during the creation of the OST were very different than the issues facing us in the 21st century.

H. THESIS OVERVIEW

This thesis will be divided into five chapters. Chapter I introduced the background information on the OST. It was broken up into two parts to set the reader up for the intended thesis questions. Part one introduces the history of the OST: events leading up to the treaty, conflicts occurring during 1960s, reasons for making the treaty, and the details of the treaty. Part two transitioned into the present day by depicting the major challenges and growth of the use of outer space. It also addressed the change of key players in space; Russia and the United States are no longer alone in their race to space. Other nations with capable space programs include but are not limited to China, Japan, and India. Commercial actors and

²³⁰ Delwyn Goodrick, “Comparative Case Studies: Methodological Briefs,” UNICEF – Office of Research: Innocenti, September 2014, http://devinfo.live.info/impact_evaluation/ie/img/downloads/Comparative_Case_Studies_ENG.pdf.

²³¹ Derek Beach, “Qualitative Political Methodology: Process-Tracing Methods in Social Sciences,” Oxford Research Encyclopedia, January 2017, <http://politics.oxfordre.com/view/10.1093/acrefore/9780190228637.001.0001/acrefore-9780190228637-e-176>.

wealthy individuals are becoming key players in the race to space. With nations, private citizens, commercial companies, and militaries all vying for their place in space, it could inherently lead to conflict. The final few paragraphs of this chapter discussed the case studies that will be examined to determine whether the OST is adequate as it stands to prevent conflict in the 21st century as new risks or threats have emerged.

Chapters II, III, and IV will look at three case studies regarding current challenges in space and analyze them against the OST to determine whether changes, amendments, or a proposal of a new international space treaty/agreement need to be made to prevent conflict. Each case study will begin with a brief history of that issue and whether it was considered during the creation of the OST. Additionally, each case study will examine political, military, and commercial interests and their involvement in current space issues. Chapter II will introduce the first case study on the mitigation of space debris. Chapter III will discuss weaponization in space, potential weapons that could be used in space, and the effects those weapons could potentially have on the United States. Chapter IV will address the future of asteroid and Moon mining and the potential concerns that might come with these new activities. The concluding chapter, Chapter V, summarizes the findings (successes and failures) on whether the OST is adequate as it stands to prevent conflict in the 21st century, highlights the gaps (what is missing?), and provides policy recommendations to the treaty in support of future U.S. or international agreements.

II. SPACE DEBRIS CASE STUDY

A. INTRODUCTION

Orbital debris, also known as “space junk,”²³² is an increasingly serious problem for satellites and their operators.²³³ This section will present a case study on the threat of space/orbital debris and address whether the Outer Space Treaty has the ability to prevent future conflicts that might arise in this area. The case study will be divided into four parts: 1) an historical analysis of space debris; 2) the threat of space debris in the 21st century; 3) an Outer Space Treaty analysis; and 4) a discussion on the potential for conflict.

B. HISTORY OF SPACE DEBRIS

In the past 60 years, according to Loretta Hall, “outer space has changed drastically from virtually debris-free to an area cluttered with man-made objects.”²³⁴ First, an historical analysis on the origins of space debris will be conducted to explain where it came from and the current role it has in the 21st century. Additionally, this analysis will discuss whether space debris was a concern at the time of the creation of the OST.

Prior to satellites being launched into space, in 1946, “scientists suggested the possibility of undetectable small chunks of natural debris”²³⁵ circling the Earth that could threaten future manned missions to space.²³⁶ At the same time, astronomer Fred Whipple had warned the United States “that a spaceship traveling toward the Moon”²³⁷ would have a 4% chance of being destroyed by small meteors streaking past Earth.²³⁸ Additionally,

²³² Jeff Foust, “Cleaning up space junk,” *The Space Review*, December 15, 2014, <http://www.thespacereview.com/article/2663/1>.

²³³ *Ibid.*

²³⁴ Loretta Hall, “The History of Space of Space Debris,” *Space Traffic Management Conference, Paper 19* (November 6, 2014), pgs. 1–12, <https://commons.erau.edu/cgi/viewcontent.cgi?article=1000&context=stm>. 1.

²³⁵ *Ibid.*

²³⁶ *Ibid.*

²³⁷ *Ibid.*

²³⁸ *Ibid.*

other notable astronomers, such as William Henry Pickering, believed “small natural satellites”²³⁹ already existed and were orbiting the Earth.²⁴⁰ By 1954, the theory of natural satellites was thought to be very likely by Director of the Nautical Almanac office of the U.S. Naval Observatory Dr. G. M. Clemence.²⁴¹ But there were disagreements on this theory among the astronomer community. Astronomer Clyde Tombaugh, who in 1930 had discovered then-planet Pluto, was skeptical of natural satellites.²⁴² He “formulated a plan to search for natural debris near both Earth and the Moon, address the threat of collision with space vehicles, and discuss the possibility, if natural satellites were found near the Earth to use them as space stations.”²⁴³ During this research project, the Soviet Union had launched *Sputnik 1* into orbit on October 2, 1957.²⁴⁴ Tombaugh was able to photograph *Sputnik 1*, which was extremely important to his study.²⁴⁵ Having the ability to take a photo of the Soviet spacecraft, correlated with his final findings regarding the existence of natural satellites.²⁴⁶ If they had existed, specifically in LEO, then Tombaugh believes they would have been detected much like *Sputnik 1*.²⁴⁷ Prior to the report’s conclusions being released the United States launched *Vanguard 1* into orbit in March 1958.²⁴⁸ In 1959, “Tombaugh’s final report stated that no natural satellites had been discovered”²⁴⁹ and “we could send rockets out in space with very little risk of collision with natural objects.”²⁵⁰ That same year, the U.S. launched two more Vanguard series satellites into orbit, which

²³⁹ Ibid.

²⁴⁰ Ibid.

²⁴¹ Ibid.

²⁴² Ibid.

²⁴³ Ibid.

²⁴⁴ Ibid.

²⁴⁵ Ibid., 1–2.

²⁴⁶ Ibid.

²⁴⁷ Ibid.

²⁴⁸ Ibid., 2.

²⁴⁹ Ibid., 1.

²⁵⁰ Ibid.

are currently not operational and have been labeled as space debris.²⁵¹ After the launching of *Sputnik*, the ‘Space Object Catalog’ was created by the U.S. Air Force to maintain an accurate picture of objects in orbit.²⁵² In the beginning days of the U.S. and Soviet space programs, space debris was of little concern, their attention was set on beating the other and completing a successful mission.²⁵³ These early launches would be the beginning of a long-term problem for satellites and operators in space.

Before June 1961, “the entire catalog of artificial objects in near-Earth orbit being tracked by the U.S. Air Force was just over 50 items, which included only spacecraft and rocket bodies.”²⁵⁴ Then, that year, “the first on-orbit break-up occurred, Ablestar’s rocket body exploded,”²⁵⁵ creating nearly 300 debris fragments.²⁵⁶ The United States “detonated a 1.4 megaton nuclear warhead in 1962, designated Starfish Prime, 400 km above the Pacific Ocean, which had devastating effects on roughly one-third of the operational satellites at the time.”²⁵⁷ This test came after the Soviet Union had broken an informal moratorium on atmospheric tests of nuclear weapons.²⁵⁸ In 1963, “the U.S. Air Force’s and DoD released half a billion whisker-thin cooper wires into orbit known as Project West Ford.”²⁵⁹ In the event the United States and the Soviet Union went to war, Project West Ford’s goal was to ensure the U.S. could provide long-range communications for military operations.²⁶⁰ Unfortunately, many of these thin cooper wires are still in orbit today,

²⁵¹ Ibid., 2.

²⁵² Ibid.

²⁵³ Marlon E. Sorge and Mary Ellen Vojtek, “Space Debris Mitigation Policy,” *Crosslink Magazine*, December 10, 2015, www.aerospace.org/crosslinkmag/fall-2015/space-debris-mitigation-policy/.

²⁵⁴ Mika McKinnon, “A History of Garbage in Space,” Gizmodo, May 07, 2014, <https://gizmodo.com/a-history-of-garbage-in-space-1572783046>.

²⁵⁵ “A Brief History of Space Debris and Reentry Events,” *Crosslink Magazine*, December 10, 2015, www.aerospace.org/crosslinkmag/fall-2015/a-brief-history-of-space-debris-and-reentry-events/.

²⁵⁶ Ibid; McKinnon, “A History of Garbage in Space,” Gizmodo.

²⁵⁷ “A Brief History of Space Debris and Reentry Events,” *Crosslink Magazine*.

²⁵⁸ Phil Plait, “The 50th anniversary of Starfish Prime: the nuke that shook the world,” *Discover Magazine: Science for the Curious*, July 9, 2012, <http://blogs.discovermagazine.com/badastronomy/2012/07/09/the-50th-anniversary-of-starfish-prime-the-nuke-that-shook-the-world/#.Won4VUxFxeV>.

²⁵⁹ “A Brief History of Space Debris and Reentry Events,” *Crosslink Magazine*.

²⁶⁰ Ibid.

adding to the increasing problem of space debris.²⁶¹ In April 1964, the U.S. launched the *Transit 5BN3* navigation satellite, which used a radioisotope thermal generator as its source of power.²⁶² During the launch, its Scout launch vehicle failed causing it to scatter radioactive materials over the Indian Ocean, resulting in, at the time, one of the worst space accidents.²⁶³ In October 1965, shortly after reaching orbit, “the U.S. Titan 3C transtage broke up at an altitude of 739 km.”²⁶⁴ At the time, this was “the worst orbital debris event, creating nearly 475 trackable space debris in the near-Earth orbit.”²⁶⁵

In 1966, NASA and individual scientists, began characterizing the hazards of orbital debris with a series of mathematical calculations.²⁶⁶ Specialists in orbital dynamics performed collision probability calculations to figure out whether space debris could become a danger for manned satellites.²⁶⁷ Results determined the hazard to be relatively small and, in addition, the risk of collision of orbital debris to spacecraft was small.²⁶⁸ Additionally, on May 7, 1966, U.S. President Lyndon B. Johnson reached out to the international community, calling for a treaty to regulate space exploration.²⁶⁹ President Johnson suggested the treaty cover topics such as “astronaut rescue and return to country of origin in the event of emergency landing, and liability for damage caused by space objects.”²⁷⁰ Shortly after President Johnson made his statement, a draft of the OST was presented to COPUOS “containing the stipulation that countries which cause damage

²⁶¹ Ibid.

²⁶² David S.F. Portree and Joseph P. Loftus, Jr., “Orbital Debris: A Chronology,” January 1999, pgs.1-149 <https://ston.jsc.nasa.gov/collections/trs/techrep/TP-1999-208856.pdf>, 6

²⁶³ Ibid., 191–192.

²⁶⁴ Ibid., 7.; Authors referenced a note from Donald J. Kessler to David S. F. Portee, August 2, 1993.

²⁶⁵ Ibid.

²⁶⁶ Donald J. Kessler, “A Partial History of Orbital Debris: A Personal View,” <http://webpages.charter.net/dkessler/files/History%20of%20Orbital%20Debris.pdf>; Originally published in *Orbital Debris Monitor* Vol. 6, No. 3, pp 16–20, 1 July, 1993, and Vol 6, No. 4, pp 10–16, 1 October, 1993, edited by Darren McKnight.

²⁶⁷ Kessler, “A Partial History of Orbital Debris: A Personal View.”

²⁶⁸ Ibid.

²⁶⁹ Portree and Loftus, “Orbital Debris: A Chronology,” 8; David S.F. Portee, “Thirty Years Together: A Chronology of U.S.-Soviet Space Cooperation (NASA CR 185707),” February 1993, 7.

²⁷⁰ President Lyndon B. Johnson, as quoted in Ibid.

through space activities should be held accountable and liable to make compensation for that damage.”²⁷¹

During this time, the international community believed an agreement for a treaty needed to be reached as quickly as possible.²⁷² This belief influenced the members of the Legal Subcommittee to decide on whether the treaty should simply provide general or limited principles or establish more concrete and specific rules for space activities.²⁷³ The earlier sessions of the Legal Subcommittee, discussed in depth principles regarding “assistance to and return of astronauts and space vehicles and liability for damages caused by space vehicles.”²⁷⁴ As Dembling and Arons recall:

Various delegations expressed a desire that the Subcommittee continue its work on these drafts during the Fifth Session, and were not satisfied with the inclusion of general provisions on those subjects as items in a treaty as broad as those suggested by the United States and the Soviet drafts. However, the Subcommittee was interested in obtaining ‘maximum results in a minimum time’ and believed it ‘should limit itself strictly to setting essential and urgent issues.’²⁷⁵

The drafts presented by the United States and the Soviet Union were “merely starting points”²⁷⁶ according to most of the delegates.²⁷⁷ Although the Legal Subcommittee was working on drafting an additional more detailed treaty on liability, nations did not object to adding an article in the OST about liability and assistance.²⁷⁸ Two broadly phrased articles on liability and return of astronauts were included in the Treaty.²⁷⁹ A French delegate stated:

²⁷¹ Ibid.

²⁷² Dembling and Arons, “The Evolution of the Outer Space Treaty,” 428.

²⁷³ Ibid.

²⁷⁴ Ibid.

²⁷⁵ Ibid.

²⁷⁶ Ibid.; Authors referenced a statement by the Canadian delegate in Sum. Rep. 61 at 7.

²⁷⁷ Ibid.

²⁷⁸ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 428.

²⁷⁹ Ibid.

the questions of liability and assistance were extremely complicated, and if any reference to them was included in the treaty under discussion, it should be very brief and simple and should merely establish the principle concerned. Any additional details might deal too rapidly with problems which had not yet been settled.²⁸⁰

The treaty “was approved by the United Nations General Assembly on December 19, 1966,”²⁸¹ and opened for signatures in Washington, London, and Moscow on January 27, 1967.²⁸² On October 10, 1967 the OST came into force.²⁸³

In 1968, ASAT technology emerged and developed into a Soviet space-related military program.²⁸⁴ In October 1968, the Soviet Union used *Cosmos 249*, their first ASAT weapon, to target *Cosmos 248*.²⁸⁵ *Cosmos 249* missed *Cosmos 248* and exploded, “creating about 110 trackable pieces of debris.”²⁸⁶ A month later, on November 1, “*Cosmos 252* ASAT exploded when it passed its target *Cosmos 248*, intentionally creating about 140 trackable debris pieces.”²⁸⁷ Throughout the years 1968–1971, the Soviets conducted seven tests, which had mixed success, but resulted in both trackable and nontrackable debris.²⁸⁸ These tests created 490 pieces of trackable debris, which were primarily attributed to interceptors breaking up “following their release of their single fragmentation

²⁸⁰ Ibid., 438.

²⁸¹ Ibid., 455.

²⁸² Ibid., 455.

²⁸³ Portree and Loftus, “Orbital Debris: A Chronology,” 9.

²⁸⁴ James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, (Stanford: Stanford University Press, 2011), 156.

²⁸⁵ Portree and Loftus, “Orbital Debris: A Chronology,” 9; Portree and Loftus referenced Nicholas L. Johnson, “Artificial Satellite Breakups (Part 2): Soviet Anti-Satellite Programme,” *Journal of the British Interplanetary Society*, Vol. 36, 1983, pp. 357–362; *Interavia Space Directory 1992–93*, Andrew Wilson, editor, p. 188.

²⁸⁶ Ibid.

²⁸⁷ Ibid.

²⁸⁸ Moltz, *The Politics of Space Security*, 157.

warheads.”²⁸⁹ The non-trackable debris that were created during these tests is most likely greater than those that could be tracked.²⁹⁰

As negotiations continued regarding liability and damage to spacecraft, NASA continued conducting analysis regarding the probability of collisions. In 1971, “the NASA Marshall Space Flight Center wrote a memorandum on Space Station Satellite Collision Avoidance.”²⁹¹ That same year, in Geneva, COPUOS held “negotiations on the Convention on International Liability for Damage Caused by Space Objects (Liability Convention).”²⁹² The Liability Convention went into effect in September 1972, elaborating on Article VII of the OST providing a definition for space objects.²⁹³ Additionally, it “provided that a launching State shall be absolutely liable to pay compensation for damage caused by its space objects on the surface of the Earth or to aircraft, and liable for damage due to its faults in space.”²⁹⁴ In the event a spacecraft has been damaged by an object, the Convention offers procedures on settling those claims.²⁹⁵

On September 30, 1974, at the 25th International Astronautical Congress in Amsterdam, “a paper was presented by Brooks, Gibson, and Bess called ‘Predicting the Probability that Earth-Orbiting Spacecraft Will Collide with Man-Made Objects in Space,’ which was a shift in thinking because research that had been done prior showed a low probability of collision.”²⁹⁶ This paper highlighted the fact that space debris that were too

²⁸⁹ Moltz, *The Politics of Space Security*, 157; Moltz referenced Nicholas L. Johnson and Darren S. McKnight, *Artificial Space Debris* (Orbit Book Co, 1987), 15.

²⁹⁰ Ibid.

²⁹¹ Portree and Loftus, “Orbital Debris: A Chronology,” 12.

²⁹² Ibid; David S.F. Portree, *Thirty Years Together: A Chronology of U.S.-Soviet Space Cooperation* (NASA CR 185707), February 1993, 14.

²⁹³ Portree and Loftus, “Orbital Debris: A Chronology,” 15.

²⁹⁴ Resolution 2777 (XXVI) Convention on International Liability for Damage Caused by Space Objects, General Assembly, 26th Session (1971), <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/liability-convention.html>.

²⁹⁵ Ibid.

²⁹⁶ Portree and Loftus, “Orbital Debris: A Chronology,” 19; Donald J. Kessler, “A Partial History of Orbital Debris: A Personal View (Part 1),” *Orbital Debris Monitor*, Vol. 6, No. 3, July 1, 1993; Donald H. Humes, David R. Brookes, Jose M. Alvarez, and T. Dale Bess, “Manmade Orbital Debris Studies at NASA Langley,” in *Orbital Debris* (NASA CP 2360), Donald J. Kessler and Shin-Yi Su, editors, 1985.

small to be tracked had the potential to collide with man-made objects.²⁹⁷ In July 1976, Donald Kessler warns space debris will continue to increase as pieces collide with one another creating even more junk in orbit.²⁹⁸ In June 1977, “Donald Kessler and Burton Cour-Palais predict that the hazard posed by orbital debris would far surpass the threat from meteoroids.”²⁹⁹

In 1978, NASA’s Donald Kessler and Burton Cour-Palais wrote an article discussing the potential of self-perpetuating orbital debris.³⁰⁰ The results of this article helped the DoD, along with NASA, evolve their debris mitigation practices, in specific to prevent Delta rocket body breakups.³⁰¹ Additionally, Kessler published a paper that same year called ‘Collision Frequency of Artificial Satellites: The Creation of Debris Belt,’³⁰² which provided a prediction stating:

By 2000, the density of space debris in Earth’s orbit would be so great that random collisions would be inevitable, and that the outcome of these random collisions would be more debris, and subsequently more collisions. This later became known as the ‘Kessler’ Effect or Syndrome.³⁰³

Between 1978 and 1979, two major events occurred increasing NASA’s space debris awareness.³⁰⁴ The first was the reentry of Soviet Satellite *Cosmos 954* and the second was the re-entry of *Skylab*.³⁰⁵ U.S. Secretary of State Cyrus Vance, shook by the disastrous re-

²⁹⁷ Ibid.

²⁹⁸ Portree and Loftus, “Orbital Debris: A Chronology,” 21; Donald J. Kessler, “Space-Debris – Environmental Assessment Needed” (JSC 11539), July 1976; Thornton L. Page, Andrew E. Potter, and Donald J. Kessler, “The History of Orbital Debris,” 1990 (unpublished draft paper).

²⁹⁹ Portree and Loftus, “Orbital Debris: A Chronology, 23; “Burton Cour-Palais and Donald J. Kessler, “Space Debris – Environmental Update I” (JSC 12949), June 1977; Thornton L. Page, Andrew E. Potter, and Donald J. Kessler, “The History of Orbital Debris,” 1990 (unpublished draft paper).

³⁰⁰ Sorge and Vojtek, “Space Debris Mitigation Policy.”

³⁰¹ Ibid.

³⁰² NASA Scientist Donald J. Kessler, as quoted in Michelle La Vone, “Kessler Syndrome: 10 Interesting and Disturbing Facts,” *Space Safety Magazine*, <http://www.spacesafetymagazine.com/space-debris/kessler-syndrome/>.

³⁰³ Ibid.

³⁰⁴ Kessler, “A Partial History of Orbital Debris: A Personal View.”

³⁰⁵ Ibid.

entry of *Cosmos 954*, began to seek more information regarding harmful objects orbiting the Earth.³⁰⁶ As noted by Elizabeth Hanes, “the unexpected crash of *Cosmos 954* in northern Canada had scattered enriched uranium across a large grassland area, which provoked global fear that a similar outcome could occur with *Skylab*’s reentry.”³⁰⁷ Although the *Skylab* space station contained no radioactive components, the fear of damage to Earth was a real threat.³⁰⁸ In May 1981, “pieces from a Delta second stage explosion were recorded and later found to make up approximately 27 percent of the tracked objects of orbital periods under 225 minutes.”³⁰⁹ The creator of the Delta rocket bodies, McDonnell Douglas Space Systems Company, was notified and an assessment was conducted that later resulted in the elimination of future explosions.³¹⁰ This was the first successful effort conducted to mitigate space debris.³¹¹

In the late 1980s, U.N. COPUOS began addressing concerns regarding space debris.³¹² Over the next decade, Aerospace Corporation, NASA, and other organizations participated in studies which resulted in an increased knowledge on the potential threat to spacecraft and their architectures due to the rapid and continued growth of space debris.³¹³ These studies resulted in “new requirements and changes to spacecraft design, operations, and end-of-life standard practices.”³¹⁴ At this time, the Soviets continued making improvements in their co-orbital ASAT program, leaving the U.S. concerned because of its deficiencies in ASAT technology.³¹⁵ In terms of a space debris problem, experts from

³⁰⁶ Ibid.

³⁰⁷ Elizabeth Hanes, “The Day Skylab Crashed to Earth: Facts About the First U.S. Space Station’s Re-Entry,” History, July 11, 2012, www.history.com/news/the-day-skylab-crashed-to-earth-facts-about-the-first-u-s-space-stations-re-entry.

³⁰⁸ Ibid.

³⁰⁹ Sorge and Vojtek, “Space Debris Mitigation Policy.”

³¹⁰ Ibid.

³¹¹ Ibid.

³¹² Ibid.

³¹³ Ibid.

³¹⁴ Ibid.

³¹⁵ Moltz, *The Politics of Space Security*, 201–202.

NASA and other engineering companies, recognized the potential these weapons had to create massive amounts of debris, which would result in U.S. security issues in space.³¹⁶ These concerns were voiced to the Air Force, causing debates within the U.S. Space Command in Colorado Springs.³¹⁷ Even the North American Aerospace Defense (NORAD) commander in chief agreed with these objections, but the Air Force, on September 13, 1985, continued with an ASAT test despite the warnings on space debris.³¹⁸ The “missile was launched from an F-15 carrying a Miniature Home Vehicle (MHV) and successfully intercepted an aging *Solwind* satellite.”³¹⁹ Nicholas Johnson, later NASA’s chief scientist for debris mitigation, stated “the test created 285 pieces of trackable orbital debris, and an unknown quantity of smaller orbital debris.”³²⁰ This test sparked political issues within Congress regarding future ASAT tests, but, most importantly, the Air Force realized the threat kinetic kill activities pose to U.S. space assets and the orbital environment.³²¹ In March 1986, the DoD realized the impact space debris could have on future military operations and committed themselves to addressing the problem.³²² The DoD adopted new debris mitigation guidelines, which stated: “Design and operations of DoD space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements.”³²³ Moltz mentions that although this new policy did not prohibit debris-causing tests, it was significant because it reiterated the problem and highlighted DoD’s commitment to helping mitigate debris.³²⁴

³¹⁶ Ibid., 202.

³¹⁷ Nicholas Johnson interview, as conducted by Moltz in Ibid.

³¹⁸ Moltz, *The Politics of Space Security*, 202.

³¹⁹ Ibid.

³²⁰ Nicholas Johnson interview, as conducted by Moltz in Ibid.

³²¹ Moltz, *The Politics of Space Security*, 202–203.

³²² Ibid., 203.

³²³ DoD statement quoted in William J. Broad, “Orbiting Junk Threatens Space Missions,” *New York Times*, August 4, 1987, p. C1., as cited by Moltz in Ibid.

³²⁴ Moltz, *The Politics of Space Security*, 203.

In 1988, for the first time in U.S. national space policy, Ronald Reagan included “the need to minimize the creation of space debris”³²⁵ in its rhetoric.³²⁶ Shortly after releasing the national space policy, an interagency report on orbital debris was published in 1989.³²⁷ It called for a joint NASA-DoD effort to produce accurate and extensive orbital debris studies, as well as mandated international cooperation on the issue.³²⁸ Over the next few years, studies and international support increased regarding the effects and mitigation techniques for orbital space debris.³²⁹

In 1993, “the Inter-Agency Space Debris Coordination Committee (IADC) was established as an international governmental forum for the worldwide coordination of activities related to the issues of man-made and natural debris in space.”³³⁰ The IADC facilitates “the exchange of information on space debris research activities between member space agencies”³³¹ in hopes of creating guidelines for international collaboration in mitigation and removal techniques.³³² In 1996, “President Clinton signed the new national space policy, which incorporated recommendations contained in the November 1995 *Interagency Report on Orbital Debris* (released in February 1996).”³³³ It addressed the commitment and interest to ensure that space debris minimization was of high priority not only to the U.S., but to other space-faring nations and international organizations.³³⁴ Through IADC, “beginning in the late 1990s, the United States would lead effort on debris

³²⁵ Sorge and Vojtek, “Space Debris Mitigation Policy.”

³²⁶ Ibid.

³²⁷ Ibid.

³²⁸ Portree and Loftus, “Orbital Debris: A Chronology,” 60.

³²⁹ Ibid.

³³⁰ Inter-Agency Space Debris Coordination Committee, IADC Space Debris Guidelines: IADC-02-01 (Steering Group and Working Group 4, 2007), [www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space Debris-Guidelines-Revision1.pdf](http://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space%20Debris-Guidelines-Revision1.pdf).

³³¹ Ibid

³³² Ibid.

³³³ Portree and Loftus, “Orbital Debris: A Chronology,” 117.

³³⁴ Ibid.

mitigation and initiating discussions on drafts for formal Space Debris Mitigation Guidelines to be adopted at an international level.”³³⁵

In 1999, the COPUOS published its Technical Report on space debris.³³⁶ The report concluded, at this time, the threat of space debris to satellites was extremely low.³³⁷ But the report also discussed the growth in the debris population and the potential for the risk of collisions and damage to increase in the future.³³⁸ In 2002, IADC released guidelines that were supported by the international community to assist in the efforts to halt the rapid growth of debris in space.³³⁹ A major event occurred a few years later, which sent the international community into a frenzy regarding space debris. In January 2007, an ASAT test was conducted by China against a non-operational weather satellite *Fengyun-1C*.³⁴⁰ The ASAT impact “instantly created around 4,500 pieces of space debris, some 3,000 remain in orbit today.”³⁴¹ The Chinese thought they “had done nothing more than test a technology developed decades before by the Soviet Union and the United States,” but they clearly miscalculated the international reaction.³⁴² This test rallied the space community into a new discussion about space security, especially in the realm of space debris.³⁴³ Shortly after this test in June 2007, with the support of all the major space-faring nations, the U.N. COPUOS approved the Space Debris Mitigation Guidelines.³⁴⁴ In the fall, this voluntary set of measures was forwarded to the United Nations for an official

³³⁵ Nicholas Johnson interview, as conducted by author in Moltz, *The Politics of Space Security*, 246.

³³⁶ Inter-Agency Space Debris Coordination Committee, IADC Space Debris Guidelines: IADC-02-01.

³³⁷ Ibid.

³³⁸ Ibid.

³³⁹ Sorge and Vojtek, “Space Debris Mitigation Policy.”

³⁴⁰ Micah Zenko, “Waste of Space,” *Foreign Policy Magazine*, April 21, 2014, <http://foreignpolicy.com/2014/04/21/waste-of-space/>.

³⁴¹ Ibid.

³⁴² Moltz, *The Politics of Space Security*, 298.

³⁴³ Ibid., 299.

³⁴⁴ Ibid.

vote.³⁴⁵ Due to this significant event, space debris was brought to the forefront of international space concerns.³⁴⁶ Here are some of the major topics addressed in the 2007 Space Debris Mitigation Guidelines:

(1) Preventing on-orbit break-ups, (2) Removing spacecraft and orbital stages that have reached the end of their mission operations from the useful densely populated orbit regions, (3) Preventing debris of orbits longer than 25 years, (4) Preventing on-orbit collisions, and (5) Limiting the objects released during normal operations.³⁴⁷

In February 2008, the Navy launched an SM-3 missile from the USS *Lake Erie* targeting *USA 193*.³⁴⁸ This event is not considered to have increased the number of space debris in orbit due to the prior planning and coordination of the shootdown.³⁴⁹

Due to the relatively low altitude of the satellite at the time of engagement, debris will begin to re-enter the Earth's atmosphere immediately. Nearly all of the debris will burn up from reentry within 24–48 hours and the remaining debris should re-enter within 40 days.³⁵⁰

The next major incident in space debris creation was in February 2009 due primarily to human error and negligence.³⁵¹ According to Micah Zenko, “an active U.S. *Iridium* communication satellite and a defunct Russian satellite unexpectedly collided roughly 500 miles above Siberia.”³⁵² This event, which could have been avoided, “caused around 2,100 pieces of debris that were larger than 10 cm.”³⁵³ The numbers calculated are for those

³⁴⁵ Ibid.

³⁴⁶ Ibid.

³⁴⁷ Inter-Agency Space Debris Coordination Committee, “IADC Space Debris Guidelines: IADC-02-01.”

³⁴⁸ The Reentry of Space Object USA 193,” Australian Space Academy, Accessed on March 8, 2018, www.spaceacademy.net.au/watch/debris/usa193.htm.

³⁴⁹ Ibid.

³⁵⁰ Ibid.

³⁵¹ Zenko, “Waste of Space.”

³⁵² Ibid.

³⁵³ Ibid.

space debris that can currently be tracked; the number that are too small to track is unknown, posing a significant threat to spacecraft in lower Earth orbits.³⁵⁴

On January 22, 2013, a small Russian satellite, “*Ball Lens In The Space (BLITS)*,”³⁵⁵ was struck by space debris that had been created from the Chinese ASAT test against *Fengyun 1C* Satellite in 2007.³⁵⁶ Russian scientists Vasiliy Yurasov and Andrey Nazarenko, both with the Institute for Precision Instrument Engineering (IPIE), noticed a change in performance, altitude, and velocity in their nanosatellite.³⁵⁷ The scientists said “it was not immediately clear whether the satellite was merely wounded or completely incapacitated.”³⁵⁸ According to Leonard David, “the International Laser Ranging Service later confirmed that *BLITS* had indeed collided with a piece of space debris”³⁵⁹ from the Chinese ASAT test.³⁶⁰ Additionally, the *International Space Station (ISS)* has also been hit by tiny fragments from satellites or lost equipment.³⁶¹ In 2014, “NASA had to perform special maneuvers to raise the ISS’s altitude by half a mile to avoid a part of a European rocket barreling down into its orbital plane.”³⁶²

In the beginning, space debris was being produced in insignificant amounts by normal spacecraft activities. Space debris included “upper stages of launch vehicles,

³⁵⁴ Nicholas Johnson, as quoted in Patrick Caughill, “500,000 Pieces of Space Junk are orbiting the Earth. Here’s how we can get rid of them,” *Futurism.com*, April 9, 2017, <https://futurism.com/500000-pieces-space-junk-orbiting-earth-get-rid/>.

³⁵⁵ Leonard David, “Russian Satellite Hit by Debris from Chinese Anti-Satellite Test,” *Space.com*, March 8, 2013, <https://www.space.com/20138-russian-satellite-chinese-space-junk.html>.

³⁵⁶ *Ibid.*

³⁵⁷ *Ibid.*

³⁵⁸ Vasiliy Yurasov and Andrey Nazarenko, as quoted in *Ibid.*

³⁵⁹ David, “Russian Satellite Hit by Debris from Chinese Anti-Satellite Test.”

³⁶⁰ Vasiliy Yurasov and Andrey Nazarenko, as quoted in David, “Russian Satellite Hit by Debris from Chinese Anti-Satellite Test.”

³⁶¹ Lizzie Plaugic, “This is what happens when a tiny piece of flying space debris hits ISS,” *The Verge.com*, May 12, 2016, <https://www.theverge.com/2016/5/12/11664668/iss-window-chip-space-debris-tim-peake>.

³⁶² *Ibid.*

disabled spacecraft, dead batteries, solid rocket motor waste, and refuse from human missions.”³⁶³ According to NASA,

the first 40 years of space exploration produced the first 10,000 pieces of softball-sized debris. But in the last decade alone, 13,000 pieces were created in space, which increased the number of total space objects by over sixty percent.³⁶⁴

The history shows the growth of the field of orbital space debris, and it is an ugly picture for the future of space. Recent incidents, like the ones mentioned above, will continue to occur due to the increasing threat of space debris.

C. THREAT OF SPACE DEBRIS

On April 21, 2017, there was an agreement among the participants at the 7th European Conference on Space Debris, “that the continuing growth in space debris posed an urgent threat to vital orbital regimes.”³⁶⁵ Previously, in 2016, J. C. Liou, NASA Chief Scientist for Orbital Debris, provided a presentation at the 4th ASEAN Regional Forum Workshop on Space Security in Singapore displaying the significant increase in debris orbiting in the near-Earth space environment.³⁶⁶ During this presentation, they presented a graphic showing the progression of space debris starting before 1957 to 2016, which can be seen in Figure 1.

³⁶³ Zenko, “Waste of Space.”

³⁶⁴ According to NASA, as quoted in Ibid.

³⁶⁵ “International Consensus on Debris Threat: Findings from the 7th European Conference on Space Debris,” European Space Agency, April 21, 2017, www.esa.int/Our_Activities/Operations/Space_Debris/International_consensus_on_debris_threat.

³⁶⁶ J. C. Liou, “Growth of Orbital Debris” (presentation, NASA, The 4th ASEAN Regional Forum Workshop on Space Security Singapore, 24–25 October 2016), <https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20160012733.pdf>.

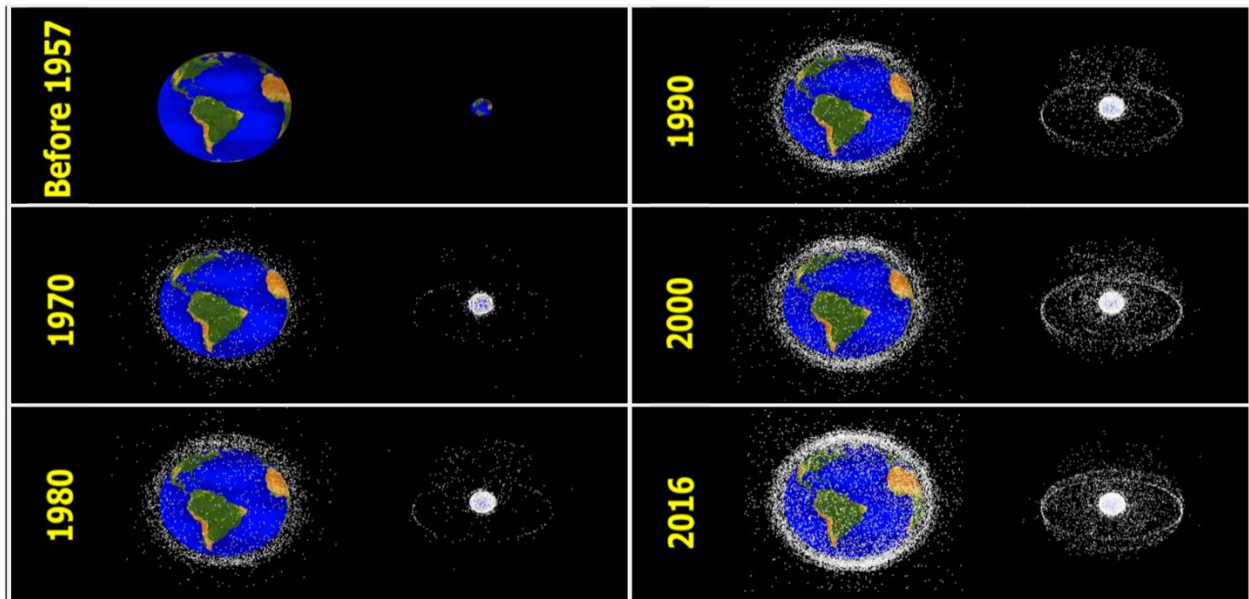


Figure 1. The Near-Earth Space Environment³⁶⁷

According to NASA, “space debris is any man-made object in orbit about the Earth which no longer serves a useful function. Such debris includes non-functional spacecraft, abandoned launch vehicle stages, mission-related debris, and fragmentation debris.”³⁶⁸ One of the conclusions from the recent 7th European Conference on Space Debris “estimated there to be around 750,000 objects larger than 1 cm and an astounding 166 million objects larger than 1 mm that reside in commercially, militarily, and scientifically valuable Earth orbits.”³⁶⁹

The challenging aspect to space debris is those debris that are too small to be tracked.³⁷⁰ NASA believes “that there are millions of pieces of debris”³⁷¹ the size of tiny paint flecks, which are untrackable due to their small size, but could damage a spacecraft

³⁶⁷ J. C. Liou, “Growth of Orbital Debris.”

³⁶⁸ “Space Debris and Human Spacecraft,” NASA, September 26, 2013, https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.

³⁶⁹ “International Consensus on Debris Threat: Findings from the 7th European Conference on Space Debris,” European Space Agency.

³⁷⁰ NASA, “Space Debris and Human Spacecraft.”

³⁷¹ Ibid.

due their velocity of roughly 17,500 mph.³⁷² Nicholas Johnson, NASA chief scientist for orbital debris, warns that non-trackable debris are the most significant threat to future missions in space.³⁷³ Additionally, space debris pose a problem at both lower and higher altitudes because they tend to hang around for long periods of time.³⁷⁴ In lower orbits, space debris “will eventually be pulled by the Earth’s gravity and burn-up upon re-entering,”³⁷⁵ but until that time they threaten spacecraft in LEO.³⁷⁶ The U.S. military operates a majority of its essential satellites in LEO.³⁷⁷ The United States is not the only country at risk because almost “half of the world’s 1,100 active satellites operate in LEO.”³⁷⁸ Dr. Joel Primack, professor of Physics at the University of California, Santa Cruz, gives us a break-down on the physics of debris in his article “Debris and Future Space Activities.” Dr. Primack states “debris in orbits higher than about 800 kilometers (km) above the Earth’s surface will be up there for decades, above 1,000 km for centuries, and above 1,500 km effectively forever.”³⁷⁹ Therefore, there is a significant risk at higher altitudes for collisions with pieces of debris, thus creating a never-ending cycle of debris creation.³⁸⁰

D. OUTER SPACE TREATY ANALYSIS

According to Ram S Jakhu and Tanveer Ahmad, “the issue of space debris mitigation has not been explicitly addressed in the five primary UN treaties that deal with

³⁷² Ibid.

³⁷³ Nicholas Johnson, as quoted in NASA, “Space Debris and Human Spacecraft.”

³⁷⁴ Zenko, “Waste of Space.”

³⁷⁵ Ibid.

³⁷⁶ Ibid.

³⁷⁷ Ibid.

³⁷⁸ Ibid.

³⁷⁹ Joel R. Primack, “Debris and Future Space Activities” (Occasional Paper No. 10, Middlebury Institute of International Studies at Monterey: James Martin Center for Nonproliferation Studies, 2002), 18–22, <http://www.nonproliferation.org/wp-content/uploads/2016/09/op10.pdf>, 18.

³⁸⁰ Ibid.

outer space and related activities.”³⁸¹ The analysis conducted in this section will discuss the OST’s ability or inability to provide guidelines to cover space debris mitigation and removal. This case study presents the hypothesis: If the current amount of space debris continues to expand, endangering space-based assets, it is likely there will be conjunctions that could cause conflict in the foreseeable future that the OST cannot prevent. The previous section showed the threat of increased space debris to space-based assets; this section will address whether the articles within the OST can cover the increasing issues regarding space debris in the 21st century.

Several provisions of the OST could be interpreted to demonstrate the treaty’s ability to address and regulate debris mitigation and active debris removal.³⁸² But, it is important to note that space debris is not specifically mentioned in the OST nor is there an internationally agreed upon definition.³⁸³ Joanne Wheeler states “the OST offers minimal guidance regarding space debris mitigation at the state level,”³⁸⁴ leaving room for different interpretations.³⁸⁵ The following discussion will highlight specific articles in the OST and analyze potential interpretations to see whether the treaty can adequately cover the threat of space debris.

Article I of the OST “provides that the exploration and use of outer space shall be carried out for the benefit and in the interests of all countries ... and shall be the province of all humankind.”³⁸⁶ Interpretations supporting the OST address the idea that this article implies that states subject to the treaty have an obligation to mitigate debris.³⁸⁷ As mentioned in the previous section, space debris pose a significant threat to space-based

³⁸¹ Ram S Jakhu and Tanveer Ahmad, “The Outer Space Treaty and states’ obligation to remove space debris: a U.S. perspective,” *The Space Review*, November 13, 2017, www.thespacereview.com/article/3370/1.

³⁸² *Ibid.*

³⁸³ Joanne Wheeler, “Space debris: The legal issues,” *Royal Aeronautical Society*, January, 3, 2014, <https://www.aerosociety.com/news/space-debris-the-legal-issues/>.

³⁸⁴ *Ibid.*

³⁸⁵ *Ibid.*

³⁸⁶ Outer Space Treaty, as quoted in Jakhu and Ahmad, “The Outer Space Treaty and states’ obligation to remove space debris: a U.S. perspective.”

³⁸⁷ *Ibid.*

assets and could potentially hinder countries from freely exploring and using outer space.³⁸⁸

Articles VI and VII could potentially provide guidelines for the threat of space debris. According to Article VI, “states are responsible for their national space activities conducted by either the government or non-governmental entities.”³⁸⁹ Article VII holds “the launching state internationally liable to compensate for damage caused by its space objects or component parts to another state party to the OST or to its natural or juridical persons.”³⁹⁰ These articles are just a baseline and require an additional amount of guidance from the Liability Convention.³⁹¹ Regarding Article VI and VII, the OST will likely not be able to prevent conflict in the event a conjunction occurs. The OST is a starting point, but it cannot be treated as the standalone policy to prevent conflict regarding liability fault.

The Liability Convention, although not perfect, represents a more effective regulation in terms of liability and the space environment.³⁹² The Liability Convention provides guidelines on damage and compensation caused by objects in space.³⁹³ But a few issues with the guidelines could make problems worse regarding space debris. In Article I of the Convention, the term “space object,”³⁹⁴ is defined which “includes component parts of a space object as well as its launch vehicle and parts thereof.”³⁹⁵ This definition raises

³⁸⁸ Ibid.

³⁸⁹ Ibid.

³⁹⁰ Ibid.

³⁹¹ Jakhu and Ahmad, “The Outer Space Treaty and states’ obligation to remove space debris: a U.S. perspective.”

³⁹² Lawrence D. Roberts, “Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes,” *Boston College International and Comparative Law Review*, Vol. 15 Issue 1 (December 1, 1992), pgs. 51–73, <http://lawdigitalcommons.bc.edu/cgi/viewcontent.cgi?article=1531&context=iclr>, 63.

³⁹³ Ibid.

³⁹⁴ Resolution 2777 (XXVI) Convention on International Liability for Damage Caused by Space Objects, General Assembly, 26th Session (1971), <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/liability-convention.html>; Also cited in Roberts, “Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes.” and Frans G. von der Dunk, “The 1972 Liability Convention: Enhancing Adherence and Effective Application.”

³⁹⁵ Ibid.

the question to what extent does the term space debris fall within the term space object.³⁹⁶ The issue is that in most cases space debris cannot be attributed to a specific space object.³⁹⁷ An additional problem deals with the Liability Convention's inability to provide solutions or support when damage is caused by an untraceable space debris.³⁹⁸ The final major concern is regarding the Article I's definition for "damage."³⁹⁹ The definition for "damage equates to loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations."⁴⁰⁰ The argument is that "damage is confined to just physical damage to property and mental damage to personnel."⁴⁰¹ The definition provided shows no concern for the overall damage to the space environment, which is exactly what space debris harms.⁴⁰²

Article IX of the OST could potentially provide guidelines on space debris mitigation. Article IX states:

in the exploration and use of outer space, ... States parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space ... with due regard to the corresponding interests of all other State Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space ... and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of

³⁹⁶ Frans G. von der Dunk, "The 1972 Liability Convention: Enhancing Adherence and Effective Application," *University of Nebraska Digital Commons: Space, Cyber, and Telecommunications Law Program Faculty Publications*, 1998, pgs. 366–373, <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=https://www.bing.com/&httpsredir=1&article=1049&context=spacelaw>, 368.

³⁹⁷ Ibid.

³⁹⁸ Ibid.

³⁹⁹ Ibid., 369.

⁴⁰⁰ Resolution 2777 (XXVI) Convention on International Liability for Damage Caused by Space Objects, General Assembly.

⁴⁰¹ Von der Dunk, "The 1972 Liability Convention: Enhancing Adherence and Effective Application," 369; See also P.L. Meredith and G.S. Robinson, *Space Law: A Case Study for the Practitioner* (1992), 62–4; C.Q. Christol, *The Modern International Law of Outer Space* (1982), 97–100; S. Gorove, *Developments in Space Law* (1991), 224–242.

⁴⁰² Von der Dunk, "The 1972 Liability Convention: Enhancing Adherence and Effective Application," 369.

extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.⁴⁰³

Article IX mentions “that state parties shall conduct all their activities in space with due regard to the corresponding interests of all other State Parties.”⁴⁰⁴ One interpretation of this, presented by Joanne Wheeler, could be that “State Parties are obliged to avoid the creation of, reduce, and even remove, space debris.”⁴⁰⁵ By having State Parties oblige, it allows for nations to continue to explore and use space without the increased fear of collisions with space debris.⁴⁰⁶ Another aspect of Article IX that should be highlighted is the phrase “so as to avoid harmful contamination”⁴⁰⁷ and the clause stating “that State Parties shall adopt appropriate measures for this purpose.”⁴⁰⁸ This article provides no guidance or information as to what exactly “harmful contamination”⁴⁰⁹ is or what constitutes an appropriate measure.⁴¹⁰ Could space debris be considered as “harmful contamination?”⁴¹¹ According to Wheeler, she believes that phrase is used to prevent contamination produced by biological or radioactive materials and it does not refer to space debris.⁴¹² Another aspect of Article IX worth mentioning is where it calls on nations to avoid “activities that could cause harmful interference with the activities of other State Parties in the ... use of outer space”⁴¹³ and to “undertake appropriate international

⁴⁰³ Outer Space Treaty, U.S. State Department.

⁴⁰⁴ Outer Space Treaty, as quoted in Wheeler, “Space debris: The legal issues.”

⁴⁰⁵ Ibid.

⁴⁰⁶ Ibid.

⁴⁰⁷ Outer Space Treaty, as quoted in Ibid.

⁴⁰⁸ Ibid.

⁴⁰⁹ Ibid.

⁴¹⁰ Wheeler, “Space debris: The legal issues.”

⁴¹¹ Outer Space Treaty, as quoted in Ibid.

⁴¹² Ibid.

⁴¹³ Outer Space Treaty, as quoted in Ibid.

consultations before proceeding with any such activity.”⁴¹⁴ One interesting point made by Michael J. Listner suggests “that orbital debris is already interfering now with State Parties to the OST”⁴¹⁵ and therefore attributable debris could be considered a violation of Article IX.⁴¹⁶ Another interpretation, presented by Wheeler, discusses the issues with consultations regarding activities that could potentially cause space debris; she says “it is difficult to describe the existence or creation of space debris as a future ‘planned’ activity.”⁴¹⁷ Additionally, there are no guidelines or regulations that allow State parties to retroactively address past activities that created space debris.⁴¹⁸

The analysis conducted above on the OST leads to the conclusion that although certain articles could be interpreted to cover the current debris issue, it is not all encompassing and leaves too much to interpretation to adequately prevent conflict in the 21st century. In the following section, real events and hypothetical scenarios will be presented just to reemphasize the OST inability to address the current threat of space debris. In the concluding chapter of this thesis, potential recommendations will be provided to address and overcome the gaps within the OST.

E. POTENTIAL FUTURE CONFLICTS

According to scientists, quoted by Ian Sample, Science Editor for the *Guardian* news, “the steady rise in space junk that is floating around the planet could provoke a political row and even armed conflict.”⁴¹⁹ During the Space Foundation’s 27th National Symposium in 2011, Commander of U.S. Air Force Command at the time, General William

⁴¹⁴ Outer Space Treaty, as quoted in Michael J. Listner, “Space Debris Remediation and The Customary Usage of Article IX,” *Space Thoughts* (blog), November 10, 2015, <https://spacethoughtsblog.wordpress.com/2015/11/10/space-debris-remediation-and-the-customary-usage-of-article-ix/>.

⁴¹⁵ Listner, “Space Debris Remediation and The Customary Usage of Article IX.”

⁴¹⁶ Ibid.

⁴¹⁷ Wheeler, “Space debris: The legal issues.”

⁴¹⁸ Ibid.

⁴¹⁹ Scientists, as quoted in Ian Sample, “Rise in space junk could prove armed conflict say scientists,” *The Guardian*, January 22, 2016, <https://www.theguardian.com/science/2016/jan/22/rise-in-space-junk-could-provoke-armed-conflict-say-scientists>.

Shelton, said it best when he said “the traffic is increasing. We’ve now got over 50 nations that are participants in the space environment.”⁴²⁰ Additionally, the space environment is no longer just nation states or government agencies, the commercial and private sectors have entered into the domain adding a new area of concern if space debris are not addressed on a more serious arena.⁴²¹ This section will consider the potential conflicts that could occur regarding space debris separated by those that are most likely or most dangerous. Additionally, hypothetical scenarios will be discussed to emphasize the reality of future conflict regarding space debris.

1. Most Likely

Marshall Kaplan, an orbital debris expert within the Space Department at the John Hopkins Applied Physics Laboratory, states “the buildup of debris is not a naturally reversible process. If we are to clean up space, it will certainly be complex and very expensive.”⁴²² The major question is who is going to pay for it? As mentioned above, there are over 50 nations in space⁴²³; is it realistic to think that each space-faring nation will contribute to the clean-up in space? Or will one or two countries take on much of the cost? Even Kaplan suggests that “it is unlikely space-faring nations are going to do anything significant about cleaning up space; as any cleanup would be too expensive.”⁴²⁴ Additionally, Kaplan addresses the lack of technology available to economically cleanup space, and with increased technology comes added costs.⁴²⁵ And, if the capability exists to remove space objects from outer space, this could then potentially become a more dangerous concern. What if that technology could also be used as a space weapon to pluck adversary satellites from the sky? That could potentially cause conflicts that would reach

⁴²⁰ General William Shelton, as quoted in Leonard David, “Ugly truth of space junk: No feasible solutions,” Space on NBC NEWS.com, May 10, 2011, www.nbcnews.com/id/42975224/ns/technology_and_science-space/t/ugly-truth-space-junk-no-feasible-solutions/#.WqLFq0xFzD5.

⁴²¹ Sample, “Rise in space junk could prove armed conflict say scientists.”

⁴²² Marshall Kaplan, as quoted in David, “Ugly truth of space junk: No feasible solutions.”

⁴²³ General William Shelton, as quoted in David, “Ugly Truth of space junk: No feasible solutions.”

⁴²⁴ Marshall Kaplan, as quoted in David, “Ugly Truth of space junk: No feasible solutions.”

⁴²⁵ Ibid.

both political and military arenas. Furthermore, space debris increase the risk of collisions occurring in outer space, which, in turn, raise costs of operating satellites.⁴²⁶ Operators have to consider in the design phase “greater expenditures of fuel and interruptions of missions from space debris avoidance maneuvers.”⁴²⁷ These rising costs could potentially “make it financially unviable to perform certain types of space missions in the future, leading to loss of social benefits.”⁴²⁸ The goal is to preserve space for all to use safely without worry from space debris, but these questions and concerns proposed suggest that cost is one of the most likely international disputes or disagreements that will be faced in the future. If not addressed, it could lead to more alarming conflicts. Let us imagine a hypothetical scenario: A proposed international agreement suggests creating an international agency that is solely dedicated to developing space debris mitigation technology. This agency is different than IADC, as it is specifically dedicated to the research and development of technology, only to be used for space debris mitigation and clean-up. In this proposed agreement, it suggests that representatives from each space-faring nations and additional countries that have signed the OST be sent to this agency and that the budget for these developing technologies and inventions be split among the space-faring nations governments. What happens if Russia or the United States decide not to contribute? Will one country carry the burden of all the costs? What if a space-faring nation do not have the means to afford it? Do they not get to participate in space? These scenarios could occur in the future if space debris is not addressed on an international level.

An additional likely conflict deals with the issue of liability and attribution; what is the solution to damage caused by space debris that is unattributable “to a certain space object and thereby to a certain nation state?”⁴²⁹ Although Articles VI and VII of the OST could provide guidelines for a collision that can be attributed, realistically, they are too

⁴²⁶ Brian Weeden, “The economics of space sustainability,” *The Space Review*, June 4, 2012, www.thespacereview.com/article/2093/1.

⁴²⁷ Ibid.

⁴²⁸ Ibid.

⁴²⁹ Frans von der Dunk, “Space Debris and the Law,” *Space, Cyber, and Telecommunications Law Program Faculty Publications*, 2001, <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?referer=https://www.bing.com/&httpsredir=1&article=1003&context=spacelaw>.

generic to address all the various scenarios that could occur regarding space debris.⁴³⁰ Let us imagine two hypothetical scenarios. First, a U.S. satellite is struck by space debris that can be attributed to the 2007 Chinese ASAT test, causing severe damage; and, second, an essential U.S. military satellite is struck by unattributed space debris, causing severe damage as well as disrupting U.S. military operations. These two scenarios could very well happen. The first scenario has the likelihood to cause political instability, which could lead to a military confrontation. If it were a commercial U.S. Satellite, then the U.S. could demand compensation for damages through the Liability Convention. But what if the Chinese refuse to admit guilt or refuse to pay? That is going to cause some political tensions between the United States and China. Now, if the satellite hit were a strategic U.S. military satellite, then this could cause a little more strife within the military community. This scenario would not likely lead to war, but it does have the potential to create tension between the U.S. military and the Chinese government. The second scenario causes even more concern because the collision cannot be attributed and, therefore, the U.S. military must operate without a certain capability and must bear the costs to fix it. Military service operators could be in danger for a period of time, while that satellite is non-operational. Additionally, it does not have to be a U.S. satellite, what if the *International Space Station* were struck? Commercial companies are also promoting space tourism as well. The potential for innocent lives to be lost raises the level of conflict to a higher level, especially if that debris can be attributed to another country. The scenarios and concerns presented above suggest that liability and attribution are two of the more likely issues that could create political instabilities or even military disputes.

2. Most Dangerous

One of the more dangerous concerns is the idea that the world will reach “a point of no return in space”⁴³¹ meaning there will be so much space junk that the ability to operate ceases to exist.⁴³² In Marshall Kaplan’s view, “space-faring nations have already

⁴³⁰ Wheeler, “Space debris: The legal issues.”

⁴³¹ Marshall Kaplan, as quoted in David, “Ugly truth of space junk: No feasible solutions.”

⁴³² Ibid.

passed the point of no return, with the accumulation of debris objects in LEO steadily building over the past 50 years.”⁴³³ As discussed earlier, NASA’s Kessler, established a similar concept called the Kessler Syndrome, which stated “when debris reaches a critical density in particular orbit, it can set off a chain reaction of collisions that create more debris, eventually making the orbit unusable.”⁴³⁴ The importance of this statement is with the word “eventually,” because Kessler understood that this process could take decades.⁴³⁵ But, he wanted the world, especially the U.S., “to understand that if we don’t actively start removing five to ten objects per year for the next 100 years, we’ll have an unstable environment.”⁴³⁶ Unstable environments have the potential to lead to political and military crisis.

For example, imagine a hypothetical future scenario where LEO has been banned for satellite usage due to the immense amount of traffic, which no longer allows satellites to orbit safely without being hit by debris. Also, the satellites left in LEO are colliding with one another, creating even more debris and, additionally, making it difficult to launch satellites into higher orbits. This becomes a global conflict; militaries lose capabilities, and civilians lose basic luxuries that commercial space offers such as Internet connectivity, satellite television broadcasts, and other communications. The scenario presented above could result in an international crisis, creating the potential for more dangerous political and military disputes and disagreements. If space were unusable, the world might then become unstable, since we now depend on a variety of data from space for society, national militaries, and the international economy to function.

The loss of satellites, specifically military assets, to space debris could incite armed conflict between space-faring nations.⁴³⁷ Armed conflict or even war in space would be the most dangerous possibility resulting from space debris collisions. Vitaly Adushkin,

⁴³³ Ibid.

⁴³⁴ Donald Kessler, as quoted in Foust, “Cleaning up space junk.”

⁴³⁵ Ibid.

⁴³⁶ Ibid.

⁴³⁷ Vitaly Adushkin, as quoted in “How space junk could lead to war,” *The Week Magazine*, January 26, 2016, www.theweek.co.uk/space/68922/how-space-junk-could-lead-to-war.

from the Russian Academy of Sciences, says that there can only be two likelihoods when a military defense satellite suddenly fails: “an unregistered collision with space debris or an aggressive action by an adversary.”⁴³⁸ Both of those possibilities deal with a sensitivity that has the potential to become a politically or militarily dangerous conflict.⁴³⁹

F. CONCLUSION

The amount of space debris is increasing apace; as it continues to increase, so does the risk of collisions to both government and commercial space assets. This case study discussed the progression of space debris through history showing the steady and continuing increase over time. Space debris was not a high priority issue during the creation of the OST due to the limited amount of debris orbiting the earth during that time. This case study also addressed the threat that space debris plays in the 21st century and discussed the importance of evaluating the OST’s ability to guide and direct space-faring nations on this issue. The analysis of the OST’s capability to aid in the challenges posed by space debris determined that even though certain articles could cover the issue, they are too generic to cover all the possible space debris scenarios that could occur in space, and they offer no specific remedies. Therefore, in conclusion, the OST without amendment, would not be able to prevent conflicts resulting from space debris collisions from occurring in the 21st century.

⁴³⁸ Ibid.

⁴³⁹ Ibid.

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III. WEAPONIZATION OF SPACE CASE STUDY

A. INTRODUCTION

The weaponization of space in the 21st century represents a dangerous threat to the security of everyone on Earth.⁴⁴⁰ But, some argue that space weapons, rather than being a threat, provide deterrence and therefore could be considered a stabilizing effort.⁴⁴¹ U.S. General John E. Hyten, commander of U.S. Strategic Command, suggests “deterrence means war will never be fought in space”⁴⁴² and “the best way to prevent war is to be prepared for war.”⁴⁴³ For the purpose of this thesis, I will define a space weapon as anything that can be used to cause damage to any component of a satellite’s architecture (i.e., ground, link, or spacecraft) or deny its services from being accessed. This section will present a case study on the threat of weaponizing space and address whether the Outer Space Treaty could prevent future conflict. The case study will be divided into four parts: 1) an historical analysis of weaponizing space; 2) the threat of space weapons in the 21st century; 3) an Outer Space Treaty analysis; and 4) a discussion of the potential for conflict.

B. HISTORY OF WEAPONIZATION OF SPACE

Space power has changed the way wars are fought, so much so, that most conflicts of the 21st century cannot be fought and won without the use of space assets.⁴⁴⁴ This reliance on space, especially for the United States, has prompted arguments regarding weaponizing space.⁴⁴⁵ First, an historical analysis of weaponizing space will explain its

⁴⁴⁰ Excerpts from the book Karl Grossman, *Weapons in Space* (Seven Stories Press: 2001), accessed on March 17, 2017, www.thirdworldtraveler.com/Militarization_Space/Weapons_Space.html.

⁴⁴¹ Cheryl Pellerin, “Hyten: Deterrence in Space Means No War Will be Fought There,” U.S. Department of Defense, January 26, 2017, <https://www.defense.gov/News/Article/1061833/hyten-deterrence-in-space-means-no-war-will-be-fought-there/>.

⁴⁴² Ibid.

⁴⁴³ Ibid.

⁴⁴⁴ Leonard David, “Weapons in Space: Dawn of a New Era,” Space.com, June 17, 2005, <https://www.space.com/325-weapons-space-dawn-era.html>.

⁴⁴⁵ Ibid.

origins and its current role in the 21st century. Additionally, this analysis will discuss whether space weapons were a concern at the time of the creation of the OST.

Shortly after the ending of World War II in 1945, a new conflict emerged, the Cold War, pitting two major super powers, the United States and the Soviet Union, against one another.⁴⁴⁶ The Cold War created tensions between the U.S. and USSR that, by the late 1950s, had reached into outer space.⁴⁴⁷ Space became another competitive arena in which “each side sought to prove their superiority in technology and military firepower.”⁴⁴⁸ Although numerous movements supported peace, stability, and the banning of nuclear tests in space in the 1950s, “the weaponization (and nuclearization) of space occurred almost immediately after the opening of this new environment.”⁴⁴⁹ On October 4, 1957, panic erupted in the United States as they witnessed the launching of Soviet satellite *Sputnik* from the R-7 intercontinental ballistic missile.⁴⁵⁰ The significant power of the Soviet R-7 missile demonstrated the possibility to deliver nuclear weapons capable of reaching the United States.⁴⁵¹ This sparked an urgency in the U.S. to respond and, in January 1958, the U.S. Army launched *Explorer I*.⁴⁵² Additionally, in the summer of 1958, the U.S. tested three nuclear weapons in space.⁴⁵³ In response, the Soviet Union began testing nuclear weapons as well.⁴⁵⁴ Results of these tests showed the effects of radiation in space were different than that in Earth’s atmosphere, often times persisting much longer in space which could negatively affect manned spaceflights in the future as well as satellite performance.⁴⁵⁵ During continued negotiations on a test ban, “the Soviet Union and the United States

⁴⁴⁶ History.com Staff, “The Space Race,” History.com, 2010, <https://www.history.com/topics/space-race>.

⁴⁴⁷ Ibid.

⁴⁴⁸ Ibid.

⁴⁴⁹ James Clay Moltz, *The Politics of Space Security*, 47.

⁴⁵⁰ History.com Staff, “The Space Race.”

⁴⁵¹ Ibid.

⁴⁵² Ibid.

⁴⁵³ Moltz, *The Politics of Space Security*, 47.

⁴⁵⁴ Ibid.

⁴⁵⁵ Ibid.

suspended nuclear tests via a moratorium that lasted from November 1958 to September 1961.”⁴⁵⁶

U.S. political and military advisors, fearing the Soviets had continued undisclosed nuclear testing throughout the moratorium and significantly advancing in nuclear technology, pressured President Kennedy to resume testing.⁴⁵⁷ In a 1961 address to the United Nations, “President Kennedy challenged the Soviet Union ‘not to an arms race, but to a peace race.’”⁴⁵⁸ This was an unsuccessful effort, and he reluctantly announced the resumption of atmospheric and exo-atmospheric testing.⁴⁵⁹ In July 1962, the U.S. Starfish Prime, “a large 1.4 megaton explosion,”⁴⁶⁰ space nuclear test occurred, resulting in several service outages of U.S. and Soviet spacecraft, putting manned spaceflights at risk.⁴⁶¹ This catastrophic event threatened President Kennedy’s ambitious efforts to reach the Moon, causing a shift in thinking regarding exo-atmospheric nuclear testing.⁴⁶² This change in thinking strengthened internal U.S. negotiations on going forward with a test ban policy for outer space.⁴⁶³

The Cold War was driven by the assumption that any weapons that the Soviet Union and the United States had were to be used.⁴⁶⁴ During these years the Pentagon began planning for “Moon-based nuclear weapons aimed at Earth, nuclear ASAT weapons, manned military space stations, and a variety of other offensive and defensive systems.”⁴⁶⁵ The Soviet Union had similar military space programs that included plans for “an orbital

⁴⁵⁶ John F. Kennedy Presidential Library and Museum, “Nuclear Test Ban Treaty.”

⁴⁵⁷ Ibid.

⁴⁵⁸ President John F. Kennedy, as quoted in John F. Kennedy Presidential Library and Museum, “Nuclear Test Ban Treaty.”

⁴⁵⁹ Ibid.

⁴⁶⁰ Moltz, *The Politics of Space Security*, 64.

⁴⁶¹ Ibid.

⁴⁶² Ibid., 131.

⁴⁶³ Ibid.

⁴⁶⁴ Ibid., 47.

⁴⁶⁵ Ibid.

space station, space-to-space weapons, and space-to-Earth weapons.”⁴⁶⁶ The international community feared that these parallel ambitions would initiate an intensely competitive arms race in space.⁴⁶⁷ In 1962, while the superpowers steadily increased their military strength, U.S. Secretary of State Dean Rusk warned that space has the potential to become the newest warfighting domain.⁴⁶⁸ But much to the international community’s surprise, the United States and the Soviet Union never deployed these weapon systems in any of their satellite architectures.⁴⁶⁹ The Soviet Union and the U.S. remained competitive regarding space activities and military research programs, but both norms and treaties restrained them.⁴⁷⁰ Both countries realized that their ability to engage in civilian manned missions, commercial satellites, and passive military technologies outweighed developing technologies that could threaten their use of space.⁴⁷¹

On June 10, 1963, Kennedy addressed American University announcing “a need for a new round of high-level arms negotiations with the Russians and boldly called for an end to the Cold War.”⁴⁷² In this commencement speech, which was broadcast in the U.S.S.R. and reprinted in the Soviet press, Kennedy said “if we cannot end our differences, at least we can help make the world a safe place for diversity.”⁴⁷³ Shortly after, negotiations for a nuclear test ban resumed in Moscow.⁴⁷⁴ President Kennedy sent Averell Harriman, an experienced diplomat respected by the Russian politician leading the Soviet Union, Nikita Khrushchev, to negotiate “an agreement to limit the scope of a test ban.”⁴⁷⁵ In early test-ban discussions, the Soviet Union was wary of in-country checks on their

⁴⁶⁶ Ibid., 48.

⁴⁶⁷ Ibid.

⁴⁶⁸ Secretary of State Dean Rusk, as quoted by Ibid.

⁴⁶⁹ Moltz, *The Politics of Space Security*, 50.

⁴⁷⁰ Ibid.

⁴⁷¹ Ibid.

⁴⁷² John F. Kennedy Presidential Library and Museum, “Nuclear Test Ban Treaty..”

⁴⁷³ President John F. Kennedy, as quoted in Ibid.

⁴⁷⁴ Ibid.

⁴⁷⁵ Ibid.

testing sites, but after negotiations an agreement was made to exclude underground tests which eliminated the need for these inspections.⁴⁷⁶ After 12 days of negotiations, the three nations (U.S., UK, and Soviet Union) agreed to a partial test ban, eliminating testing in the atmosphere, underwater, and in space.⁴⁷⁷ Other provisions of the treaty:

It allowed underground nuclear tests as long as no radioactive debris falls outside the boundaries of the nation conducting the test and it pledged signatories to work toward complete disarmament, an end to armaments race, and an end to the contamination of the environment by radioactive substances.⁴⁷⁸

On August 5, 1963, “the Partial (or Limited) Nuclear Test Ban Treaty was signed in Moscow by U.S. Secretary Dean Rusk, Soviet Foreign Minister Andrei Gromyko, and British Foreign Secretary Lord Home.”⁴⁷⁹ With the support of the three powers, the final version of the treaty sealed their commitment to ending the contamination of space with radioactive substances.⁴⁸⁰ Over the next few months, President Kennedy with the help from experts, including leading scientists, the secretaries of the defense and state departments, and the chairman of the Joint Chiefs of Staff, convinced a wary American public and Senate to accept the treaty.⁴⁸¹ Finally, “on September 24, 1963, by an 80–19 margin, the Senate approved the Partial Test Ban Treaty (PTBT).”⁴⁸² The inclusion of space in the PTBT marked the first step toward settling space competition issues through peaceful and political negotiations rather than confrontations.⁴⁸³

⁴⁷⁶ Ibid.

⁴⁷⁷ Moltz, *The Politics of Space Security*, 138; John F. Kennedy Presidential Library and Museum, “Nuclear Test Ban Treaty.”

⁴⁷⁸ John F. Kennedy Presidential Library and Museum, “Nuclear Test Ban Treaty.”; For the full text of the Partial (or Limited) Test Ban Treaty, see the State department website at <http://www.state.gov/t/ac/trt/4797.htm> (accessed March 25, 2018).

⁴⁷⁹ John F. Kennedy Presidential Library and Museum, “Nuclear Test Ban Treaty.”

⁴⁸⁰ Partial (or Limited) Test Ban Treaty, as quoted in Moltz, *The Politics of Space Security*, 139.

⁴⁸¹ Moltz, *The Politics of Space Security*, 139; John F. Kennedy Presidential Library and Museum, “Nuclear Test Ban Treaty.”

⁴⁸² Moltz, *The Politics of Space Security*, 140.

⁴⁸³ Ibid.

In the fall of 1963, shortly after the approval of PTBT, support for limiting military activities in space grew.⁴⁸⁴ At the United Nations, the U.S. and Soviet Union reached an additional agreement “pledging not to orbit any weapons of mass destruction.”⁴⁸⁵ On October 17, 1963, G.A. Resolution 1884 was adopted and called on the States

to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, installing such weapons on celestial bodies, or stationing such weapons in outer space in any other manner.⁴⁸⁶

The growing rapprochement between Kennedy and Khrushchev stopped with President Kennedy’s assassination in November 1963 and Vice President Johnson became president.⁴⁸⁷ President Johnson, more so than the Kennedy administration, stopped unnecessary military competition with the Soviet Union and focused primarily on the race to the Moon.⁴⁸⁸ His focus was more toward civilian prospects in space, specifically in regard to beating the Soviets to the Moon, rather than strictly military.⁴⁸⁹

As the intensity of the Moon race continued between the United States and the Soviet Union, the international community pleaded with them to agree on some sort of guidelines on the “exploration of the Moon and other celestial bodies.”⁴⁹⁰ Within the legal subcommittees of COPUOS, very little progress regarding additional space agreements and treaties had been made since 1963.⁴⁹¹ Within the U.S. government, ongoing discussions took place about a future space treaty that could use the model of the Antarctic Treaty

⁴⁸⁴ Ibid., 141.

⁴⁸⁵ Ibid; See Arthur M. Schlesinger Jr., *A Thousand Days: John F. Kennedy in the White House* (New York: Houghton Mifflin, 1965), pp. 920–21, as cited in Moltz, *The Politics of Space Security*, 141.

⁴⁸⁶ A/RES/18/1884 (XVIII), 18th session, General Assembly (1963), <http://www.un-documents.net/a18r1884.htm>.

⁴⁸⁷ Moltz, *The Politics of Space Security*, 142.

⁴⁸⁸ Ibid.

⁴⁸⁹ Ibid., 143.

⁴⁹⁰ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 425.

⁴⁹¹ Moltz, *The Politics of Space Security*, 149.

(1959).⁴⁹² Using this model in space, could “rule out the emplacement of weapons on the Moon and planets but not affect passive military use of non-terrestrial regions of space.”⁴⁹³ Starting in mid-1966, the United States, using the 1963 U.N. Resolution, began an international effort to create a formal treaty.⁴⁹⁴ Both the U.S. and the Soviet Union submitted drafts to COPUOS, the major difference between the two was the United States version only applied to celestial bodies while the Soviets included “celestial bodies and outer space.”⁴⁹⁵ In regards to weapons in space, Article IV of the final version of the treaty stated “no weapons of mass destruction shall be placed in orbit or on celestial bodies, or stationed in outer space in any other manner; celestial bodies shall be used exclusively for peaceful purposes.”⁴⁹⁶ President Johnson stated that Article IV was “the most important arms control development since the 1963 treaty banning nuclear testing in the atmosphere, in space, and under water.”⁴⁹⁷ The principles in the “Nuclear Test Ban Treaty and the United Nations Resolution 1884”⁴⁹⁸ were used to shape the language found in Article IV of the OST.⁴⁹⁹ It also directly took Articles VIII and IX from the draft proposed by the United States.⁵⁰⁰ Additionally, similar rhetoric from the Antarctic Treaty, used in the U.S. draft, was added to Article IV addressing “the use of military personnel, facilities, or equipment for peaceful purposes.”⁵⁰¹ After a year of negotiations, in a unanimous vote in December 1966 at the General Assembly, the United Nations adopted G.A. Resolution 2222 or also referred to as the Outer Space Treaty.⁵⁰² On January 27, 1967, in simultaneous

⁴⁹² Ibid.

⁴⁹³ Ibid.

⁴⁹⁴ Ibid.

⁴⁹⁵ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 428.

⁴⁹⁶ Outer Space Treaty, U.S. State Department.

⁴⁹⁷ President Lyndon B. Johnson, as quoted in Dembling and Arons, “The Evolution of the Outer Space Treaty,” 432.

⁴⁹⁸ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 433.

⁴⁹⁹ Ibid..

⁵⁰⁰ Ibid.

⁵⁰¹ Outer Space Treaty, as quoted in Ibid.

⁵⁰² Moltz, *The Politics of Space Security*, 150.

ceremonies, the OST was opened for signatures and signed by the three major space powers in Washington, Moscow, and London.⁵⁰³

Despite the success of the OST, it had failed to address the U.S.-Soviet conflict over anti-ballistic missiles (ABM) systems, which if deployed could threaten space as well as their satellites.⁵⁰⁴ President Johnson announced his commitment to pursuing a treaty to ban ABM systems, but in the event the Soviets rejected these negotiations, he added \$375 million in the budget proposal to deploy an ABM network.⁵⁰⁵ Prospects for success in making space more peaceful did not appear promising when, in 1968, the Soviet Union emerged with a program aimed at the developing ASAT technology, conducting tests between the years 1968–71.⁵⁰⁶ But the tests abruptly stopped because of a more cooperative climate between the U.S. and the Soviet Union under the new Nixon-Kissinger policy of detente.⁵⁰⁷ Due to the increased international cooperation, “the Soviet and U.S. arms control negotiators met in Helsinki to discuss more specific plans for a future treaty linking offensive missile limits to restrictions on ABM deployments in the so-called Strategic Arms Limitation Talks (SALT).”⁵⁰⁸ In early 1972, the Soviets were willing to negotiate restricting their largest missiles, only if the United States agreed to restrain any further developments of their ABM defenses.⁵⁰⁹ The ABM Treaty originally allowed site-specific missile defenses at two locations—a national capital or an offensive missile squadron—with no more than 100 missiles apiece (but this was later amended in 1974 to allow each side only one defended site).⁵¹⁰ Additionally, the treaty “prohibited the development, testing and deployment of space-based, sea-based, air-based, and mobile

⁵⁰³ Ibid.

⁵⁰⁴ Ibid., 152.

⁵⁰⁵ Ibid.

⁵⁰⁶ Ibid., 156–157.

⁵⁰⁷ Paul Stares, as quoted in Ibid., 166; Paul Stares, “*The Militarization of Space: U.S. Policy 1945–84*,” (Cornell University Press, 1993), 135.

⁵⁰⁸ Moltz, *The Politics of Space Security*, 167.

⁵⁰⁹ Ibid., 168.

⁵¹⁰ Ibid.

land-based systems and components.”⁵¹¹ Further, the final version of the treaty specified conditions for a limited ban on ASATs, by specifying that, the parties agree to accept verification measures and not to interfere with so-called “national technical means”⁵¹² (which both sides understood to mean satellites).⁵¹³ These agreements were important developments in space, providing legally binding constraints and safe access to space.⁵¹⁴ In terms of treaties, the PTBT, the OST, the ABM Treaty, and SALT I created a culture of restraint and deterrence.⁵¹⁵

By the late 1970s, the U.S. felt the Soviet Union was no longer invested in cooperation due “to the stationing of mobile SS-20 nuclear tipped missiles in Europe and the resumption of ASAT weapons testing in 1976.”⁵¹⁶ President Ford, prior to leaving office in 1977, issued a mixed directive (“National Security Decision Memorandum 345”).⁵¹⁷ The directive ordered the government to carry out two tasks.⁵¹⁸ First, the State Department had to try to negotiate anti-ASAT arms control with the Soviet Union.⁵¹⁹ Second, the Pentagon was instructed to develop a deployable ASAT.⁵²⁰ The Carter administration would continue to reach out to the Soviets to negotiate space arms control agreements.⁵²¹ As Soviet ASAT tests continued, U.S.-Soviet negotiations began with the

⁵¹¹ “Anti-Ballistic Missile Treaty (1972),” atomicarchive.com, <http://www.atomicarchive.com/Treaties/Treaty9.shtml>.

⁵¹² ABM Treaty, as quoted in Moltz, *The Politics of Space Security*, 169–170; See text of the ABM Treaty, reprinted in Johnson, *Soviet Military Strategy in Space*, Appendix 5, 253–57.

⁵¹³ Ibid.

⁵¹⁴ Moltz, *The Politics of Space Security*, 170.

⁵¹⁵ Ibid., 174.

⁵¹⁶ Ibid., 178.

⁵¹⁷ Ibid., 179–180.

⁵¹⁸ Moltz, *The Politics of Space Security*, 180; Lt. Col. (USAF) Peter L. Hays, *United States Military Space: Into the Twenty-First Century*, Occasional Paper No.42 (Colorado Springs: U.S. Air Force Academy, Institute for National Security Studies, September 2002),102-3.; See also Stares, *Militarization of Space*, 171.

⁵¹⁹ Ibid.

⁵²⁰ Ibid.

⁵²¹ Moltz, *The Politics of Space Security*, 181.

aim of producing formal and specific guidelines on banning ASATs.⁵²² Even though a working agreement was reached between the two superpowers in 1979, the negotiations were postponed indefinitely in 1980, “following the Soviet invasion of Afghanistan in December 1979.”⁵²³ In 1981, the CD began discussions and negotiations on the prevention of an arms race in space (PAROS) treaty due to the unresolved issues regarding space weaponization.⁵²⁴

In March 1983, “President Ronald Reagan proposed his Strategic Defense Initiative (SDI).”⁵²⁵

SDI was intended to defend the United States from attack from Soviet intercontinental ballistic missiles (ICBMs) by intercepting the missiles at various phases of their flight. For the interception, the SDI would require extremely advanced technological systems, yet to be researched and developed. Among the potential components of the defense system were both space- and earth-based laser battle stations, which, by a combination of methods, would direct their killing beams toward Soviet targets.⁵²⁶

After the announcement of SDI, the Soviets followed with “their classic dual-track strategy,”⁵²⁷ meaning on the one hand they continued advancements in their secret military programs while, at the same time, becoming more vocal on arms control efforts.⁵²⁸ The Soviet Union, shortly after President Reagan announced his proposed plans for SDI, publicized its intent to have a Soviet-specific moratorium on ASAT launches into space.⁵²⁹ Additionally, the Soviets proposed to the U.N. a new draft treaty which “banned the testing and deployment of ‘space-strike’ weapons, the prohibition on testing and use of manned

⁵²² Ibid., 185–186.

⁵²³ Ibid. 186–187.

⁵²⁴ “Prevention of an Arms Race in Outer Space,” Federation of American Scientists, https://fas.org/programs/ssp/nukes/ArmsControl_NEW/nonproliferation/NFZ/NP-NFZ-PAROS.html.

⁵²⁵ *Encyclopaedia Britannica*, “Strategic Defense Initiative: United States Defense System,” *Encyclopaedia Britannica*, <https://www.britannica.com/topic/Strategic-Defense-Initiative>.

⁵²⁶ Ibid.

⁵²⁷ Moltz, *The Politics of Space Security*, 196.

⁵²⁸ Ibid.

⁵²⁹ Ibid.

ASATs or other military systems, and the destruction of existing ASAT systems.”⁵³⁰ However, the U.S. declined to support the proposal, because of the difficulty in knowing how many ASATs the Soviets had and whether all ASATs had been destroyed.⁵³¹ In regards to Soviet developments in co-orbital ASATs, the Reagan administration and the U.S. Air Force continued pursuing advancements in ASAT technologies and conducted a test on September 13, 1985, intercepting an aging *Solwind* satellite.⁵³² That same year, “the CD established an ad hoc committee on PAROS.”⁵³³

In the late 1980s, a shift in Soviet military space policy under new Soviet leader Mikhail Gorbachev showed a sincere commitment to future U.S.-Soviet space arms control discussions.⁵³⁴ Soviet assurances allowed Americans in the space program to feel encouraged with future space relations.⁵³⁵ However, space competition continued between the two nations, leaving the U.S. a bit more reserved yet still receptive toward the possibility of future cooperation.⁵³⁶ President Bush, in the spring of 1989, announced a decrease in the budget allotted for SDI due to the difficulty of proving the requirement for such a system.⁵³⁷ This administration focused on the concept of Brilliant Pebbles, rather than on Reagan’s full-scale missile defense initiatives.⁵³⁸ Brilliant Pebbles “was a non-nuclear system of satellite based, watermelon-sized mini-missiles designed to use a high-velocity kinetic warhead.”⁵³⁹ SDI supporters from the Reagan’s legacy staff continued to push for developments despite the continued cuts to the program by the Bush

⁵³⁰ Ibid., 197.

⁵³¹ Ibid.

⁵³² Ibid., 201–202.

⁵³³ Federation of American Scientists, “Prevention of an Arms Race in Outer Space.”

⁵³⁴ Moltz, *The Politics of Space Security*, 214.

⁵³⁵ Ibid., 216.

⁵³⁶ Ibid.

⁵³⁷ Ibid., 222.

⁵³⁸ Ibid.

⁵³⁹ “Space Weapons: Brilliant Pebbles,” Blue Knight Production Webpages, 2001–2016, http://thelivingmoon.com/45jack_files/03files/Space_Weapons_07_Brilliant_Pebbles.html.

administration.⁵⁴⁰ Also around this time, in December 1991, the Soviet Union faced its own political challenges which resulted in the end of the Soviet Union.⁵⁴¹ This dissolution of the U.S.S.R. marked the official end to the Cold War in space.⁵⁴²

During the 1990s, the United States shifted its attention to rogue states, such as North Korea and Iraq, because of the risk of small-scale missile attacks.⁵⁴³ In January 1993, the Clinton administration initiated several changes in U.S. policy on space security: moving away from SDI, and returning space decision making to NASA and the Office of Science and Technology Policy.⁵⁴⁴ Additionally, Secretary of Defense Les Aspin made additional changes by switching the focus from national missile defense (NMD) to more ground-based theater missile defense (TMD) due “to the threats consistent with Iraqi scud use in the 1991 Gulf War.”⁵⁴⁵ President Clinton also explored possible options to amend the ABM Treaty to allow certain types of limited missile defense to appease Republicans in Congress.⁵⁴⁶ Throughout the Clinton administration, continued battles took place within Congress over space and missile defense issues.⁵⁴⁷

In the fall of 1996, the White House issued a new space policy statement.⁵⁴⁸ This marked a significant event because it was the first modification of space policy since the end of the Cold War.⁵⁴⁹ The new space policy highlighted “the critical need to use space

⁵⁴⁰ Moltz, *The Politics of Space Security*, 225.

⁵⁴¹ Ibid., 226.

⁵⁴² Ibid.

⁵⁴³ Lawrence D. Freedman, “Anti-Ballistic Missile Treaty: International Treaty,” Encyclopaedia Britannica, <https://www.britannica.com/event/Anti-Ballistic-Missile-Treaty>.

⁵⁴⁴ Moltz, *The Politics of Space Security*, 235; On this shift, see Dwayne A. Day, “A New Space Council?” *Space Review*, June 21, 2004, online at <http://www.thespacereview.com/article/163/2>, as cited by Moltz.

⁵⁴⁵ Moltz, *The Politics of Space Security*, 235.

⁵⁴⁶ Freedman, “Anti-Ballistic Missile Treaty: International Treaty.”

⁵⁴⁷ Moltz, *The Politics of Space Security*, 240.

⁵⁴⁸ Ibid., 245.

⁵⁴⁹ Ibid.

to ‘monitor arms control and non-proliferation agreements.’”⁵⁵⁰ Additionally, it discussed the Clinton administration’s willingness and openness to possible additional space arm controls and other agreements.⁵⁵¹ But, as Russia, Australia, and Canada continued to promote PAROS, the United States showed little evidence of following its own policies of openness to new space security concepts.⁵⁵²

In December of 2001, the Bush administration saw no value or benefit in trying to preserve the ABM Treaty.⁵⁵³ President Bush gave official notice to the Russian government of his plan to withdraw from the ABM Treaty, which became effective in June 2002.⁵⁵⁴ This was a significant event because it marked “the first time the United States had withdrawn from a major arms control agreement.”⁵⁵⁵ Additionally, as efforts continued in the UN to adopt a PAROS resolution, the United States grew frustrated with the negotiations.⁵⁵⁶ For the first time since the Clinton administration, the Pentagon made a significant change to its previous policy “on abstaining from the yearly PAROS resolution.”⁵⁵⁷ Finally, in 2005, the United States delegation “voted against this otherwise unanimous U.N. resolution that called the states to refrain from using space for weapons purposes and urged the CD to take up the issue of a new treaty at its earliest convenience.”⁵⁵⁸ The United States staunchly opposed PAROS, arguing “it was unnecessary because there are no space weapons and thus there can be no arms race in

⁵⁵⁰ Moltz, *The Politics of Space Security*, 246; “Fact Sheet: National Space Policy,” Office of Science and Technology Policy, September 19, 1996, p.4, on the Federation of American Scientists’ website at <http://www.fas.org/spp/military/docops/national/nstc-8.htm>.

⁵⁵¹ Moltz, *The Politics of Space Security*, 246.

⁵⁵² Ibid.

⁵⁵³ Freedman, “Anti-Ballistic Missile Treaty: International Treaty.”

⁵⁵⁴ Ibid.

⁵⁵⁵ Ibid.

⁵⁵⁶ Moltz, *The Politics of Space Security*, 282.

⁵⁵⁷ Ibid.; as cited by Moltz, among its various clauses, the PAROS resolution “emphasizes the necessity of further measures... to prevent an arms race in outer space” and “calls upon all States... to continue actively to the objective of the peaceful use of outer space... and to refrain from actions contrary to that objective.”

⁵⁵⁸ Ibid.; As noted by Moltz, only Israel voted with the United States in rejecting the measure.

outer space at this time.”⁵⁵⁹ This opposition set by the Bush administration signified a staunch U.S. objection to future efforts regarding space arms controls.⁵⁶⁰

During Bush’s second term, a major change in the strategic dynamics of space relations occurred, with the emergence of China as a major space player and its continued push to support a new treaty “banning space weapons.”⁵⁶¹ The U.S. was wary of China’s intentions in space and in future arms control agreements when its laser weapon research program became public in 2006.⁵⁶² Additionally, China conducted an ASAT test in 2007 causing even more wariness of Chinese intentions in space.⁵⁶³ Later in February 2008, the United States conducted an ASAT action using a “SM-3 launched from the *USS Lake Erie* (CG 70) to target and successfully destroy the *USA-193* satellite.”⁵⁶⁴ This event was heavily debated. The United States offered its official explanation as “a missile was launched to knock out a derelict spy satellite, to head off the possibility of it splashing a half ton of toxic hydrazine fuel somewhere on Earth.”⁵⁶⁵ But others believed, it was a direct response to the Chinese ASAT test.⁵⁶⁶

In 2008, shortly after the Chinese ASAT test, “the Russian Federation and China presented a draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects (PPWT) to the UN Conference on Disarmament.”⁵⁶⁷ Some in the international community acknowledged the PPWT as “a

⁵⁵⁹ Federation of American Scientists, “Prevention of an Arms Race in Outer Space.”

⁵⁶⁰ Moltz, *The Politics of Space Security*, 282.

⁵⁶¹ Ibid., 260.

⁵⁶² Ibid.

⁵⁶³ Ibid., 261.

⁵⁶⁴ George Galdorisi, “U.S. Navy Missile Defense: Operation Burnt Frost: U.S. Navy missile defense, yesterday, today, and tomorrow, Part 17,” Defense Media Network, May 18, 2013, <https://www.defensemedianetwork.com/stories/u-s-navy-missile-defense-operation-burnt-frost/>.

⁵⁶⁵ James Oberg, “U.S. Satellite Shootdown: The Inside Story,” IEEE Spectrum, August 1, 2008, <https://spectrum.ieee.org/aerospace/satellites/us-satellite-shootdown-the-inside-story>.

⁵⁶⁶ Ibid.

⁵⁶⁷ P.J. Blout and the blog faculty, “Draft Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force Against Outer Space Objects,” Res Communis (blog), February 20, 2008, <https://rescommunis.wordpress.com/2008/02/20/draft-treaty-on-the-prevention-of-the-placement-of-weapons-in-outer-space-the-threat-or-use-of-force-against-outer-space-objects/>.

welcomed step toward the non-weaponization of space.”⁵⁶⁸ The “PPWT seeks to ban the placement of weapons in outer space and the threat or use of force against outer space objects.”⁵⁶⁹ Although the PPWT signifies one of the more substantive efforts thus far to maintain weapons-free outer space, it is still not perfect and contains a few unclear and flawed provisions.⁵⁷⁰ The United States opposed the draft PPWT due to the Bush Administration’s National Space Policy specifically stating:

The United States will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space. Proposed arms control agreements or restrictions must not impair the rights of the United States to conduct research, development, testing, and operations or other activities in space for U.S. national interests.⁵⁷¹

The United States opposed the treaty because it felt the provisions on ASATs did not address the problem nor did it equate to the intent of the treaty.⁵⁷² The draft treaty made no mention on prohibiting ASAT development and testing, yet it banned their hostile use against objects in space.⁵⁷³ This meant that nations could continue to test kinetic, debris-producing ASATs, if they were not used against foreign satellites.⁵⁷⁴ The treaty was proposed to prevent an arms race in space, yet nowhere in the treaty did it outright ban ASATs, which are considered space weapons.⁵⁷⁵ The PPWT did provide a thorough explanation and definition of a weapon in outer space:⁵⁷⁶

Any device placed in outer space, based on any physical principle, which has been specially produced or converted to destroy, damage, or disrupt the

⁵⁶⁸ Cesar Jaramillo, “In Defence of the PPWT Treaty: Toward a Space Weapons Ban,” *The Ploughshares Monitor* 30, No. 4 (Winter 2009): http://ploughshares.ca/pl_publications/in-defence-of-the-ppwt-treaty-toward-a-space-weapons-ban/.

⁵⁶⁹ Ibid.

⁵⁷⁰ Ibid.

⁵⁷¹ “U.S. National Space Policy,” Office of Space Commerce, August 31, 2006, https://obamawhitehouse.archives.gov/sites/default/files/national_space_policy_6-28-10.pdf.

⁵⁷² Jaramillo, “In Defence of the PPWT Treaty.”

⁵⁷³ Ibid.

⁵⁷⁴ Ibid.

⁵⁷⁵ Ibid.

⁵⁷⁶ Ibid.

normal functioning of objects in outer space, on the Earth or in the Earth's atmosphere, or to eliminate a population or components of the biosphere which are important to human existence or to inflict damage on them.⁵⁷⁷

But it offered no way to verify their absence from space. Still, some viewed the PPWT as a unique opportunity for the international community to create “a robust, unambiguous, and universal space security treaty that unequivocally prohibited the weaponization of space,”⁵⁷⁸ yet it failed to accomplish this goal.⁵⁷⁹ Also in 2008, the European Union (EU) published a non-legally-binding draft Code of Conduct for Outer Space Activities; the EU submitted a revision in 2010.⁵⁸⁰ The code asked members to create “policies and procedures to minimize the possibility of accidents ... or any form of harmful interference with other States’ right to the peaceful exploration and use of outer space.”⁵⁸¹ It also addressed three basic principles:

1) Freedom of access to space for peaceful purposes, 2) Preservation of the security and integrity of space objects in orbit; and 3) Due consideration for the legitimate defense interests of states.⁵⁸²

During the Obama administration, officials were torn on whether to support the code.⁵⁸³ If the United States supported the code, it could lead to the establishment of essential rules of the road for behavior and activities in space.⁵⁸⁴ In 2010, President Obama released his National Space Policy which mentioned “that the United States will consider proposals and

⁵⁷⁷ Article 1c of PPWT, as quoted in Jaramillo, “In Defence of the PPWT Treaty.”

⁵⁷⁸ Jaramillo, “In Defence of the PPWT Treaty.”

⁵⁷⁹ Ibid.

⁵⁸⁰ Micah Zenko, “Policy Innovation Memorandum: A Code of Conduct for Outer Space,” Council on Foreign Relations, November 30, 2011, <https://www.cfr.org/report/code-conduct-outer-space>.

⁵⁸¹ Ibid; “Draft International Code of Conduct for Outer Space Activities,” European Union, Version March 31, 2014, http://www.eeas.europa.eu/archives/docs/non-proliferation-and-disarmament/pdf/space_code_conduct_draft_vers_31-march-2014_en.pdf.

⁵⁸² Zenko, “Policy Innovation Memorandum.”

⁵⁸³ Ibid.

⁵⁸⁴ Ibid.

concepts for arms control measures if they are equitable, effectively verifiable, and enhance the national security of the United States and its allies.”⁵⁸⁵

In 2014, an updated PPWT was submitted to United Nations CD.⁵⁸⁶ The United States, under the Obama administration, opposed the new draft treaty, maintaining that it still failed to correct the initial 2008 draft problems.⁵⁸⁷ Frank A. Rose, deputy assistant Secretary of State for arms control, verification, and compliance, mentioned President Obama’s 2010 National Space Policy as reasoning for the continued opposition. He “told the CD that the United States would agree to arms control proposals or discussions if they were equitable, effectively verifiable, and enhance the security of all.”⁵⁸⁸ Additionally, Rose said that the updated PPWT failed to meet these criteria.⁵⁸⁹

According to Alexander Chanock, “despite the relatively peaceful beginnings of space development, in recent years space has become increasingly more important for military affairs.”⁵⁹⁰ Satellites provide vital support to warfighters in conducting military operations.⁵⁹¹ Realizing the significance of possible space control, the United States, Russia, and China are developing both offensive and defensive weapons that can be used in space.⁵⁹² The next section will address the concerns with weaponizing space, offering

⁵⁸⁵ “National Space Policy of the United States of America,” ObamaWhite House archives, June 28, 2010, accessed on May 28, 2018, https://obamawhitehouse.archives.gov/sites/default/files/national_space_policy_6-28-10.pdf.

⁵⁸⁶ Frank A. Rose quoting 2010 National Space Policy, as quoted in Bill Gertz, “U.S. Opposes New Draft Treaty from China and Russia Banning Space Weapons,” *The Washington Free Beacon*, June 19, 2014, <http://freebeacon.com/national-security/u-s-opposes-new-draft-treaty-from-china-and-russia-banning-space-weapons/>.

⁵⁸⁷ Ibid.

⁵⁸⁸ Frank A. Rose, as quoted in Gertz, “U.S. Opposes New Draft Treaty from China and Russia Banning Space Weapons.”

⁵⁸⁹ Ibid.

⁵⁹⁰ Alexander Chanock, “The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century,” *Journal of Air Law and Commerce* 78, (2013): 691–710, <https://scholar.smu.edu/cgi/viewcontent.cgi?referer=https://www.bing.com/&httpsredir=1&article=1327&context=jalc>, 693.

⁵⁹¹ Ibid.

⁵⁹² Ibid.

examples and types of weapons. Additionally, it will provide analysis on countries that are testing, funding, and employing these types of weapons.

C. THREAT OF WEAPONIZING SPACE

While weapons have not been placed in outer space, the militarizing of space began at the beginning of the space race.⁵⁹³ To our knowledge, space-based weapons have yet to be effectively deployed.⁵⁹⁴ But, the significant threat from ground and sea-based weapons (i.e., ASATs) against satellites and their infrastructures has led countries to invest time and resources into the development of offensive and defensive space countermeasures.⁵⁹⁵ A National Institute for Public Policy report stated “U.S. space systems are among the most fragile and vulnerable assets operated by the U.S. military and our adversaries are aware of our weaknesses.”⁵⁹⁶ According to Bill Gertz, a defense and national security reporter for the Washington times, China, North Korea, Russia, and Iran are rapidly developing capabilities that could “deny, degrade, or even destroy U.S. and allied space capabilities.”⁵⁹⁷ Additionally, the National Institute for Public Policy report addressed comments made by the Joint Chiefs of Staff in regards to space conflict. They “warned that space conflict would be intense, highlighted by satellite maneuvering to hinder the operation of other satellites, co-orbital jamming, and the use of ground-based lasers to dazzle or destroy imaging sensors.”⁵⁹⁸ As mentioned in Chapter I, no definition of a space weapon has been accepted by the international community. For the purpose of this thesis, it will define a space weapon as anything that can be used to damage any component of a satellites’ architecture (i.e., ground, link, or spacecraft) or deny its services from being accessed. First, this thesis will provide a brief overview on the potential types of weapons

⁵⁹³ “The Real Danger from Space Weapons,” Stratfor: Worldview, February 22, 2016, <https://worldview.stratfor.com/article/real-danger-space-weapons>.

⁵⁹⁴ Ibid.

⁵⁹⁵ Ibid.

⁵⁹⁶ Bill Gertz, “Foreign space threats grow,” *The Washington Times*, September 6, 2017, <https://www.washingtontimes.com/news/2017/sep/6/foreign-space-threats-grow/>.

⁵⁹⁷ Ibid.

⁵⁹⁸ The Joint Chiefs of Staff, as quoted in Gertz, “Foreign space threats grow.”

that could be used to target any component of the satellite architecture. This discussion will not delve into any classified information. Second, an analysis will be conducted on various countries developing offensive and defensive space capabilities which could include nuclear weapons, the use of ground/orbit based anti-satellite weapons (ASAT), electronic jammers/spoofing (GPS/SATCOM/downlink or uplink signal), weaponized satellites, directed-energy weapons, and cyber or military intrusions on satellite ground control stations.⁵⁹⁹

1. Nuclear Weapons

The most effective way that a satellite can be neutralized is to employ nuclear weapons.⁶⁰⁰ According to Sam Seitz, “the detonation of nuclear weapons in space would generate an electromagnetic pulse (EMP) that could fry satellite electronics, rendering them inoperable.”⁶⁰¹ Nuclear EMP is considered a significant threat “as it can cover an entire continent and cripple tiny circuits inside modern electronics on a massive scale.”⁶⁰² The concern with nuclear detonations in space is the altitude at which they occur.⁶⁰³ For example, “at high elevation, gamma rays can more easily spread out, hitting many upper-atmosphere air molecules over a large area at once.”⁶⁰⁴ In 2008, the EMP Commission released a report supporting this concern with high-altitude detonations, concluding “that the right nuclear device detonated at the right altitude could bathe the entire continental U.S. in EMP, disrupting telecommunications and power grid infrastructures to catastrophic effect.”⁶⁰⁵ Although nuclear weapons cause the most destruction when employed, it is

⁵⁹⁹ Gertz, “Foreign space threats grow.”

⁶⁰⁰ Sam Seitz, “Dynamics of Space Weaponization and the ASAT Threat,” *Politics in Theory and Practice: Analyzing International Relations and American Politics*, July 13, 2016, <https://politicstheorypractice.wordpress.com/2016/07/13/dynamics-of-space-weaponization-and-the-asat-threat/>.

⁶⁰¹ Ibid.

⁶⁰² Dave Mosher, “Nuclear bombs trigger a strange EMP effect that could destroy your electronics—here’s how it works,” *Business Insider Australia*, June 8, 2017, <https://www.businessinsider.com.au/nukes-electromagnetic-pulse-electronics-2017-5>.

⁶⁰³ Ibid.

⁶⁰⁴ Ibid.

⁶⁰⁵ 2008 EMP Commission report, as quoted in Ibid.

highly unlikely they will be used to target nations' spacecraft.⁶⁰⁶ States realize that by detonating a nuclear weapon in space, they could limit their space-based capabilities as well as affect friendly and allied space systems.⁶⁰⁷ Additional reasons that make nuclear weapons usage improbable are: the idea that such use would trigger "a regional or global nuclear war,"⁶⁰⁸ not to mention the pressure to respect the international norm established in the OST.⁶⁰⁹

2. Anti-Satellite Weapons (ASAT)

According to Sam Seitz, the recent "growth of ground-based ASAT weapons systems poses the greatest threat to the continued peaceful development and use of space."⁶¹⁰ As discussed in the previous section regarding nuclear weapons, kinetic-kill ASATs provide the user with an advantageous opportunity because it decreases the likelihood that tensions will escalate to the use of nuclear weapons.⁶¹¹ But although the conflict might not escalate to nuclear warfare, it does not guarantee that a country would not respond and retaliate by attacking the adversary's critical space assets. In February of 2018, the Israeli Homeland Security (IHLS) Internet website wrote an article, "New Anti-Satellites Weapons Operational In 2020," discussing the concern with Russia's and China's advancing developments in ASAT missiles.⁶¹² According to the intelligence directorate of the U.S. Joint Chiefs of Staff, by 2020, China and Russia will have "combat-capable missiles that could shootdown U.S. LEO objects."⁶¹³ Also, as mentioned in a RAND think-tank report, "the United States has their own arsenal of ASAT weapons."⁶¹⁴ Additionally,

⁶⁰⁶ Seitz, "Dynamics of Space Weaponization and the ASAT Threat."

⁶⁰⁷ Ibid.

⁶⁰⁸ Ibid.

⁶⁰⁹ Ibid.

⁶¹⁰ Ibid.

⁶¹¹ Ibid.

⁶¹² "New Anti-Satellites Weapons Operational In 2020," Israeli Homeland Security Internet website, February 9, 2018, <https://i-hls.com/archives/81269>.

⁶¹³ Intelligence Directorate of the Joint Chiefs of Staff, as quoted in Ibid.

⁶¹⁴ RAND Think Tank Report, as mentioned in Ibid.

kinetic-kill ASATs have the potential to generate large amounts of orbital debris, which Chapter II discussed as extremely problematic for satellite operations.⁶¹⁵ Currently, the international community has been unsuccessful in adopting treaties regulating ASAT weapons.⁶¹⁶

3. Electronic Jammers/Spoofing (Cyber Attacks)

Jamming is one of the more well-known techniques to impair and degrade satellite capabilities.⁶¹⁷ The most common definition for “jamming is the act of intentionally directing electromagnetic energy toward a communication (or navigation) system to disrupt or prevent signal transmission.”⁶¹⁸ Information security training expert, James Taylor, stated “satellite jamming incidents have occurred in various countries like Russia, Cuba, Iran, China, and even the United States.”⁶¹⁹ There are two techniques to jam a satellite: orbital and terrestrial.⁶²⁰ Below are some definitions of such jamming, as provided by the INFOSEC Institute:

Orbital jamming: The attacker sends a beam of contradictory signals directly toward a satellite via a rogue uplink station. The jamming signals are mixed with legitimate signals, thus interfering with them. The jamming signals are able to override the legitimate transmission, blocking its transmission to the recipient. Terrestrial jamming: The attacker transmits rogue frequencies in the direction of terrestrial targets (ground satellite dishes). Rather than targeting the satellite itself, as is the case in orbital jamming, it involves transmitting rogue frequencies in the direction of local consumer level satellite dishes. The jamming frequencies are limited to a

⁶¹⁵ Seitz, “Dynamics of Space Weaponization and the ASAT Threat.”

⁶¹⁶ Israeli Homeland Security Internet website, “New Anti-Satellites Weapons Operational In 2020.”

⁶¹⁷ Hacking Satellites...Look Up to the Sky,” INFOSEC Institute Posted in General Security, September 18, 2013, <http://resources.infosecinstitute.com/hacking-satellite-look-up-to-the-sky/>.

⁶¹⁸ Alexander Rügamer and Dirk Kowalewski, “Jamming and Spoofing GNSS – An Underestimated Risk?!” FIG Working Week 2015, https://www.fig.net/resources/proceedings/fig_proceedings/fig2015/papers/ts05g/TS05G_ruegamer_kowalewski_7486.pdf.

⁶¹⁹ “How to do satellite jamming,” International Institute of Cyber Security, April 27, 2015, <https://iicybersecurity.wordpress.com/2015/04/27/how-to-do-satellite-jamming/>.

⁶²⁰ Institute Posted in General Security, “Hacking Satellites...Look Up to the Sky.”

specific area and are able to interfere only with the frequency emanating from the satellite in a specific location.⁶²¹

Satellites are vulnerable to jamming attacks during uplink and downlink transmissions between the user, satellite, or ground stations.⁶²² The most dangerous attack targets the satellite receiving the uplink, while attacks against the ground or user terminals cause more minor damage to the satellite architecture.⁶²³ Attackers can vary in skill level, and their effectiveness also depends on what exactly is being jammed.⁶²⁴ Attributing jamming to a specific nation, individual, or entity is extremely challenging because these attacks can be conducted “using off-the-shelf-technology”⁶²⁵ and sometimes do not require technologically savvy equipment or personnel.⁶²⁶ Additionally, this creates an even bigger problem if the country whose satellite has been jammed cannot attribute the jamming to any specific country or organization.⁶²⁷

An additional attack that can be used against satellite infrastructure is spoofing. Spoofing is defined by the INFOSEC Institute as “a deliberate transmission of fake signals, associated to the intended satellite target, with the intentions of fooling that satellite receiver into providing false information to the users.”⁶²⁸ This is considered extremely dangerous in a military context because the attackers could feed false information into a system that provides situational awareness for military operations.⁶²⁹ For example, GPS is

⁶²¹ Ibid.

⁶²² Ibid.

⁶²³ Ibid.

⁶²⁴ Ibid.

⁶²⁵ Ibid.

⁶²⁶ Ibid.

⁶²⁷ Ibid.

⁶²⁸ Rügamer and Kowalewski, “Jamming and Spoofing GNSS – An Underestimated Risk?!”

⁶²⁹ Berenice Baker, “Satellites and spoofing – how hackers falsify situational awareness,” Army Technology, November 17, 2013, www.army-technology.com/features/feature-satellites-spoofing-hackers-falsify-situational-awareness/.

considered to be vulnerable to a spoofing attack.⁶³⁰ According to Dinesh Manadhar at the University of Tokyo, “spoofing is easy, and it only requires an instrument called a GPS simulator.”⁶³¹ Although it is considered easy to spoof a GPS signal, it is extremely hard to detect when a spoofing attack has occurred.⁶³²

4. Directed-Energy Weapons

The Department of Defense, in Joint Publication 3–13.1, Electronic Warfare, defines a directed-energy weapon “as an umbrella term covering technologies that produce a beam of concentrated electro-magnetic energy or atomic or subatomic particles.”⁶³³ Directed-energy weapons “can take the form of lasers, high-powered microwaves, and particle beams”⁶³⁴ which can be adapted for space warfare.⁶³⁵ According to Phillip Swarts, directed-energy weapons “could shut down enemy vehicles or communication networks, destroy incoming missiles or be used for a range of other purposes.”⁶³⁶ Currently, the challenge that these weapons present is the ability to deploy them due to their large size and weight.⁶³⁷ However, future research aims to make adjustments to the lasers, decreasing

⁶³⁰ Mark L. Psiaki and Todd E. Humphreys, “Protecting GPS From Spoofers Is Critical to the Future of Navigation,” *IEEE Spectrum*, July 29, 2016, <https://spectrum.ieee.org/telecom/security/protecting-gps-from-spoofers-is-critical-to-the-future-of-navigation>.

⁶³¹ Dinesh Manadhar, as quoted in Shusuke Murai, “GPS Spoofing is No Joke: Dangers of GPS Data Hacking Realized,” *Japan Times*, November 28, 2016, <http://www.govtech.com/security/GPS-Spoofing-is-No-Joke-Dangers-of-GPS-Data-Hacking-Realized.html>.

⁶³² “Is Russia developing a GPS spoofing system? Ships in the Black Sea may have been misdirected by a new cyber weapon, experts claim,” *DailyMail.com*, August 11, 2017, <http://www.dailymail.co.uk/sciencetech/article-4781714/Is-Russia-developing-GPS-spoofing-system.html>.

⁶³³ Joint Chiefs of Staff, *Electronic Warfare*, JP-3-13.1 (Joint Chiefs of Staff, January 25, 2007), <https://fas.org/irp/doddir/dod/jp3-13-1.pdf>.

⁶³⁴ Leonard David, “E-Weapons: Directed Energy Warfare In the 21st Century,” *Space.com*, January 11, 2006, <https://www.space.com/1934-weapons-directed-energy-warfare-21st-century.html>.

⁶³⁵ *Ibid.*

⁶³⁶ Phillip Swarts, “Air Force has directed energy weapons; now comes the hard part,” *AirForce Times*, June 25, 2016, <https://www.airforcetimes.com/news/your-air-force/2016/06/25/air-force-has-directed-energy-weapons-now-comes-the-hard-part/>.

⁶³⁷ *Ibid.*

their size so that they can be deployed.⁶³⁸ The most alarming concern with directed-energy weapons is that their use is often difficult to detect, as they can affect targets without having to destroy them.

5. Overview of the United States Counterspace Capabilities

According to the Secure World Foundation report on “Global Counterspace Capabilities; An Open Source Assessment,” “the United States has had an established doctrine and policy on counterspace capabilities for several decades, although not always publicly expressed.”⁶³⁹ Specifically, two doctrines exist in the United States to provide guidelines for operations and activities in outer space, “an Air Force doctrine developed by U.S. Air Force Space Command and a joint doctrine developed by U.S. Strategic Command.”⁶⁴⁰ Currently, these two doctrines separate space control operations into two specific categories: offensive space control (OSC) and defensive space control (DSC).⁶⁴¹ Some of the United States counterspace weapons are summarized in Table 1, using the categories from the Space Assessment Report 2018 conducted by the Center for Strategic and International Studies (CSIS) Aerospace Security Project: Kinetic-Physical, Non-Kinetic Physical, Electronic, and Cyber.⁶⁴²

⁶³⁸ Alane Kochems and Andrew Gudgel, “The Viability of Directed-Energy Weapons,” The Heritage Foundation, April 28, 2006, <https://www.heritage.org/missile-defense/report/the-viability-directed-energy-weapons>.

⁶³⁹ Brian Weeden and Victoria Samson, “Global Counterspace Capabilities: An Open Source Assessment,” Secure World Foundation, April 2018, https://swfound.org/media/206118/swf_global_counterspace_april2018.pdf;

⁶⁴⁰ Ibid., 3–17.

⁶⁴¹ Ibid.

⁶⁴² Todd Harrison, Kaitlyn Johnson, and Thomas G. Roberts, “Space Threat Assessment 2018,” A report of the CSIS Aerospace Security Project, April 2018, pps. i-iv, 1–34, https://aerospace.csis.org/wp-content/uploads/2018/04/Harrison_SpaceThreatAssessment_FULL_WEB.pdf, 2–4.

Table 1. United States Counterspace Weapons⁶⁴³

United States: Counterspace Weapons			
Kinetic-Physical	Non-Kinetic Physical	Electronic	Cyber
1) U.S. Co-Orbital ASAT – Although the United States has never had an officially recognized co-orbital ASAT program, it did test and develop many of the underlying technologies as part of its missile defense programs during the Cold War 2) Direct-Ascent ASAT – while the U.S. does not have an operational DA-ASAT capability, it does have operational midcourse missile defense interceptors that have been demonstrated in an ASAT role against LEO satellites – ASM-135 Air-Launched DA-ASAT 3) Ground-Based Midcourse System (GMD) and Standard Missile 3 (SM-3) ship launched via Aegis	1) LEO/GEO Rendezvous Proximity Operations (RPO) capabilities – Geostationary Space Situational Awareness Program (GSSAP)	1) Counter Communications System (CCS) which can be deployed globally to provide uplink jamming capability against geostationary communications satellites 2) Jamming Global Navigation Satellite System capabilities 3) NAVWAR – effort to develop strategy for how the U.S. military could conduct both defensive and offensive operations to protect U.S. use of PNT capabilities while also interdicting or preventing adversary use of PNT.	1) United States is preparing to conduct cyber espionage, disruption, and attack operations against the space assets of rival states 2) Demonstrated the ability and willingness to engage in cyberattacks against non-space targets

In 2014, space security became a primary focus in U.S. policy.⁶⁴⁴ Senior military leadership, such as General John E. Hyten, Commander of United States Strategic Command, began openly discussing “the inevitability of conflict on Earth extending to

⁶⁴³ Weeden and Samson, “Global Counterspace Capabilities: An Open Source Assessment.”; David P. Fidler, “Cybersecurity and the New Era of Space Activities,” Council on Foreign Relations, April 3, 2018, <https://www.cfr.org/report/cybersecurity-and-new-era-space-activities>.

⁶⁴⁴ Weeden and Samson, “Global Counterspace Capabilities: An Open Source Assessment,” 3–17.

space and the need for the U.S. military to prepare to defend itself.”⁶⁴⁵ This shift has resulted in organizational changes within the national security space organization.⁶⁴⁶ In 2018, a new organization known as the National Space Defense Center (NSDC) became operational.⁶⁴⁷ NSDC’s primary mission is “to improve the collaboration between military and intelligence communities to respond to attacks in space.”⁶⁴⁸ Additionally, the United States conducts wargames and exercises dedicated “to practicing and refining its counterspace doctrine.”⁶⁴⁹ As shown in Table 1 and the analysis provided, the United States continues to invest in military strategies dedicated to developing counterspace weapons. If conflict occurs in the future the United States could target adversary assets in space, which means that if space weaponization is not addressed in the immediate future, there is cause for concern.

6. Overview of Adversary Counterspace Capabilities

The United States is not the only nation developing counterspace weapons technology, other nations such as China, Russia, North Korea, and Iran have continued pursuing these technological advantages. The adversary threat discussions provided below over China, Russia, North Korea, and Iran are compiled from various sources reporting use or development of offensive and defensive space weapons by these countries. Additionally, a basic overview of several types of counterspace weapons and technologies these nations are currently assessed to have or are being developed will be given, which was assembled from the recently released unclassified CSIS “Space Threat Assessment 2018.”⁶⁵⁰ This

⁶⁴⁵ Ibid., 3–17-3-18; John E. Hyten, “Overcoming Our Space Vulnerabilities,” Speech at the Space and Missile Defense Symposium, August 12, 2014, <http://www.afspc.af.mil/About-Us/Leadership-Speeches/Speeches/Display/Article/731712/overcoming-our-space-vulnerabilities/>.

⁶⁴⁶ Weeden and Samson, “Global Counterspace Capabilities: An Open Source Assessment,” 3–18.

⁶⁴⁷ Ibid.; Shellie-Anne Espinosa, “National Space Defense Center Transitions to 24/7 Operations,” Air Force Space Command Public Affairs, January 26, 2018, <http://www.afspc.af.mil/News/Article-Display/Article/1423932/national-space-defense-center-transitions-to-247-operations/>.

⁶⁴⁸ Ibid.

⁶⁴⁹ Weeden and Samson, “Global Counterspace Capabilities: An Open Source Assessment,” 3–19.

⁶⁵⁰ Harrison, Johnson, and Roberts, “Space Threat Assessment 2018.”

report covers the countries that the United States believes are the greatest threats to its assets in space.⁶⁵¹

(1) China

China is considered a major space power after successfully conducting numerous missions in outer space.⁶⁵² It has also increased funding to research advancements in counterspace weapons and technology.⁶⁵³ The Space Assessment Report 2018 emphasized China's desire to achieve superiority in space, which meant "it must ensure its ability to fully utilize its own space assets while simultaneously degrading, disrupting, or destroying its [sic] adversary's space capabilities."⁶⁵⁴ The Israeli Homeland Security Internet website mentioned China's unwavering interest in pursuing various robust counterspace capabilities.⁶⁵⁵ Some of China's counterspace weapons are summarized in Table 2, using the categories from the "Space Assessment Report 2018": Kinetic-Physical, Non-Kinetic Physical, Electronic, and Cyber.⁶⁵⁶

⁶⁵¹ Ibid., 1.

⁶⁵² Ibid., 6.

⁶⁵³ Ibid., 8.

⁶⁵⁴ Ibid., 8.

⁶⁵⁵ "China's Counterspace Weapons," Israeli Homeland Security Internet Webpage, November 2, 2015, <https://i-hls.com/archives/66372>.

⁶⁵⁶ Harrison, Johnson, and Roberts, "Space Threat Assessment 2018," 2–4.

Table 2. China Counterspace Weapons⁶⁵⁷

China: Counterspace Weapons			
Kinetic-Physical	Non-Kinetic Physical	Electronic	Cyber
1) SC-19 direct-ascent ASAT (capable of threatening assets in LEO orbit) 2) New DN-3 ASAT (capable of reaching higher orbiting assets) 3) Testing and developing satellites to perform co-orbital capabilities—such as SJ-12 which has advanced maneuvering to conduct proximity operations 4) Aolong-1 spacecraft which has a robotic arm.	1) Developing and advancing in directed energy technologies (blinding and damaging optical sensors) 2) High-powered Laser system developments and testing 3) Probable ICBMs gives China a latent capability to launch a nuclear weapon into LEO	1) Development and deployment of satellite jamming systems is a high priority in China 2) Jamming U.S. millimeter wave satellite communications capability 3) Spoofing and jamming GPS kits—easily accessible and highly capable	1) Highly advanced cyber capabilities 2) China demonstrated hacking capabilities against U.S. Satellites and were successful

A report by the congressional U.S.-China Economic and Security Review Commission, states “China’s People’s Liberation Army believes demonstrating capabilities that can damage or destroy satellites is important to deterring adversaries, and that the anti-satellite threat is a more credible deterrent than nuclear arms.”⁶⁵⁸ If conflict occurs, Chinese military analysts believe that China will conduct offensive operations against satellites in order to “deprive an opponent of initiative on the battlefield and make it difficult for them to bring their precision-guided weapons into full play.”⁶⁵⁹ Additionally, Chinese strategy discusses plans to conduct “military cyberattacks that can take control of satellites by hacking into the microwave signals used by satellites.”⁶⁶⁰ For example, if the United States and China were to go to war, China would likely target both computer networks and satellite ground control stations to dismantle the United States military operations reliant

⁶⁵⁷ Ibid., 8–11; See Space Threat Assessment 2018 provided references on pp. 28–30 regarding Russia counterspace weapons.

⁶⁵⁸ Report by the congressional U.S.-China Economic and Security review commission, as quoted in Israeli Homeland Security, “China’s Counterspace Weapons.”

⁶⁵⁹ Ibid.

⁶⁶⁰ Ibid.

on satellites.⁶⁶¹ As shown in Table 2 and the analysis provided, China has the capability to threaten assets in space, which means that if space weaponization is not addressed in the immediate future, there is cause for concern.

(2) Russia

Following its post-Cold War deterioration and the rise of Vladimir Putin since 2000, Russia has strived to reconstitute its superpower status in space.⁶⁶² In April of 2018, the Secure World Foundation released a report, “Global Counterspace Capabilities: An Open Source Assessment,” which suggests that there is evidence to support this refocus on regaining its counterspace capabilities.⁶⁶³ Some of Russia’s counterspace weapons are summarized in Table 3:⁶⁶⁴

Table 3. Russia Counterspace Weapons⁶⁶⁵

Russia: Counterspace Weapons			
Kinetic-Physical	Non-Kinetic Physical	Electronic	Cyber
1) ASAT weapon program dating back to the early 1960s 2) Naryard—most powerful co-orbital ASAT (significant threat to GEO) 3) Rendezvous and Proximity Operations (RPO) 4) PL-19 Nudol - Direct-Ascent ASAT (significant threat to LEO) 5) S-300 and S-400—Surface to Air missile	1) Actively tested and developed directed-energy counterspace weapons 2) Development of a laser ASAT weapon (blinding and dazzling techniques) 3) Robust network of ground-based lasers	1) Advanced Electronic Attack Capabilities (Jamming and Spoofing) 2) Six different jamming and radio monitoring platforms, including the R-330Zh jammer and the R-381T2 UHF radio monitoring system. 3) GPS Jamming system called Pole-21	1) Most advanced in the world—use cyber-attacks daily 2) Russian hackers have hacked and accessed satellite data using the malware Turla

⁶⁶¹ Israeli Homeland Security Internet Webpage, “China’s Counterspace Weapons.”

⁶⁶² Sandra Erwin, “Analysts: Space weapons proliferating, there is more congestion and competition,” Spacenews.com, April 11, 2018, <http://spacenews.com/analysts-space-weapons-proliferating-there-is-more-congestion-and-competition/>.

⁶⁶³ Secure World Foundation report “Global Counterspace Capabilities: An Open Source Assessment,” as quoted in Ibid.

⁶⁶⁴ Harrison, Johnson, and Roberts, “Space Threat Assessment 2018,” 2–4.

⁶⁶⁵ Harrison, Johnson, and Roberts, “Space Threat Assessment 2018,” 13–15; See Space Threat Assessment 2018 provided references on pp. 30–32 regarding Russia counterspace weapons.

The Secure World Foundation report indicates the high priority placed on advancements and deployment of electronic warfare weapons.⁶⁶⁶ For example, unclassified intelligence reporting suggests that Russia's usage of jamming and electronic warfare techniques is part of a larger goal to dominating the information environment.⁶⁶⁷ Russia believes the "role of space in conflict is to provide the information necessary to employ one's forces and weapons and to deny that ability to one's adversary."⁶⁶⁸ In the event conflict occurs, Russia has the capability to target all levels of war (i.e., tactical, strategic, and operational).⁶⁶⁹ For example, at the tactical level, Russia can employ GPS jammers capable of denying the United States and its allies access to GPS satellites.⁶⁷⁰ Russia will continue to promote the incorporation of counterspace technologies throughout its military "to both protect its own space-enabled capabilities and degrade or deny those capabilities to adversaries."⁶⁷¹ As shown in Table 3 and in the analysis provided, Russia has the capability to deny and threaten an adversary's use of space-based assets, which means that if space weaponization is not addressed in the immediate future, there is cause for concern.

(3) Iran

In the recent decade, Iran has increased its efforts in space as well as continued to advance and develop their ballistic missile program.⁶⁷² Additionally, Iran has a "proven space launch vehicle, the Safir Rocket, which has placed four small satellites in orbit."⁶⁷³ Information regarding Iran's intent in space is not openly known, "but evidence suggests that Iran views the ability "to deny the United States and its allies the use of space in a

⁶⁶⁶ Secure World Foundation report "Global Counterspace Capabilities: An Open Source Assessment," as quoted in Erwin, "Analysts: Space weapons proliferating, there is more congestion and competition."

⁶⁶⁷ Weeden and Samson, "Global Counterspace Capabilities: An Open Source Assessment."

⁶⁶⁸ Ibid., 2–32.

⁶⁶⁹ Ibid., 2–33.

⁶⁷⁰ Ibid., 2–33.

⁶⁷¹ Ibid., 2–35.

⁶⁷² Harrison, Johnson, and Roberts, "Space Threat Assessment 2018," 16.

⁶⁷³ Weeden and Samson, "Global Counterspace Capabilities: An Open Source Assessment," 4–2.

regional conflict is critical to its security.”⁶⁷⁴ Although Iran is not a key player in outer space, it has developed counterspace weapons that have the ability to put space systems at risk.⁶⁷⁵ Some of Iran’s counterspace weapons are summarized in Table 4.⁶⁷⁶

Table 4. Iran Counterspace Weapons⁶⁷⁷

Iran: Counterspace Weapons			
Kinetic-Physical	Non-Kinetic Physical	Electronic	Cyber
1) Open source information does not indicate that Iran is attempting to develop either direct-ascent or co-orbital ASAT weapons 2) Ballistic missile technology—which could transfer to future kinetic ASAT capability	1) Iran may have acquired and used a laser dazzling or blinding counterspace system on a United States satellite—this technology may have been obtained from Russia or China—but limited public knowledge exists 2) Iran has not yet developed a nuclear weapon	1) Extensive deployment of electronic attacks against space systems, including uplink jamming, downlink jamming, and spoofing. 2) Spoof GPS Signals—most concerning	1) Advanced offensive cyber capabilities that could be used to target U.S. space systems. 2) Exploring the military uses of cyber capabilities to disrupt enemy missile defense systems, remotely piloted aircraft, logistics operations, and command and control links.

The Secure World Foundation report suggests that “there is significant public evidence that Iran has the ability to conduct electronic warfare attacks against commercial satellite broadcasters.”⁶⁷⁸ In addition to jamming against commercial satellite broadcasters, evidence suggests that Iran “could interfere with satellite-based command and control signals or GPS signals.”⁶⁷⁹ Currently, Iran’s primary space strategy is focused on cyber and electronic warfare rather than kinetic ASAT capabilities.⁶⁸⁰ Even without a kinetic counterspace capability, Iran is considered a formidable threat because of its

⁶⁷⁴ Reference 148, as cited in Harrison, Johnson, and Roberts, “Space Threat Assessment 2018,” 17.

⁶⁷⁵ Harrison, Johnson, and Roberts, “Space Threat Assessment 2018,” 17.

⁶⁷⁶ Ibid., 2–4.

⁶⁷⁷ Harrison, Johnson, and Roberts, “Space Threat Assessment 2018,” 17–18; See Space Threat Assessment 2018 provided references on pp. 32–33 regarding Russia counterspace weapons.

⁶⁷⁸ Weeden and Samson, “Global Counterspace Capabilities: An Open Source Assessment,” 4–3.

⁶⁷⁹ Ibid., 4–4.

⁶⁸⁰ Ibid., 4–5.

advancing spoofing and jamming capabilities.⁶⁸¹ As shown in Table 4 and in the analysis provided, Iran has the capability to deny and degrade its adversary's space assets, which means that if space weaponization is not addressed in the immediate future, there is cause for concern.

(4) North Korea

The Secure World Foundation reports that “North Korea does not appear motivated to develop counterspace assets, though certain capabilities in their ballistic missile program might be eventually evolved for such a purpose.”⁶⁸² Currently, the information available does not suggest that North Korea “is making substantial efforts to build or sustain a space industrial base.”⁶⁸³ But its missile program, with likely assistance from China, Iran, and/or Pakistan, continues to advance.⁶⁸⁴ With little information on North Korea's space doctrine, the “Space Threat Assessment 2018” assesses that if North Korea uses counterspace weapons, it would be because it is “focused on ensuring the survival of the regime and deterring foreign aggression, specifically the United States.”⁶⁸⁵ Some of North Korea's counterspace weapons are summarized in Table 5:⁶⁸⁶

⁶⁸¹ Ibid., 4–5.

⁶⁸² Ibid., 5–1.

⁶⁸³ Harrison, Johnson, and Roberts, “Space Threat Assessment 2018,” 19

⁶⁸⁴ Ibid.

⁶⁸⁵ Ibid., 20.

⁶⁸⁶ Ibid., 2–4.

Table 5. North Korea Counterspace Weapons⁶⁸⁷

North Korea: Counterspace Weapons			
Kinetic-Physical	Non-Kinetic Physical	Electronic	Cyber
1) To date North Korea has not tested, or indicated that it is attempting to develop, a direct-ascent or co-orbital ASAT capability. 2) Ballistic Missile technology could serve as a basis for kinetic ASAT capability but would have to overcome significant technological hurdles	1) Some evidence that North Korea may be developing or has already acquired nuclear EMP devices—but it is not likely the obtain the level of technology required to use directed-energy weapons, such as lasers that can dazzle or blind 2) Given its existing ballistic missile and nuclear capabilities, North Korea could theoretically launch a nuclear weapon	1) North Korea has acquired and is actively using electronic attack capabilities against U.S. space assets 2) GPS Jamming capability—operate via mobile platforms making it hard to locate and neutralize in conflict	1) Cyber forces are well organized and among the best in the world 2) Cyber-attacks have been launched against South Korea, United States, and other countries. 3) Hack into and intercept information as well as inject corrupt information into the links of the satellites

North Korea has proven its electronic warfare capabilities “by interfering with GPS navigation in the vicinity of South-North border and nearby coastal areas.”⁶⁸⁸ According to unnamed U.S. officials mentioned in the Secure Foundation report, “this type of jamming would not affect U.S. military members who use the military GPS signals.”⁶⁸⁹ As shown in Table 5 and in the analysis provided, North Korea currently lacks any serious known capability to target adversary space assets, but its developing missile program could serve as a basis for future counterspace technologies, which is cause for concern if space weaponization is not addressed in the near future.⁶⁹⁰

⁶⁸⁷ Ibid.,” 20–21; See Space Threat Assessment 2018 provided references on p. 33–34 regarding Russia counterspace weapons.

⁶⁸⁸ Weeden and Samson, “Global Counterspace Capabilities: An Open Source Assessment,” 5–6.; “North Korea jamming GPS signals near South border,” BBC News, April 1, 2016, <http://www.bbc.com/news/world-asia-35940542>.

⁶⁸⁹ Ibid., “Pentagon concerned about North Korea jamming GPS signals, officials say,” Fox News US, April 6, 2016, <http://www.foxnews.com/us/2016/04/06/pentagon-concerned-about-north-korea-jamming-gps-signals-officials-say.html>.

⁶⁹⁰ Harrison, Johnson, and Roberts, “Space Threat Assessment 2018.”

D. OUTER SPACE TREATY ANALYSIS

The OST was the second of the space arms control treaties; as mentioned, it was modeled after the Antarctic Treaty.⁶⁹¹ This case study presents the hypothesis: If countries continue to go forward weaponizing space without further legal agreements, the OST as it stands will not be able to adequately prevent conflict. The previous section showed the threat of space weapons and discussed countries continuing to develop counterspace technologies; this section will address whether the articles within the OST can cover the increasing concerns regarding the development of space weapons in the 21st century.

The first few articles of the OST are regarded as the initial provisions to dictate the use of space and could be interpreted to address and prevent future weaponization from occurring in space.⁶⁹² Article I states “the exploration and use of outer space, including the moon and other celestial bodies, 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.”⁶⁹³ Additionally, Article IV states “the Moon and other celestial bodies shall be used by all State Parties to the Treaty exclusively for peaceful purposes.”⁶⁹⁴ Interpretation of these two articles could suggest that weaponizing space would not be in the interest or benefit all State parties and would be considered an activity that is not peaceful.⁶⁹⁵ Moreover, the continuing development of satellite technology and weapons continues to challenge the international agreement of space to be used for peaceful purposes.⁶⁹⁶ Despite a general consensus on peaceful purposes, the lack of an agreed upon definition causes debates within the space community on whether those guidelines are

⁶⁹¹ “Outer Space Treaty (1967),” atomicarchive Arms Control Treaties, www.atomicarchive.com/Treaties/Treaty4.shtml.

⁶⁹² “International Legal Agreements Relevant to Space Weapons,” Union of Concerned Scientists: Science for a Healthy Planet and Safer World, February 11, 2004, <https://www.ucsusa.org/nuclear-weapons/space-weapons/international-legal-agreements#.WsGY3kxFzD5>.

⁶⁹³ Outer Space Treaty, U.S. State Department.

⁶⁹⁴ Ibid.

⁶⁹⁵ Steven Freeland, “Peaceful Purposes? Governing the Military Uses of Outer Space,” *European Journal of Law Reform* 18, no. 1 (2016), Western Sydney University School of Law Research Paper No. 03/2017, Available at SSRN: <https://ssrn.com/abstract=2899901>.

⁶⁹⁶ Ibid.

“directed against non-military rather than non-aggressive activities.”⁶⁹⁷ Although, during the creation of the treaty, “the principal space powers agreed to treat all military activities in outer space as permitted except those explicitly prohibited by the treaty or customary law.”⁶⁹⁸ The term “military”⁶⁹⁹ has also sparked debates when linked with activities in space, simply because commercial satellites currently can be and are being used for military operations.⁷⁰⁰ Furthermore, most countries have satellites that can be considered “dual-use,”⁷⁰¹ which means in terms of space weapons, it is hard “to plausibly claim that space weapons acquired or developed are strictly defensive.”⁷⁰² If dual-use technologies being developed continue, such use will significantly hinder any future discussions regarding the weaponization of space.⁷⁰³

Certain other articles of the OST could be interpreted and used to challenge or prevent State Parties to the Treaty from weaponizing space. Article VI states:

State Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried out by governmental agencies or by non-governmental agencies, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.⁷⁰⁴

With the potential weaponization of space, Article VI could provide a legal argument for those State Parties that want to challenge other State Parties’ space weaponization

⁶⁹⁷ Ibid.

⁶⁹⁸ Hans-Joachim Heintz, “Peaceful Uses of Outer Space and International Law,” space4peace.org, Accessed March 15, 2018, <http://www.space4peace.org/ethics/puosil.htm>.

⁶⁹⁹ Ibid.

⁷⁰⁰ Ibid.

⁷⁰¹ Caldicott and Eisendrath, *War in Heaven: The Arms Race in Outer Space*, 85.

⁷⁰² Ibid.

⁷⁰³ Emily Taft, “Outer Space: The Final Frontier or the Final Battlefield,” Duke Law and Technology Review, <https://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=1313&context=dltr>.

⁷⁰⁴ Outer Space Treaty, U.S. State Department.

activities.⁷⁰⁵ State Parties may perceive space weaponization as a non-peaceful use of space.⁷⁰⁶ Additionally, Article IX states:

A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies may request consultation concerning the activity or experiment.⁷⁰⁷

Any State Party to the OST has the right, under Article IX, to request a consultation with another Party member.⁷⁰⁸ A consultation could be used if one State Party felt that another State Parties' research advancements, testing, or use of space weapons conflicted with the peaceful-uses rhetoric of the OST, therefore providing adequate guidance to prevent conflict.⁷⁰⁹

According to Cesar Jaramillo, the weaponization of space is unavoidable because the OST is "outdated, inadequate, and insufficient."⁷¹⁰ The OST "does not explicitly prohibit the placement or use of other types of weapons."⁷¹¹ For example, the OST does not cover Earth-based weapons, such as ASATs, that can target satellites.⁷¹² These are provisions, according to Jaramillo, that are in need of clearer regulation or outright bans and prohibitions.⁷¹³ Article IV of the OST states:

State 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

⁷⁰⁵ Union of Concerned Scientists: Science for a Healthy Planet and Safer World, "International Legal Agreements Relevant to Space Weapons."

⁷⁰⁶ Ibid.

⁷⁰⁷ Outer Space Treaty, U.S. State Department.

⁷⁰⁸ Union of Concerned Scientists: Science for a Healthy Planet and Safer World, "International Legal Agreements Relevant to Space Weapons."

⁷⁰⁹ Ibid.

⁷¹⁰ Jaramillo, "In Defence of the PPWT Treaty: Toward a Space Weapons Ban."

⁷¹¹ Ibid.

⁷¹² Ibid.

⁷¹³ Ibid.

destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.⁷¹⁴

Article IV “only bans weapons of mass destruction (WMD) from orbit,”⁷¹⁵ but it does not consider the various ground, air, and sea-based weapons that could be deployed against satellites, or even worse against their ground-control elements.⁷¹⁶ The OST is often criticized for “its ill-defined use of the term ‘weapon’ within its provisions,”⁷¹⁷ much like its use of ambiguous phrase ‘peaceful purposes’ that was discussed earlier.⁷¹⁸ Nations, such as the United States, Russia, China, Iran, and North Korea, “have already started deploying space weapons.”⁷¹⁹ In addition, proponents of weaponizing space believe that dual-use satellites already represent viable weapons and therefore any prohibition will be ineffective.⁷²⁰ Since almost anything in outer space can be used as a weapon, the lack of a standing legal agreement defining space weapons increases the risk for conflict.⁷²¹ Steve Mirmina, professor of space law at Georgetown, provides an example using NASA’s Robotic Refueling Mission.⁷²² This mission is designed to provide refueling in space,

⁷¹⁴ Outer Space Treaty, U.S. State Department.

⁷¹⁵ Ibid.

⁷¹⁶ Union of Concerned Scientists: Science for a Healthy Planet and Safer World, “International Legal Agreements Relevant to Space Weapons.”

⁷¹⁷ Dr. Columba Peoples, “The Securitization of Outer Space: Challenges for Arms Control” (Working paper No.02-10, School of Sociology, Politics and International Studies at University of Bristol, 2010), 6, <http://www.bristol.ac.uk/media-library/sites/spais/migrated/documents/peoples0210i.pdf>.

⁷¹⁸ Ibid.

⁷¹⁹ Peter Kamocsai, “Op-Ed: Why the U.S. Should Be a Leader in Space Weaponization,” SpaceNews.com, January 10, 2015, <http://spacenews.com/commentary-why-the-u-s-should-be-a-leader-in-space-weaponization/>.

⁷²⁰ Peoples, “The Securitization of Outer Space: Challenges for Arms Control,” 6; One pro-weaponization blog quotes U.S. STRATCOM Commander General Kevin P. Chilton as follows: ‘Let us say you build a craft capable of pulling alongside a satellite, extending a robotic arm, and plucking the satellite’s solar panels off, thereby disabling it. Would you consider that a space weapon? Well, if so, that would mean the U.S. space shuttle is a space weapon.’ – see http://closingvelocity.typepad.com/closing_velocity/2009/01/obama-to-ban-spaceshuttle-astronauts.html.

⁷²¹ “Outer Space: Militarization, weaponization, and the prevention of an arms race,” Reaching Critical Will: A project of the Women’s International League for Peace and Freedom, 2018, <http://reachingcriticalwill.org/resources/fact-sheets/critical-issues/5448-outer-space>.

⁷²² Steve Mirmina, as quoted in Jane C. Hu, “The Battle for Space,” SLATE, December 23, 2014, http://www.slate.com/articles/health_and_science/space_20/2014/12/space_weapon_law_u_s_china_and_russia_developing_dangerous_dual_use_spacecraft.html.

which Mirmina debates could also give other countries the idea that if the capability exists to refuel a satellite, then the ability to approach and conduct attacks on adversary satellites exists.⁷²³ The only regulations that have been made regarding space weapons lie in a treaty that was established more than fifty years ago.⁷²⁴ The OST could not have predicted the increase in space weapon technology; without specific guidelines nations will continue to test, fund, and possibly field weapons that can both be deployed to space and be used from Earth.

The analysis conducted above on the OST leads to the conclusion that although certain articles could be interpreted to cover some of the current weaponization of space issues, they are not all encompassing and leave too much to interpretation to adequately prevent conflict in the 21st century. Additionally, technological advancements in space and the emerging threats were not considered in the OST and, therefore cannot adequately cover new space weapons technology. Supplementary guidance or treaties are needed in the future or space could become another warfighting domain. This need will be further illustrated in the next section when presented with hypothetical scenarios that could potentially create conflict due to a lack of international agreements that can deal with the complexities of this threat. In the concluding chapter of this thesis, potential recommendations will be provided to address and overcome the gaps within the OST.

E. POTENTIAL FUTURE CONFLICTS

In recent years, both the commercial and military sectors have become increasingly dependent on space-based services and assets.⁷²⁵ This growing reliance comes with an increased vulnerability whether from an accidental interruption or a deliberate targeting of space-based assets..⁷²⁶ But with the continued development of space weapons by the U.S., Russia, China, Iran, and North Korea, the future of space looks as if it will be

⁷²³ Ibid.

⁷²⁴ Hu, "The Battle for Space."

⁷²⁵ Nayef Al-Rodhan, "Preventing Future Conflicts in Outer Space," Center for Security Studies, March 14, 2018, <https://isnblog.ethz.ch/security/preventing-future-conflicts-in-outer-space>.

⁷²⁶ Ibid.

weaponized.⁷²⁷ This section will consider potential conflicts that could occur regarding the weaponization of space, separated by those that are most likely or most dangerous. Additionally, hypothetical scenarios will be discussed to emphasize the reality of future conflict regarding weaponizing space.

1. Most Likely

Space weaponization, according to Alexander Chanock, “raises several concerns for both countries and people on Earth.”⁷²⁸ Conflicts in space do not just affect one person or one country, they have the potential to affect the entire world.⁷²⁹ Chanock believes the most likely conflict that will occur is an arms race, much like the Cold War in terms of nuclear weapons.⁷³⁰ An arms race has the potential to destabilize the international community, increasing the possibility of an armed conflict.⁷³¹ Let us examine a hypothetical scenario, U.S. intelligence collects imagery showing the recent Chinese stationing of multiple ASAT launchers and systems for possible future testing and deployments. This announcement creates instability amongst the international community leading to other countries, such as the United States, feeling forced to respond, possibly with space-based weapons. To make matters worse, Russia follows suit and enters the arms race. An arms race is just the beginning to a bigger issue. With no specific ASAT bans adopted, these three countries could continue to fund and test these weapons and, if they felt it necessary, deploy and use these weapons against one another. Additionally, space weapons can be very expensive, which could cause internal political concerns because of the amount of money that would be needed to stay ahead in an arms race to space.⁷³² The scenarios and concerns presented above suggest that an arms race would most likely create political instabilities that will eventually lead to military disputes.

⁷²⁷ Chanock, “The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century,” 696.

⁷²⁸ Ibid.

⁷²⁹ Ibid.

⁷³⁰ Ibid.

⁷³¹ Ibid.

⁷³² Ibid.

Another additional likely conflict deals with the testing and use of weapons against objects in space resulting in the creation of space debris.⁷³³ As noted by Joel Primack, one of the premier experts on space debris,

The weaponization of space would make the debris problem much worse, and even one war in space could encase the entire planet in a shell of whizzing debris that would thereafter make space near the Earth highly hazardous for peaceful as well as military purposes.⁷³⁴

Space debris is a complex threat. Hence, this thesis featured a dedicated case study (chapter II) on this concern. Let us look at a real situation revolving around space weapons: the Chinese tested their ASAT in 2007, “producing over 2,087 trackable debris and 35,000 untrackable debris.”⁷³⁵ Later in January 2013, one of these debris hit a Russian spacecraft causing severe damage.⁷³⁶ This collision illustrates a significant concern because “if one controlled military test can cause harmful debris six years later, a space war could have disastrous consequences for space assets that could continue for years after the conflict ended.”⁷³⁷ With no regulations or guidance on space weapons (i.e., ASATs) or space debris, this could cause both political disagreements and even lead to military disputes. Specifically, according to Alexander Chanock, this issue “is especially dangerous for the United States because its civilian and military infrastructures are heavily intertwined with its space assets.”⁷³⁸ For example, if a communications satellite is lost, an immediate reduction in the U.S.’s ability to communicate and share information will occur, placing

⁷³³ Ibid.

⁷³⁴ Joel Primack, as quoted in Ibid.

⁷³⁵ Chanock, “The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century,” 696; T.S. Kelso, Center for Space Standards & Innovation, *Analysis of the 2007 Chinese ASAT Test and the Impact of its Debris on the Space Environment* 321 (2007).

⁷³⁶ Chanock, “The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century,” 697–698; John Didymus, *Chinese Anti-Satellite Weapon Hits Russian Satellite*, Digital J., March 9, 2013, <http://www.digitaljournal.com/article/345243>.

⁷³⁷ Chanock, “The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century,” 698.

⁷³⁸ Ibid.

any current military operations at risk.⁷³⁹ Additionally, from a commercial or social perspective, individuals who rely on satellites for Internet connectivity, television signals, cell phone reception, and radio broadcasts will lose or have degraded service.⁷⁴⁰

2. Most Dangerous

The use of dual-use technology presents a more dangerous situation, increasing the potential for conflict. Let us look at some real-world examples that have the potential to spark instability. The U.S. intelligence community has reported that “China has a satellite with an extendable robotic arm that it says can be used to collect space junk but likely can also be used to cripple working satellites.”⁷⁴¹ Additionally, according to Theresa Hitchens, senior research associate at the University of Maryland’s Center for International and Security Studies, certain “U.S. satellites that can dock with existing satellites to refuel them could be turned into weapons by ordering them to bump enemy satellites out of orbit or equipping them with jammers or lasers.”⁷⁴² Let us examine a hypothetical scenario, the Chinese have launched a new satellite with a laser on it intended to be used to clean up space debris. Tensions between the United States and China have been rapidly escalating due to continuous Chinese jamming and spoofing of GPS signals resulting in numerous U.S. Navy ship collisions, aggressive maneuvering in the South China Sea, and the shootdown of multiple U.S. aircraft. The U.S. retaliates with multiple air strikes on mainland China. China decides to take the fight further, targeting U.S. satellites that are providing imagery to target mainland China. It decides it will use its newly launched debris removal satellite laser capability against U.S. imagery satellites, leaving the U.S. without the capability of collecting imagery for future strikes. Although this scenario is unlikely in the near future, it shows the potential threat dual-use satellites could play in space warfare.

⁷³⁹ George Dvorsky, “What Would Happen If All Our Satellites Were Suddenly Destroyed?,” Gizmodo.com, June 04, 2015, <https://io9.gizmodo.com/what-would-happen-if-all-our-satellites-were-suddenly-d-1709006681>.

⁷⁴⁰ Ibid.

⁷⁴¹ Gillian Rich, “Space Warfare: Why the U.S. Is So Vulnerable Despite SpaceX’s Wins,” Investor’s Business Daily, March 02, 2018, <https://www.investors.com/news/war-in-space-why-the-us-has-never-been-more-vulnerable-despite-spacex-wins/>.

⁷⁴² Theresa Hitchens, as quoted in Ibid.

As China's and Russia's military space programs and counterspace technologies continue to rapidly advance, challenging U.S. dominance in outer space, "the power struggle risks sparking a dangerous conflict that could cripple or even destroy the entire planet's space-based infrastructure."⁷⁴³ The most dangerous issue regarding space weaponization would be a war in space or on Earth.⁷⁴⁴ Even worse would be the inability to use outer space due to the aftermath or lasting effects from a war in space. Let us examine a hypothetical scenario, the Chinese launch of multiple ASATs at U.S. GPS satellites, causing a significant reduction in U.S. military capabilities. Additionally, targeting multiple GPS satellites would affect the civilian and commercial sectors all over the globe. Although this conflict started in space, it would be extremely difficult to prevent this scenario from escalating out of control, becoming a full-blown war against China, due to the lack of norms for space warfare.⁷⁴⁵ The scenarios and concerns provided above suggest that if space-faring nations begin to weaponize space or use space weapons against adversaries without international legal agreements, it could create political instability and wars in space and on Earth, putting millions of people in danger.

F. CONCLUSION

The steady increase in technology and the continuing "proliferation of space weapons is a key issue"⁷⁴⁶ that the international community is grappling with in the 21st century.⁷⁴⁷ Since the weaponization in space may occur in the near future, the international community needs to either find a way to halt it completely or insure "that the creation of these new weapons does not destabilize the security system"⁷⁴⁸ that is already in place

⁷⁴³ Lee Billings, "War in Space May Be Closer Than Ever," *Scientific American*, August 10, 2015, <https://www.scientificamerican.com/article/war-in-space-may-be-closer-than-ever/>.

⁷⁴⁴ Ibid.

⁷⁴⁵ Ibid.; Rich, "Space Warfare: Why the U.S. Is So Vulnerable Despite SpaceX's Wins."

⁷⁴⁶ Chanock, "The Problems and Potential Solutions Related to the Emergence of Space Weapons in the 21st Century," 710.

⁷⁴⁷ Ibid.

⁷⁴⁸ Ibid.

guiding activities in space.⁷⁴⁹ This case study discussed the progression of weaponization of space through history, showing the continued threat of these issues. The weaponization of space was a key concern during the creation of the OST regarding nuclear weapons, but it did not account for future technologies and advancements in space weapons. This chapter also addressed the threat that weaponizing space plays in the 21st century and discussed the importance of evaluating the OST's ability to guide and direct space-faring nations on this issue. The analysis of the OST's capability to aid in the challenges posed by space-faring nations' perceived need to develop space weapons determined that even though certain articles could potentially cover the issue, they simply do not address the 21st century advancements in space weapons nor do they offer any specific guidelines. Therefore, in conclusion, this chapter finds that the OST would not be able to prevent conflicts resulting from the continued development of space weapons by multiple countries in the 21st century.

⁷⁴⁹ Ibid.

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IV. ASTERIOD AND MOON MINING CASE STUDY

A. INTRODUCTION

Due to recent renewed interests in exploring space and the growth of commercial and private space companies, the idea of space mining (i.e., on asteroids, the Moon, and other planets) is no longer an idea but an achievable reality.⁷⁵⁰ This section will present a case study on the potential risks of conflict from asteroid and Moon mining and address whether the Outer Space Treaty has the ability to prevent future conflict. Unlike space debris and weaponization of space, space mining is still in the relatively beginning stages and the actual threat is unknown. Therefore, this case study will address the potential threat that asteroid and Moon mining could become in the future. The case study will be divided into four parts: 1) an historical analysis of asteroid and Moon mining (space mining); 2) the potential risks from asteroid and Moon mining in the 21st century; 3) an Outer Space Treaty analysis; and 4) a discussion on the potential for conflict.

B. HISTORY OF ASTEROID AND MOON MINING

The concept of space mining is not something new, the idea dates back centuries.⁷⁵¹ In the late 1800s, Russian scientist, Konstantin Tsiolkovsky, “prophesized the construction of mines of the surface of asteroids.”⁷⁵² Later in 1926, “Tsiolkovsky released his 16-point plan for colonization of the galaxy.”⁷⁵³ The twelfth point referenced the inherent need to exploit asteroids for sustainable resources in order to attain autonomy from Earth.⁷⁵⁴ Of

⁷⁵⁰ Matt Williams, “The Future of Moon Mining,” PHYS.org, November 17, 2016, <https://phys.org/news/2016-11-future-moon.html>.

⁷⁵¹ Matthew Shaer, “The Asteroid Miner’s Guide to the Galaxy: U.S. companies are preparing to tap the solar system’s riches. But will they share the trillion-dollar deep-space marker with hungry foreign competitors?,” *Foreign Policy Magazine*, April 28, 2016, <https://foreignpolicy.com/2016/04/28/the-asteroid-miners-guide-to-the-galaxy-space-race-mining-asteroids-planetary-research-deep-space-industries/>.

⁷⁵² Ibid.

⁷⁵³ Ibid.

⁷⁵⁴ Ibid.

note, some of the earliest mentions of space mining were just illustrations in science fiction stories.⁷⁵⁵ For example, Garrett Serviss' 1898 story "Edison's Conquest of Mars" described an armada comprised of human space explorers who stumbled upon a mining outpost on an asteroid, while enroute to attack Mars.⁷⁵⁶ The spacefaring humans realized that they had stumbled upon a literal goldmine of opportunities.⁷⁵⁷ Also, in 1944 Isaac Asimov's published "Catch That Rabbit," detailing a plot "that placed two bored corporate overseers on an asteroid, where they watched a team of robotic miners plying their trade."⁷⁵⁸ Although these were ideas of science fiction writers, outer space was seen as a new area of opportunity and competition for the world.⁷⁵⁹ The race to space was about to begin between the United States and the Soviet Union. Therefore, discussions regarding the conduct of space activities that involved the exploitation of celestial bodies (i.e., Moon, asteroids, and other planets), were also about to begin.

Prior to 1960, discussions had already taken place regarding celestial bodies.⁷⁶⁰ Two major concerns were discussed: 1) "The possibility of nation-states acquiring sovereignty over all or part of a natural celestial body"⁷⁶¹ and 2) "What would be required under existing law to make such a claim legally valid."⁷⁶² Comparisons were being made to past examples of countries claiming sovereignty over areas on Earth's surface.⁷⁶³ The Soviet Union announced on September 14, 1959, "a rocket carrying their flag had crashed

⁷⁵⁵ Shaer, "The Asteroid Miner's Guide to the Galaxy: U.S. companies are preparing to tap the solar system's riches."

⁷⁵⁶ Matt Novak, "Asteroid Mining's Peculiar Past," BBC, November 18, 2014, <https://www.bbc.com/future/story/20130129-asteroid-minings-peculiar-past>.

⁷⁵⁷ Ibid.

⁷⁵⁸ Shaer, "The Asteroid Miner's Guide to the Galaxy: U.S. companies are preparing to tap the solar system's riches."

⁷⁵⁹ Ibid.

⁷⁶⁰ Dembling and Arons, "The United Nations Celestial Bodies Convention," 535–536.

⁷⁶¹ Ibid.

⁷⁶² Dembling and Arons, "The United Nations Celestial Bodies Convention," 535–536; Libson and Katzenbach, *Report to the National Aeronautics and Space Administration on the Law of Outer Space*, A.B.A. Found. 22(a) (1960).

⁷⁶³ Ibid.

onto the Moon's surface."⁷⁶⁴ The United States was quick to respond, warning the Soviets this feat did not give them any territorial claims or rights over the Moon.⁷⁶⁵ Surprisingly, the Soviets did not assert sovereignty over the Moon.⁷⁶⁶ Additionally, in 1959, a resolution was approved by the American Bar Association excluding celestial bodies from claims of sovereignty and maintaining their use for "the common interest of mankind."⁷⁶⁷ COPUOS reported the potential problems that could transpire if nations decided to claim celestial bodies.⁷⁶⁸ In 1960, President Eisenhower presented three proposals to the General Assembly, with his first one stating that "we agree that celestial bodies are not subject to national appropriation by any claims of sovereignty."⁷⁶⁹ But by this time, COPUOS had already decided:

while scientific programs envisaged relatively early exploration of celestial bodies, human settlement and extensive exploitation of resources were not likely in the near future. For this reason, the Committee believed that problems relating to the settlement and exploitation of celestial bodies did not require priority treatment.⁷⁷⁰

Later in 1960, John F. Kennedy was elected president.⁷⁷¹ Quickly after taking office, President Kennedy increased the budget for the U.S. space program because he had made

⁷⁶⁴ "1959: Soviet probe reaches the Moon," This Day in History at History.com, September 14, 1959, <https://www.history.com/this-day-in-history/soviet-probe-reaches-the-moon>.

⁷⁶⁵ Ibid.

⁷⁶⁶ Dembling and Arons, "The Evolution of the Outer Space Treaty," 421.

⁷⁶⁷ Ibid.; Libson and Katzenbach, Report to the National Aeronautics and Space Administration on the Law of Outer Space; See also: Wilcox, International Cooperation in the Use of Outer Space, 40 DEP'T STATE BULL. 339 (1959), McDougal et al., The Enjoyment and Acquisition of Resources in Outer Space, 111 U. PA. L. REV. 521 (1963).

⁷⁶⁸ Dembling and Arons, "The Evolution of the Outer Space Treaty," 421; Report of the AD Hoc Committee on the Peaceful Uses of Outer Space, U.N. Doc A 4141/25 (1959).

⁷⁶⁹ Ibid., 421-422; Address by President Dwight D. Eisenhower to the U.N. General Assembly, 10 Sept. 1960, 43 DEP'T STATE BULL. 554 (1960).

⁷⁷⁰ Ibid., 422; Report of the AD Hoc Committee on the Peaceful Uses of Outer Space, U.N. Doc A 4141/25 (1959).

⁷⁷¹ "1959: Soviet probe reaches the Moon," This Day in History at History.com.

a promise to the American people “that the United States would send a man to the Moon by the end of the decade.”⁷⁷²

December 20, 1961, marked the passage of “the nonbinding resolution 1721 on ‘International Cooperation in the Peaceful Use of Outer Space’” at the United Nations.⁷⁷³ Two significant principles were established in this resolution to help regulate space activities:⁷⁷⁴

Namely that international law, including the Charter of the United Nations, applies to outer space and celestial bodies, and that outer space and celestial bodies are free for exploration and use by all States in conformity with international law and are not subject to national appropriation.⁷⁷⁵

Unfortunately, as a nonbinding resolution, it was unenforceable.⁷⁷⁶ In 1962, the first session of the Legal Subcommittee occurred.⁷⁷⁷ At this session, several documents were submitted for review, one of them being “a draft Declaration of the Basic Principles Governing the Activities of States Pertaining to the Exploration and Use of Outer Space proposed by the Union of Soviet Socialist Republics (USSR).”⁷⁷⁸ This draft was not immediately supported by some members of COPUOS.⁷⁷⁹ While deliberations continued regarding this draft proposal, on the other side of the world, U.S. Vice President Lyndon Johnson addressed the American people at the Seattle World’s Fair, speaking about the benefits of asteroid mining.⁷⁸⁰ Vice President Johnson stated “someday we will be able to bring an asteroid containing billions of dollars’ worth of critically needed metals close to Earth to provide a vast source of mineral wealth to our factories.”⁷⁸¹ Additionally, during

⁷⁷² Ibid.

⁷⁷³ Moltz, *The Politics of Space Security*, 110.

⁷⁷⁴ Kopal, “Introductory Note.”

⁷⁷⁵ Ibid.

⁷⁷⁶ Moltz, *The Politics of Space Security*, 110.

⁷⁷⁷ Kopal, “Introductory Note.”

⁷⁷⁸ Ibid.

⁷⁷⁹ Ibid.

⁷⁸⁰ Novak, “Asteroid Mining’s Peculiar Past.”

⁷⁸¹ As quoted by U.S. Vice President Lyndon Johnson in Ibid.

this time, newspapers in the United States were covering topics such as the benefits of asteroid mining, referencing a “new gold rush”⁷⁸² in outer space.⁷⁸³

In 1963, the Soviet Union’s draft had finally gained favor among the members of COPUOS and a declaration was negotiated.⁷⁸⁴ Later that year in December, after negotiations ceased the General Assembly approved resolution 1962 which included nine principles, with three specifically providing protections to outer space and celestial bodies:⁷⁸⁵

1) The exploration and use of outer space shall be carried on for the benefit and in the interests of all mankind, 2) Outer Space and celestial bodies are free for exploration and use by all States on a basis of equality and in accordance with international law, and 3) Outer Space and celestial bodies are not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.⁷⁸⁶

Much like the resolution 1721, this declaration was nonbinding.⁷⁸⁷ Thus, with these resolutions, the General Assembly concurred that international law should form the framework for both activities in outer space and on celestial bodies and that no rights should be lost to individual countries.⁷⁸⁸ This event was significant because these resolutions set the foundations for future international space treaties.⁷⁸⁹

On May 7, 1966, prior to the Fifth Session, President Johnson stressed the need for action in developing an international agreement that would safeguard the Moon and other

⁷⁸² Novak, “Asteroid Mining’s Peculiar Past.”

⁷⁸³ Ibid.

⁷⁸⁴ Kopal, “Introductory Note.”

⁷⁸⁵ Ibid.

⁷⁸⁶ Resolution 1962 (XVIII), “Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space,” United Nations General Assembly (18th Session), December 13, 1963, accessed on May 10, 2018, <http://www.un-documents.net/a18r1962.htm>.

⁷⁸⁷ Kopal, “Introductory Note.”

⁷⁸⁸ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 425.

⁷⁸⁹ Kopal, “Introductory Note.”

celestial bodies.⁷⁹⁰ President Johnson presented five proposals that he felt should be considered within an international treaty, the first three discussing the Moon and celestial bodies.⁷⁹¹ Here are the first three proposals:

1. The moon and other celestial bodies be free for exploration and use by all countries. No country should be permitted to advance a claim of sovereignty.
2. There should be freedom of scientific investigation, and all countries should cooperate in scientific activities relating to celestial bodies.
3. Studies should be made to avoid harmful contamination.⁷⁹²

Shortly after these statements were made, Arthur J. Goldberg, the United States ambassador to the United Nations, “wrote a letter to the chairman of COPUOS requesting an early convening of the Legal Subcommittee to consider the treaty proposed by President Johnson.”⁷⁹³ A date, July 12, and location, Geneva, were then decided upon for formal considerations to be heard regarding an international treaty.⁷⁹⁴ The United States and the Soviet Union both submitted draft treaty proposals to COPUOS.⁷⁹⁵ One of the more significant debates within the Legal Subcommittee regarded “whether the treaty should establish rules governing activity on celestial bodies or should it include all of outer space as well.”⁷⁹⁶ The two drafts submitted to the committee highlighted this debate. The United States included only celestial bodies and the Soviet Union included celestial bodies and outer space.⁷⁹⁷ With both the United States and the Soviet Union in a fierce competition to be the first to successfully conduct a manned landing on the Moon, it was important that the committee agree on a treaty as soon as possible.⁷⁹⁸ United Nations General Assembly finally approved a treaty on December 19, 1966, and opened it for signatures on January

⁷⁹⁰ President Lyndon B. Johnson, as quoted in Dembling and Arons, “The Evolution of the Outer Space Treaty,” 425.

⁷⁹¹ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 425.

⁷⁹² President Lyndon B. Johnson, as quoted in *Ibid.*

⁷⁹³ Dembling and Arons, “The Evolution of the Outer Space Treaty,” 426.

⁷⁹⁴ *Ibid.*, 427.

⁷⁹⁵ *Ibid.*, 426.

⁷⁹⁶ *Ibid.*, 428.

⁷⁹⁷ *Ibid.*

⁷⁹⁸ *Ibid.*, 427.

27, 1967.⁷⁹⁹ The final version of the treaty included several articles that detailed safeguards and regulations for use of the Moon and other celestial bodies.⁸⁰⁰

On July 20, 1969, U.S. *Apollo 11* and its crew successfully landed on the Moon.⁸⁰¹ The astronauts collected rock and soil samples from the Moon's surface and successfully brought them back to NASA to further analyze.⁸⁰² Additionally, from 1970–1976, the Soviet Union, in competition with the United States, successfully launched and conducted three robotic missions bringing back samples from the Moon.⁸⁰³ The Soviet Union used the *Luna* series spacecraft which “drilled a few tens of cm below the Moon's surface using a drill at the end of a sampling arm.”⁸⁰⁴ *Luna 16*, the first successful mission, “returned a small sample from Mare Fecunditatis in September of 1970.”⁸⁰⁵ This event occurred between the United States *Apollo 12* and *Apollo 14* Moon missions.⁸⁰⁶ In February 1972, the Soviet Union successfully conducted its second sample return mission with *Luna 20*. *Luna 20* brought back “55 grams of soil from the Apollonius highlands region.”⁸⁰⁷ Other notable U.S. lunar missions were *Apollo 15*, *16*, and *17*, which were conducted prior to the ending of the program in December 1972.⁸⁰⁸ In 1974, the Soviet Union *Luna 23* was unsuccessful in collecting samples due to technical difficulties.⁸⁰⁹ But, in August 1976, *Luna 24* was the third successful Soviet sampling mission to the Moon.⁸¹⁰ *Luna 24* was

⁷⁹⁹ Ibid., 455.

⁸⁰⁰ Ibid.

⁸⁰¹ Ryan A Zeigler and Eric A. Nielsen, “Lunar Sample Public Displays Information,” NASA.gov, September 14, 2017, <https://curator.jsc.nasa.gov/lunar/displays/index.cfm#history>.

⁸⁰² Ibid.

⁸⁰³ Zeigler and Nielson, “Lunar Sample Public Displays Information.”; Robert Garner, “Lunar Reconnaissance Orbiter,” NASA.gov, March 16, 2010, https://www.nasa.gov/mission_pages/LRO/multimedia/lroimages/lroc-20100316-luna.html.

⁸⁰⁴ Garner, “Lunar Reconnaissance Orbiter.”

⁸⁰⁵ Ibid.

⁸⁰⁶ Ibid.

⁸⁰⁷ Ibid.

⁸⁰⁸ Ibid.

⁸⁰⁹ Ibid.

⁸¹⁰ Ibid.

able to “drill over 2 meters into the lunar soil thus collecting a better section and their largest sample to date, 170 grams.”⁸¹¹

From the years 1972 to 1979, the General Assembly and its Legal Subcommittee applied the principles already established in the OST to elaborate on an additional treaty regarding specific activities on the Moon.⁸¹² In 1979, after deliberations the General Assembly adopted the “Moon Agreement (Moon Treaty) in resolution 34/68.”⁸¹³ This agreement, a follow-on to the OST, provided additional guidelines regarding space activities involving the Moon and all other celestial bodies.⁸¹⁴ Additionally, in Article II of the agreement it states “all activities on the moon, including its exploration and use shall be carried out in accordance with international law, in particular the Charter of the United Nations,” therefore placing authority and jurisdiction within the international community.⁸¹⁵ It was written with the intent to safeguard the Moon from becoming another arena for conflict.⁸¹⁶ It maintained that the Moon, like outer space, should remain an area to benefit everyone.⁸¹⁷ It continued to highlight “that the Moon and all other celestial bodies must be used exclusively for peaceful purposes.”⁸¹⁸ Most importantly in regards to space mining,

The Agreement provided that the Moon and its natural resources are the common heritage of mankind and that an international regime should be

⁸¹¹ Ibid.

⁸¹² “Summary Statement for the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies,” United Nations Office for Outer Space Affairs, Accessed April 12, 2018, <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/intromoon-agreement.html>.

⁸¹³ Ibid.

⁸¹⁴ Rens Steenhard, “The Moon Agreement of 1979: What Relevance to Space Activities?,” Peace Palace Library Collection, September 3, 2010, <https://www.peacepalacelibrary.nl/2010/09/the-moon-agreement-of-1979-what-relevance-to-space-activities/>.

⁸¹⁵ RES 34/68, “Agreement Governing the Activities of States on the Moon and Other Celestial Bodies,” General Assembly 1979, Accessed on April 12, 2018, http://www.unoosa.org/pdf/gares/ARES_34_68E.pdf; Steenhard, “The Moon Agreement of 1979: What Relevance to Space Activities?”

⁸¹⁶ Steenhard, “The Moon Agreement of 1979: What Relevance to Space Activities?”

⁸¹⁷ Ibid.

⁸¹⁸ “Summary Statement for the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies,” United Nations Office for Outer Space Affairs.

established to govern the exploitation of such resources when such exploitation is about to become feasible.⁸¹⁹

Although the Agreement acquired enough approvals to enter into force in June 1984, currently, no major nation ratified it, and numerous others failed to sign it.⁸²⁰

In more recent years, on November 25, 2015, “President Barack Obama signed into law the Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015 (SPACE Act of 2015).”⁸²¹ This act allows U.S. citizens and commercial companies to legally participate in mining activities in space.⁸²² Additionally, this act grants resource rights to U.S. space mining companies, allowing them to sell the resources extracted and harvested from asteroids.⁸²³ It does not give U.S. citizens or commercial space mining companies any ownership over celestial bodies they have selected to harvest resources.⁸²⁴

C. POTENTIAL RISKS OF ASTEROID AND MOON MINING

As more space mining operations occur in the future, this could provoke a new, more threatening gold rush.⁸²⁵ This section will address the potential problems and risks that asteroid and Moon mining could bring to the 21st century. The first concern, and likely the most significant, is the lack of international agreements or detailed treaties regarding

⁸¹⁹ Ibid.

⁸²⁰ Steenhard, “The Moon Agreement of 1979: What Relevance to Space Activities?”

⁸²¹ “U.S. Makes Space History: President Obama Signs Law Enabling Commercial Exploration and Use of Space Resources,” Deep Space Industries (DSI), November 25, 2015, <http://deepspaceindustries.com/u-s-makes-space-history/>.

⁸²² Library of Congress, “Summary on H.R. 2262 - U.S. Commercial Space Launch Competitiveness Act,” Accessed May 4, 2018, <https://www.govtrack.us/congress/bills/114/hr2262/summary#libraryofcongress>.

⁸²³ Gbenga Oduntan, “Who owns space? U.S. asteroid-mining act is dangerous and potentially illegal,” The Conversation, November 25, 2015, <http://theconversation.com/who-owns-space-us-asteroid-mining-act-is-dangerous-and-potentially-illegal-51073>.

⁸²⁴ Library of Congress, “Summary on H.R. 2262 - U.S. Commercial Space Launch Competitiveness Act.”

⁸²⁵ Alexander Jones, “Mining Outer Space: The New Gold Rush?,” International Banker, March 16, 2016, <https://internationalbanker.com/brokerage/mining-outer-space-new-gold-rush/>; Renu Rangela, “Space is under the threat of becoming a battleground for mining companies,” *International Business Times*, January 15, 2016, <http://www.ibtimes.com.au/space-under-threat-becoming-battleground-mining-companies-1500792>.

space mining.⁸²⁶ Frans von der Dunk, a space law professor at the University of Nebraska—Lincoln, argues that “proponents of asteroid mining view mining activities similarly to the ‘global commons’ status of the high seas: no state may colonize the Atlantic Ocean, yet anyone can harvest its fish.”⁸²⁷ Joanne Gabrynowicz by contrast, editor-in-chief emerita of the *Journal of Space Law*, details the arguments of those against asteroid mining using Antarctica as an example of a “global commons.”⁸²⁸ She argues that Antarctica has internationally approved treaties and guidelines on extraction activities, whereas outer space does not.⁸²⁹ Additionally, von der Dunk gives an argument in support of Gabrynowicz’s claim of needing additional guidelines and clarification in asteroid mining.⁸³⁰ Without clarification, von der Dunk defends the argument regarding common ownership rights to resources.⁸³¹ If the international community does not agree on rules that detail extraction and the sharing of benefits and resources, this could spark political instabilities.⁸³² Gabrynowicz draws an analogy between space mining and past colonial invasions and exploitations, which is especially frightening for developing countries.⁸³³ Currently, the international community has not come to an agreement on a universal set of regulations for space mining.⁸³⁴ Thus, the conflicting views on the legality of mining in space could become a major concern in the 21st century.⁸³⁵

Although asteroid and Moon mining may promise substantial economic benefits, it would be wrong not to mention that there is a potential threat of economic disruption to

⁸²⁶ Jesse Dunietz, “Floating Treasure: Space Law Needs to Catch Up with Asteroid Mining,” *Scientific American*, August 28, 2017, <https://www.scientificamerican.com/article/floating-treasure-space-needs-to-catch-up-with-asteroid-mining/>.

⁸²⁷ Frans von der Dunk, as quoted in *Ibid.*

⁸²⁸ Joanne Gabrynowicz, as quoted in *Ibid.*

⁸²⁹ *Ibid.*

⁸³⁰ Dunietz, “Floating Treasure.”

⁸³¹ Frans von der Dunk, as quoted in *Ibid.*

⁸³² Dunietz, “Floating Treasure.”

⁸³³ Joanne Gabrynowicz, as quoted in *Ibid.*

⁸³⁴ Dunietz, “Floating Treasure.”

⁸³⁵ *Ibid.*

resource-exporting nations.⁸³⁶ According to Jesse Dunietz a computer scientist at Securing America's Future Energy (SAFE), miners in space "will target water-rich asteroids for their hydrogen potential, then mineral-rich asteroids for their nickel and iron-ore."⁸³⁷ Another resource that will be harvested is platinum, which means there is potential risk to the market on Earth.⁸³⁸ Platinum has no purpose in outer space, therefore, mining companies would extract these resources and bring them to Earth.⁸³⁹ As technology increases and the ability to target larger asteroids becomes available, it is thought the harvested platinum from space could negatively affect the Earth's platinum industries.⁸⁴⁰ Let us look at an example given by Charles Kieck, head of energy and precious metals at Afriforesight (a commodities research firm in Cape Town, South Africa):

An asteroid with a diameter of about 1000 meters (about 3280 feet) could yield about 100,000 tons of platinum. The Earth produces a few hundred tons per year, on average. And even then, the main suppliers are struggling to keep up. South Africa produces more than two-thirds of the world's platinum, but the country's mining sector has been racked by labor unrest and shaft closures. For thousands of men forced to work underground and live above ground in impoverished conditions, being replaced by robots in space could have both its advantages and disadvantages.⁸⁴¹

Another way to address this situation is to look at the ethical aspect of space mining. Brother Guy Consolmagno, an American Jesuit and research astronomer for the Vatican Observatory, raises the issue suggesting robots could manufacture as easily as the mine leading to a large unemployment rate in these nations that rely heavily on exporting

⁸³⁶ Brother Guy Consolmagno's lecture, as quoted in Chris Borgen, "The Ethics and Economics of Asteroid Mining (and the Role of Law)," *Opinio Juris* (blog), February 21, 2010, <http://opiniojuris.org/2010/02/21/the-ethics-and-economics-of-asteroid-mining-and-the-role-for-law/>.

⁸³⁷ Lynsey Chutel, "NASA's latest mission will show if asteroid mining will be a real threat to the global platinum industry," *QUARTZ: Africa*, September 9, 2016, <https://qz.com/776894/nasas-latest-mission-will-be-a-real-threat-to-the-global-platinum-industry/>.

⁸³⁸ Charles Kieck, as quoted in *Ibid*.

⁸³⁹ *Ibid*.

⁸⁴⁰ *Ibid*.

⁸⁴¹ *Ibid*.

minerals.⁸⁴² Space mining is still in the beginning stages and results most likely would not be seen until 2030, but it is important to begin thinking about this potential problem.⁸⁴³

The next potential issue space mining presents is that the technology required to conduct such activities could be viewed as threatening. Mining in space does not necessarily require that humans travel to the asteroid or the Moon to harvest these raw materials.⁸⁴⁴ Since the 1970s, NASA and other space advocates have researched different means to extract resources from space (i.e., asteroids, the Moon, and other planets and their Moons).⁸⁴⁵ Karl Tate provided a graphic illustrating the distinct types of asteroids and techniques for space mining.⁸⁴⁶

The infographic, which is cited in references, shows three potential ways asteroids could be mined and provides descriptions on the specific techniques.⁸⁴⁷ The first, which was developed by NASA and AMES, is known as the on-site technique.⁸⁴⁸ This technique would use a robot prospector that drills on-site and then brings the extracted materials back to Earth.⁸⁴⁹ What if an adversary sees this capability as a threat? If a robot can drill into an asteroid or a rock; what's stopping this technology to be used on adversary spacecraft? The second, which is being developed by Deep Space Industries (DSI), is known as the tow truck technique.⁸⁵⁰ This technique would use rocket power to "haul the asteroid into Earth

⁸⁴² Brother Guy Consolmagno, as quoted in Borgen, "The Ethics and Economics of Asteroid Mining (and the Role of Law)."

⁸⁴³ Charles Kieck, as quoted in Chutel, "NASA's latest mission will show if asteroid mining will be a real threat to the global platinum industry."

⁸⁴⁴ Dr. Phil Metzger, as quoted in John N, "If Mining in Space is Possible, Why Aren't we Doing it?," EDGYLABS, September 23, 2016, <https://edgylabs.com/if-mining-in-space-is-possible-why-arent-we-doing-it>.

⁸⁴⁵ Karl Tate, "How Asteroid Mining Could Work (Infographic)," Space.com, January 22, 2013, <https://www.space.com/15391-asteroid-mining-space-planetary-resources-infographic.html>.

⁸⁴⁶ Ibid.

⁸⁴⁷ Tate, "How Asteroid Mining Could Work (Infographic)."

⁸⁴⁸ Ibid.

⁸⁴⁹ Ibid.

⁸⁵⁰ Ibid.

orbit,”⁸⁵¹ much like a tow-truck would tow a car.⁸⁵² Similarly, NASA proposed the mission Asteroid Redirect Mission (ARM), which would have used a similar technique.⁸⁵³ ARM was intended to “visit a large near-Earth asteroid, collect a multi-ton boulder from its surface by grabbing it using a robotic arm, and then redirect it into a stable orbit around the Moon for further analysis.”⁸⁵⁴ Although the Trump administration terminated this project, the same questions apply to this technology. Also, having a robotic arm in space is cause for alarm, simply because, if the arm can grab an asteroid, what is stopping the arm from grabbing an adversary’s satellite? If an adversary interprets this capability and technology as a threat, there is potential that conflict could occur in the future. The final technique, which was proposed by NASA and the Keck Observatory, is known as the bag-it technique.⁸⁵⁵ This final technique would use a capsule designed to “enclose an asteroid up to 23 feet in diameter for transport to the Moon’s orbit”⁸⁵⁶ so it can be exploited later.⁸⁵⁷ Hypothetically, this technology could be used for more than just encompassing an asteroid. What if an adversary decides to encompass another country’s satellite? This would remove it from being used, and if the technology exists, could destroy the satellite upon encapsulation. The following paragraphs briefly overview some of the U.S. companies and space agencies involved in space mining as well as those of other countries, beside the United States, that are becoming more interested in this field of activities. Additionally, these overviews will provide some current technologies and capabilities in space mining.

⁸⁵¹ Ibid.

⁸⁵² Ibid.

⁸⁵³ Brain Dunbar and Jim Wilson, “What is NASA’s Asteroid Redirect Mission?,” NASA, August 3, 2017, <https://www.nasa.gov/content/what-is-nasa-s-asteroid-redirect-mission>; Tate, “How Asteroid Mining Could Work (Infographic).”

⁸⁵⁴ Ibid.

⁸⁵⁵ Tate, “How Asteroid Mining Could Work (Infographic).”

⁸⁵⁶ Ibid.

⁸⁵⁷ Ibid.

1. Who is conducting Space Mining?

a. NASA

NASA realized that there was a lack of knowledge regarding analyzing and extracting the raw materials from asteroids.⁸⁵⁸ As mentioned above, NASA's ARM robotic spacecraft would have demonstrated the ability to exploit and analyze a specified asteroid, it had a secondary mission "to perform defensive asteroid deflection measures to protect Earth."⁸⁵⁹ Additionally, NASA has created the spacecraft *Origins, Spectral Interpretation, Resource Identification, Security and Regolith Explorer (OSIRIS-REx)* with a mission to return an asteroid sample to Earth.⁸⁶⁰ *OSIRIS-REx* launched in September 2016 with the intention of arriving at the asteroid Bennu in October of 2018.⁸⁶¹ Dante Lauretta, principal investigator for NASA's *OSIRIS-REx*, contends that the mission serves as a secondary benefit for any entity that has interest in asteroid exploitation and its technology, even though its primary purpose is for advancements in scientific research.⁸⁶²

b. Planetary Resources

Planetary Resources was the first commercial/private company to advertise an asteroid-mining business.⁸⁶³ In April of 2012, Planetary Resources "announced their plans to mine Near-Earth Asteroids (NEAs) for resources ranging from water to precious metals."⁸⁶⁴ Chris Lewicki, president and chief engineer, said "Planetary Resources' mission is not only to expand the world's resource base, but we want to increase people's

⁸⁵⁸ William Steigerwald, "New NASA Mission to Help Us Learn How to Mine Asteroids," NASA, August 8, 2013, <https://www.nasa.gov/content/goddard/new-nasa-mission-to-help-us-learn-how-to-mine-asteroids>.

⁸⁵⁹ Dunbar and Wilson, "What is NASA's Asteroid Redirect Mission?"

⁸⁶⁰ Steigerwald, "New NASA Mission to Help Us Learn How to Mine Asteroids."

⁸⁶¹ Ibid.

⁸⁶² Dante Lauretta, as quoted in Ibid.

⁸⁶³ Mike Wall, "Asteroid-Mining Project Aims for Deep-Space Colonies," Space.com, January 22, 2013, <https://www.space.com/19368-asteroid-mining-deep-space-industries.html>.

⁸⁶⁴ "Asteroid Mining Plans Revealed By Planetary Resources, Inc.," Planetary Resources, April 24, 2012, <https://www.planetaryresources.com/2012/04/asteroid-mining-plans-revealed-by-planetary-resources-inc/>.

access to, and understanding of, our planet and solar system by developing capable and cost-efficient systems.”⁸⁶⁵ Currently, Planetary Resources has three spacecraft: *ARKYD-301*, *ARKYD-6*, and *ARKYD-3R*.⁸⁶⁶ These spacecraft were launched into Earth orbit with the primary purpose of identifying sources of water that could be used to sustain human life as well as repurposed into rocket fuel but have provided a secondary purpose in demonstrating mining capable technology for future missions to asteroids.⁸⁶⁷

c. *Deep Space Industries*

Deep Space Industries (DSI) was the second commercial/private company to advertise an asteroid-mining business.⁸⁶⁸ DSI made its debut in the space mining sector in 2013 with CEO David Gump advertising their plan “to launch a fleet of prospecting spacecraft to near-Earth asteroids”⁸⁶⁹ by 2015.⁸⁷⁰ Unfortunately, their 2015 goal was not met and currently they have not yet sent any spacecraft to an asteroid.⁸⁷¹ But, DSI continues to pursue asteroid mining missions that include both exploiting and harvesting both metals and water from asteroids.⁸⁷² DSI believes that successfully harvesting resources from space is the first step toward future colonies in space.⁸⁷³ DSI plans to use four phases to develop and operate their spacecraft in order to mine an asteroid.⁸⁷⁴

The first phase, prospecting, involves using sophisticated scientific equipment on tiny scouts or small spacecraft to locate and study asteroids. Once the prospecting spacecraft identify locations or specific asteroids, the

⁸⁶⁵ Chris Lewicki, as quoted in “Asteroid Mining Plans Revealed By Planetary Resources, Inc.,” Planetary Resources.

⁸⁶⁶ “Missions: About the Exploration Program,” Planetary Resources, <https://www.planetaryresources.com/missions/arkyd-301/>.

⁸⁶⁷ Ibid.

⁸⁶⁸ Wall, “Asteroid-Mining Project Aims for Deep-Space Colonies.”

⁸⁶⁹ David Gump, as quoted in Ibid.

⁸⁷⁰ Ibid.

⁸⁷¹ Wall, “Asteroid-Mining Project Aims for Deep-Space Colonies.”

⁸⁷² Ibid.; David Gump, as quoted in Ibid.

⁸⁷³ “Who We Are,” Deep Space Industries, <https://deepspaceindustries.com/company/>.

⁸⁷⁴ “The Deep Space Approach: 4 Phases of Asteroid Mining,” Deep Space Industries, <https://deepspaceindustries.com/mining/>.

second phase, harvesting is conducted. Harvesting uses specialized robotic spacecraft to extract and transport resources back to Earth. After the asteroid materials are returned to the near-Earth environment, they must be processed. The third phase is processing or separating the resources harvested into usable materials, so they can be manufactured. Lastly, the final phase manufacturing, discusses the possibilities of repurposing the materials by using a 3D printer, known as the Microgravity Foundry, to create high-strength metal components in zero gravity.⁸⁷⁵

One of DSI's planned missions is the *Prospector-1* which is intended to investigate an asteroid and then determine if that object contains valuable resources for extraction.⁸⁷⁶ Prior to this mission, DSI alongside its international partner, Luxembourg, will launch *Prospector-X* to test space mining technologies, thereby paving the way for the *Prospector-1* mission.⁸⁷⁷ By the end of the decade, DSI and the government of Luxembourg anticipate success in their exploration missions, allowing the company to begin harvesting for resources.⁸⁷⁸

d. Moon Express

In 2010, a private company by the name of Moon Express was co-founded by Bob Richards and Naveen Jain.⁸⁷⁹ Its mission is to colonize the moon for commercial and living purposes.⁸⁸⁰ Its original goal was to land on the Moon by the end of 2017, but that was pushed to March of 2018, which also was not met.⁸⁸¹ But with no current commercial

⁸⁷⁵ Ibid; Wall, "Asteroid-Mining Project Aims for Deep-Space Colonies."

⁸⁷⁶ Deep Space Industry Staff, "Prospector-1: First Commercial Interplanetary Mining Mission," Deep Space Industries Media Resources, <http://deepspaceindustries.com/first-commercial-interplanetary-mission/>.

⁸⁷⁷ Ibid.

⁸⁷⁸ Ibid.

⁸⁷⁹ Sophie Curtis, "Billionaire entrepreneur to start mining the Moon for Gold and platinum by end of 2017," *Mirror Magazine*, February 3, 2017, <https://www.mirror.co.uk/science/billionaire-entrepreneur-start-mining-moon-9746422>.

⁸⁸⁰ "About Us," Moon Express, <http://moonexpress.com/about-us/>.

⁸⁸¹ Loren Grush, "Moon Express becomes first private company to get U.S. approval for lunar mission," *TheVerge.com*, August 3, 2016, <https://www.theverge.com/2016/8/3/12361256/moon-express-private-mission-spaceflight-us-government-approved>; Justice Namaste, "The Moon Express MX-1E Lander is heading for the Moon or Bust," *Wired.com*, November 17, 2017, <https://www.wired.com/story/the-moon-express-mx-1e-lander-is-heading-for-the-moon-or-bust/>.

guidelines regarding space activities beyond Earth orbit, the company had to undergo a multi-step licensing process.⁸⁸² On April 8, 2016, Moon Express submitted a license request to land on the Moon to the U.S. Federal Aviation Administration (FAA), which was also looked at by the other entities of the government to include the U.S. State Department, the U.S. Department of Defense, NASA, NOAA, and the Federal Communications Commission (FCC).⁸⁸³ Additionally, Moon Express provided a level of detail to the federal government regarding its payload, intentions on the Moon, and how it planned to comply with the principles in the OST.⁸⁸⁴

Moon Express tried to address three critical provisions of the Outer Space Treaty. First, nations must continually supervise all of the space missions that happen within their borders. Moon Express told the FAA it would frequently update the agency with information on the 2017 trip, so that the government could oversee it. The second rule is not messing with other nations' spacecraft or space operations. On the Moon, that mostly means the Apollo sites, and Moon Express assured the government that it would not disturb these areas. Finally, Moon Express had to show the State Department it would abide by the OST's provision that is meant to prevent people from contaminating other worlds, called planetary protection. Fortunately, the Moon doesn't host life, so Moon Express did not have to worry too much about contamination.⁸⁸⁵

After voluntarily providing this information, the FAA, the State Department, and the White House discussed this request and after a year of discussion the United States government finally authorized Moon Express to conduct Moon landings.⁸⁸⁶ This was a significant event because "Moon Express became the first and only private company to obtain this approval."⁸⁸⁷ Moon Express hoped by 2017, it would have successfully sent its

⁸⁸² Grush, "Moon Express becomes first private company to get U.S. approval for lunar mission."

⁸⁸³ Bob Richards, as quoted in Mike Wall, "Moon Express Approved for Private Lunar Landing in 2017, a Space First," Space.com, August 3, 2016, <https://www.space.com/33632-moon-express-private-lunar-landing-approval.html>.

⁸⁸⁴ Wall, "Moon Express Approved for Private Lunar Landing in 2017."

⁸⁸⁵ Grush, "Moon Express becomes first private company to get U.S. approval for lunar mission."

⁸⁸⁶ Ibid.; Moon Express Staff, "About Us," Moon Express, <http://moonexpress.com/about-us/>.

⁸⁸⁷ Moon Express Staff, "About Us."

MX-1 Rover to Moon but that date has been pushed forward.⁸⁸⁸ MX-1 Rover intends on collecting samples from the Moon as well as taking high-definition images and sending them back to Earth.⁸⁸⁹ If this mission is successful, Moon Express will then initiate its plans to mine the Moon for essential and valuable resources.⁸⁹⁰ Prior to mining operations, Moon Express intends on constructing “a robotic outpost on the South Pole of the Moon.”⁸⁹¹ Eventually, Moon Express will invest in the continuous mining of water for use on the Moon and minerals that can be sold on Earth.⁸⁹²

e. European Space Agency (ESA)

The European Space Agency (ESA) has also been involved in missions involving space mining. In 2004, the ESA launched the unmanned Rosetta Probe which has carried out several momentous events, with its primary mission to “link up with comet 67P/Churyumov-Gerasimenko.”⁸⁹³ In 2010, Rosetta successfully relays pictures of Lutetia asteroid back to Earth marking this as the “largest asteroid ever visited by a satellite.”⁸⁹⁴ Finally, in November of 2014, it successfully completed its mission by landing its probe on the pre-selected comet.⁸⁹⁵ Jean-Jacques Dordain, ESA’s Director General, noted “that their ambitious Rosetta mission had secured a place in the history books: not only was it the first to rendezvous with and orbit a comet, but it was also the first to deliver a lander to

⁸⁸⁸ Bob Richards and Daven Maharaj, “Moon Express,” Google Lunar XPrize, accessed May 22, 2018, <https://lunar.xprize.org/teams/moon-express>.

⁸⁸⁹ Curtis, “Billionaire entrepreneur to start mining the Moon for Gold and platinum by end of 2017.”

⁸⁹⁰ Ibid.

⁸⁹¹ Loren Grush, “To Mine the Moon, private company Moon Express plans to build a fleet of robotic landers: Mining the Moon for water and Minerals,” TheVerge.com, July, 12, 2017, <https://www.theverge.com/2017/7/12/15958164/moon-express-robot-landers-private-mining-outpost>.

⁸⁹² Ibid.

⁸⁹³ “European Agency Lands Spacecraft On Comet For First Time Ever,” CBS SF Bay Area, November 12, 2014, <https://sanfrancisco.cbslocal.com/2014/11/12/european-agency-lands-spacecraft-on-comet-for-first-time-ever-probe-philae-rosetta-germany/>.

⁸⁹⁴ Ibid.

⁸⁹⁵ “Touchdown! Rosetta’s Philae Probe Lands on Comet,” European Space Agency, November 12, 2014, https://www.esa.int/Our_Activities/Space_Science/Rosetta/Touchdown!_Rosetta_s_Philae_probe_lands_on_comet.

a comet's surface.”⁸⁹⁶ Additionally, the ESA has partnered with NASA on the “Asteroid Impact and Deflection Assessment Mission (AIDA),”⁸⁹⁷ specifically with the development of the “Asteroid Impact Mission (AIM).”⁸⁹⁸ AIM, set to launch in 2020, has the primary mission to:

travel to a binary asteroid system—the Paired Didymos asteroids, which will come a comparatively close 16 million km to Earth in 2022. The 800-meter diameter main body is orbited by a 170-meter moon, informally called Didymoon. This smaller body is AIM's focus: the spacecraft would perform high-resolution visual, thermal and radar mapping of the moon to build detailed maps of its surface and interior structure. AIM plans to carry at least three smaller spacecrafts—the *Mascot-2* asteroid lander, as well as two CubeSats.⁸⁹⁹

If successful, AIM would be considered Europe's contribution to a larger global effort to reduce the risk of asteroids heading toward Earth.⁹⁰⁰

2. Other Countries

The United States, ESA, and the private sector are not the only ones heavily investing in space mining. The Government of Luxembourg made an announcement in 2016, detailing its commitment to become a global leader in space mining by heavily investing in the company Planetary Resources.⁹⁰¹ Luxembourg has taken strategic steps to facilitate space mining under their country's auspices.⁹⁰² First, it created and “appointed a

⁸⁹⁶ Ibid.

⁸⁹⁷ European Space Agency Staff Writers, “Asteroid Impact Mission,” European Space Agency, accessed May 13, 2018, http://www.esa.int/Our_Activities/Space_Engineering_Technology/Asteroid_Impact_Mission/Asteroid_Impact_Mission2.

⁸⁹⁸ Ibid.

⁸⁹⁹ Ibid; European Space Agency Staff Writers, “ESA's planetary defence test set for 2020,” Phys.org, April 1, 2015, <https://phys.org/news/2015-04-esa-planetary-defence.html>.

⁹⁰⁰ Ibid.

⁹⁰¹ Ben Baseley-Walker, “SWMETHEMES: Space Mining: The Next Strategic Investment for Gulf Countries?,” SpaceWatch: Middle East, 2017, <https://spacewatchme.com/2017/07/swmethemes-space-mining-next-strategic-investment-gulf-countries/>.

⁹⁰² Ibid.

government Special Envoy for Space Resources.”⁹⁰³ Second, it financially supported and invested in several companies dedicated to space mining.⁹⁰⁴ Finally, it continued to explore the possibility of creating a specific government fund dedicated to the mining sector.⁹⁰⁵ These strategic steps, are the first moves that could allow Luxembourg to become the future Silicon Valley for space mining.⁹⁰⁶ On July 13, 2017, Luxembourg passed a space resources law, similar to the U.S. Space Act in 2015.⁹⁰⁷ Etienne Schneider, deputy prime minister of Luxembourg, says that “the passage of this law reinforces its position as a European hub for the emerging space resources industry and gives companies the rights to space resources they extract from asteroids or other celestial bodies.”⁹⁰⁸ Luxembourg is committed to this new frontier, but it is not the only one that is interested in establishing itself as a potential hub for space mining.⁹⁰⁹

Additionally, in the Persian Gulf region, the UAE’s space policy, notes space mining regulations as a high priority.⁹¹⁰ Also, Japan and China have expressed interest in future space mining legislation.⁹¹¹ As more countries invest in space mining, the potential for another competitive race in space seems likely.⁹¹²

D. OUTER SPACE TREATY ANALYSIS

The analysis conducted in this section will discuss the OST’s ability or inability to provide guidelines to cover asteroid and Moon mining. This case study presents the

⁹⁰³ Ibid.

⁹⁰⁴ Ibid.

⁹⁰⁵ Ibid.

⁹⁰⁶ Ibid.

⁹⁰⁷ Ibid.

⁹⁰⁸ Etienne Schneider, as quoted in Jeff Foust, “Luxembourg adopts space resources law,” Spacenews.com, July 17, 2017, <http://spacenews.com/luxembourg-adopts-space-resources-law/>.

⁹⁰⁹ Baseley-Walker, “SWMETHEMES: Space Mining: The Next Strategic Investment for Gulf Countries?”

⁹¹⁰ Ibid.

⁹¹¹ Ibid.

⁹¹² Ibid.

hypothesis: If the current technological advances in both the commercial and military sectors regarding asteroid and Moon mining continue to rapidly increase without further legal agreements, the OST as it stands will not be able to prevent conflict. The previous section showed the potential for international problems due to increased interest in space mining and the new capabilities/technologies associated with these new activities; this section will address whether the articles within the OST can cover the increasing issues regarding asteroid and Moon mining in the 21st century.

The OST “established space as a ‘province of all mankind’ and prohibited State Parties to the treaty from claiming or colonizing celestial bodies, to include using them for military operations.”⁹¹³ With the prospects of space mining, the OST has become the subject of debate.⁹¹⁴ Moon and asteroid mining was not even a realistic venture during the creation of the treaty, but in recent years advanced technological capabilities have made it a future possibility.⁹¹⁵ Although the U.S. and Luxembourg have established national laws regarding asteroid mining, these moves have only added to the debate on the legality of space mining and whether these new laws are in violation of the OST.⁹¹⁶

Let us first look at Articles I and II, which discuss key arguments that could determine the legality of space mining. Article I states:

The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind....Outer Space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.⁹¹⁷

⁹¹³ Dunietz, “Floating Treasure.”

⁹¹⁴ Ibid.

⁹¹⁵ Ibid.

⁹¹⁶ Foust, “Mining issues in space law.”

⁹¹⁷ Outer Space Treaty, U.S. State Department.

The first point to highlight in regard to space mining is the term “celestial body”⁹¹⁸ and “the lack of a definition provided on whether it applies to all-natural objects (including asteroids) or only to planets.”⁹¹⁹ Also, Fabio Tronchetti from the School of Law at Harbin Institute of Technology in China argues the clause stating, “the exploration and use of outer space”⁹²⁰ has been subject to interpretation regarding the word “use”⁹²¹ and how it refers to “both economic and non-economic use.”⁹²² Additionally, if space mining is to “be carried out for the benefit and interest of all countries,”⁹²³ then some space lawyers argue that Article I would prevent companies from profiting from extracted resources.⁹²⁴ Article II states “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.”⁹²⁵ This article has been interpreted in different ways. One debate is over “national appropriation.”⁹²⁶ Those in support of private-sector mining argue that this article “only refers to the assertion of national sovereignty over celestial bodies and doesn’t forbid actions, such as mining, to be conducted on them.”⁹²⁷ Another argument in support dictates that “national appropriation forbids the appropriation of territory, but not of natural

⁹¹⁸ Ibid.

⁹¹⁹ Samuel Roth, “Developing a Law of Asteroids: Constants, Variables, and Alternatives,” *Columbia Journal of Transitional Law* 54, no. 3 (Accessed April 12, 2018): pgs. 827–872, http://jtl.columbia.edu/wp-content/uploads/sites/4/2016/05/Roth_54-CJTL-827.pdf. 842.

⁹²⁰ Outer Space Treaty, U.S. State Department

⁹²¹ Ibid.

⁹²² Ibid; Fabio Tronchetti, “The Space Resource Exploration and Utilization Act: A Move Forward or a Step Back?,” *Space Policy* 34, (August 2015): 6–10.

⁹²³ Outer Space Treaty, as quoted in Oduntan, “Who owns space? U.S. asteroid-mining act is dangerous and potentially illegal.”

⁹²⁴ Ibid.

⁹²⁵ Outer Space Treaty, U.S. State Department.

⁹²⁶ Ibid.

⁹²⁷ Samuel Roth, “Developing a Law of Asteroids: Constants, Variables, and Alternatives,” *Columbia Journal of Transitional Law*, Accessed April 12, 2018, http://jtl.columbia.edu/wp-content/uploads/sites/4/2016/05/Roth_54-CJTL-827.pdf. 841.

resources.”⁹²⁸ But what happens when space companies take the entire asteroid?⁹²⁹ As mentioned in the threat section, technology exists that could harvest or even encompass the entire asteroid, which Joanne Gabrynowicz believes could be argued as a form of appropriation and therefore a violation of the OST.⁹³⁰ But, on the other hand, the OST specified only “national appropriation,”⁹³¹ therefore, some would argue, specifically, Jill Stuart at the London School of Economics and Political Science, that refers to only countries and does not include private/commercial companies.⁹³² Therefore, according to her interpretation, “private companies or individuals could make claims toward celestial territories or bodies, since they are not countries.”⁹³³ Although Stuart interprets the article in support of private industries claiming these entities, according to Sagi Kfir, DSI General Counsel, he is adamant that the U.S. commercial space mining industry does not want to lay claim to any celestial bodies themselves.⁹³⁴ These companies just want the rights to keep the material exploited from their mining missions.⁹³⁵ Also, Tronchetti provides additional support regarding Article II in that he believes the no-claims provision extends to private industries, and therefore these companies are prohibited from claiming these entities.⁹³⁶

⁹²⁸ Roth, “Developing a Law of Asteroids: Constants, Variables, and Alternatives,” 841.

⁹²⁹ Charles Stotler, “The ASTEROIDS Act and hearing: some observations on international obligations,” *The Space Review*, September 22, 2014, <http://www.thespacereview.com/article/2604/1>.

⁹³⁰ Joanne Gabrynowicz, as quoted in Charles Stotler, “The ASTEROIDS Act and hearing: some observations on international obligations,” *The Space Review*, September 22, 2014, <http://www.thespacereview.com/article/2604/1>.

⁹³¹ Outer Space Treaty, U.S. State Department.

⁹³² Jill Stuart, “The Outer Space Treaty Has Been successful – But is it Fit for the Modern Age?,” *Space.com*, February 19, 2017, <https://www.space.com/35758-outer-space-treaty-success-modern-assessment.html>.

⁹³³ Stuart, “The Outer Space Treaty Has Been successful – But is it Fit for the Modern Age?”

⁹³⁴ Sagi Kfir, “Is Asteroid Mining Legal? The Truth Behind Title IV of the Commercial Space Launch Competitiveness Act of 2015,” *Deep Space Industries*, accessed May 13, 2018, <https://deepspaceindustries.com/is-asteroid-mining-legal/>.

⁹³⁵ *Ibid.*.

⁹³⁶ Tronchetti, “The Space Resource Exploration and Utilization Act: A Move Forward or a Step Back?”

The next article that could provide guidance regarding space mining is Article VI, which states:

State Parties to the Treaty Shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by appropriate State Party to the Treaty.⁹³⁷

Art Dula, a space professor at the University of Houston, argues this article gives commercial space companies permission to mine asteroids because Article VI specifically allows “the use of outer space by nongovernmental entities.”⁹³⁸ Another perspective discusses the inability to monitor these nongovernmental mining activities.⁹³⁹ Article VI says these activities would “require authorization and continuing supervision.”⁹⁴⁰ For example, in regards to the U.S. commercial space mining companies, arguments against contend that the United States currently has no assigned licensing authority for activities such as mining or commercial Moon landings.⁹⁴¹ The United States, has the FAA, which is in charge of licensing launches and reentries, but nothing specifically established for mining or Moon landings.⁹⁴² If challenged by other State Parties to the OST, the lack of supervising authority for space mining activities could be interpreted as a U.S. failure to follow Article VI of the OST.⁹⁴³ Although the United States could appoint one, until it does it could be subject to challenges by other signatories on the treaty.

⁹³⁷ Outer Space Treaty, U.S. State Department.

⁹³⁸ Art Dula, as quoted in Natalie Wolchover, “Does Asteroid Mining Violate Space Law?,” Live Science, April 23, 2012, <https://www.livescience.com/33864-asteroid-mining-space-law.html>.

⁹³⁹ Foust, “Mining Issues in Space Law.”

⁹⁴⁰ Outer Space Treaty, U.S. State Department; Foust, “Mining Issues in Space Law.”

⁹⁴¹ Foust, “Mining Issues in Space Law.”

⁹⁴² Ibid.

⁹⁴³ Ibid.

Lastly, this section will address the U.S. SPACE Act of 2015. The passage of the U.S. SPACE Act of 2015 allows American commercial companies to legally exploit asteroids,⁹⁴⁴ which led to discussions within the United States and the international community as to whether the act violates the OST.⁹⁴⁵ Specifically, in *Journal Resources Policy*, Sarah Jane Fox, a legal scholar at Coventry University in the U.K., argues “by the current standards of international law, a country can’t just go and create laws that function outside its own borders.”⁹⁴⁶ Fox discusses her belief that the United Nations and the international community regard this U.S. law as non-binding and an overstep of its authority.⁹⁴⁷ But, not everyone agrees with Fox’s viewpoint. Tronchetti, argues that the act is intended to fill a gap due to the absence of international space laws covering the private sector’s desire to exploit natural resources in space.⁹⁴⁸ Additionally, Tronchetti, suggests that it is not impractical to envision that the passage of this act will stir controversy among other countries that are actively pursuing mining activities or exploration of the Moon (i.e., China).⁹⁴⁹ He believes these countries would demand further explanation regarding the act and would most likely enact similar legislation of their own.⁹⁵⁰ If these activities become defined by numerous national laws, the possibility of disagreements increases, unless some international body is created to manage conflicting claims.⁹⁵¹ Currently, the OST lacks the capability to address nations enacting their own national laws to cover activities in space that are not clearly defined by the treaty.

⁹⁴⁴ H.R. 2262 (114th): U.S. Commercial Space Launch Competitiveness Act, Library of Congress Summary, <https://www.govtrack.us/congress/bills/114/hr2262/summary#libraryofcongress>. (fix)

⁹⁴⁵ William Herkewitz, “The Biggest Barrier to Asteroid Mining Isn’t Technical, It’s Legal,” *Popular Mechanics*, August 16, 2016, <https://www.popularmechanics.com/space/deep-space/a22347/asteroid-mining-international-law>.

⁹⁴⁶ Sarah Jane Fox, as quoted in Ibid.

⁹⁴⁷ Sarah Jane Fox, as quoted in Herkewitz, “The Biggest Barrier to Asteroid Mining Isn’t Technical, It’s Legal.”

⁹⁴⁸ Tronchetti, “The Space Resource Exploration and Utilization Act: A Move Forward or a Step Back?,” 6.

⁹⁴⁹ Ibid., 8.

⁹⁵⁰ Ibid.

⁹⁵¹ Ibid.

The analysis conducted above on the OST leads to the conclusion that although certain articles could provide clarification to cover the current and future asteroid and Moon mining issues, the treaty itself is not all encompassing and leaves too much to interpretation to adequately prevent conflict in the 21st century. In the following section, hypothetical scenarios will be presented to reemphasize the OST's inability to address the potential conflicts that might emerge from space mining in the future. In the concluding chapter of this thesis, potential recommendations will be provided to address and overcome the gaps within the OST.

E. POTENTIAL FUTURE CONFLICTS

Space mining is being considered the “new Wild West or the new gold rush,”⁹⁵² which has the potential to create conflicts in the political, military, and commercial arenas. As more countries and the private sector become more aware to the potential benefits, this will become another competitive market.⁹⁵³ With competition comes the potential for concern. Although some countries are beginning to develop laws and policies of their own, without an international agreement, conflicts will most likely occur.⁹⁵⁴ This section will consider the potential conflicts that could occur regarding asteroid and Moon mining, separated into those that are most likely or most dangerous. Additionally, hypothetical scenarios will be discussed to emphasize the reality of future conflict regarding space mining.

1. Most Likely

Frans von der Dunk emphasizes the ambiguity over legality of private mining in space.⁹⁵⁵ This statement alone is alarming. Without future regulations or guidelines, the

⁹⁵² Dylan Love, “The Next Frontier: Space Miners are the Universe’s Future Tycoons,” CNBC, December 26, 2016, <https://www.cnbc.com/2016/12/26/the-next-frontier-space-miners-are-the-universes-future-tycoons.html>.

⁹⁵³ Ibid.

⁹⁵⁴ Baseley-Walker, “SWMETHEMES: Space Mining: The Next Strategic Investment for Gulf Countries?”

⁹⁵⁵ Frans von der Dunk, as quoted in Sarah Fecht, “Is Space Mining Legal?,” Popular Science, September 23, 2015, <https://www.popsci.com/it-could-soon-be-legal-to-mine-asteroids>.

conflict that will most likely occur is a heated political dispute about the legality of mining resulting in instability within the international community. With the passage of laws, such as the U.S. SPACE Act of 2015 and the Luxembourg Space Resources Law in 2017, these laws have become the subject to numerous legal debates. The U.S. SPACE Act is already the subject of legal discussions within the United States, as well as in the international community.⁹⁵⁶ These deliberations revolve primarily on whether this act is a violation of the principles set in the OST.⁹⁵⁷ U.S. commercial companies, such as Planetary Resources and Deep Space Industries, are satisfied with this new bill, which established the foundations for future asteroid mining activities in the private sector.⁹⁵⁸ Even though U.S. commercial companies are thrilled about these new regulations, not everyone feels the same way, especially in the international community.⁹⁵⁹ In the next paragraph, examples will be provided from different representatives within the international legal community regarding their opinions on the Space Act.

Alexander Soucek, head of legal services department at the 22-nation European Space Agency, proposed the question “Is the Commercial Space Act a violation of the OST’s prohibition of national appropriation?”⁹⁶⁰ Soucek answered the question stating “it is very controversial; I can say that. There are lots of opinions on this.”⁹⁶¹ Although Joanne Wheeler, another lawyer, refused to answer directly about the legality of the act, she admitted “it is really pushing the boundaries.”⁹⁶² Tanja Masson-Zwaan, president of the International Institute of Space Law and deputy director of the International Institute of Air and Space Law at Leiden University in the Netherlands, said many nations will interpret

⁹⁵⁶ Oduntan, “Who owns space? U.S. asteroid-mining act is dangerous and potentially illegal.”

⁹⁵⁷ Ibid.

⁹⁵⁸ Fecht, “Is Space Mining Legal?”

⁹⁵⁹ Ibid.

⁹⁶⁰ Alexander Soucek, as quoted in in Peter B. de Selding, “New U.S. Space Mining Law’s Treaty Compliance May Depend on Implementation,” Spacenews.com, December 9, 2015, <http://spacenews.com/u-s-commercial-space-acts-treaty-compliance-may-depend-on-implementation/>.

⁹⁶¹ Ibid.

⁹⁶² Joanne Wheeler, as quoted in de Selding, “New U.S. Space Mining Law’s Treaty Compliance May Depend on Implementation.”

the SPACE Act as aggressive.⁹⁶³ Even Von der Dunk has stated that “Russia and China might consider using the passage of the U.S. Space Act as another example of the economic aggression of the U.S. and going ahead of the international law.”⁹⁶⁴ What if countries, such as China or Russia, decide to create a national law similar to the U.S. Space Act? How will the United States feel about their new laws? Let us look at a hypothetical scenario, Russia has enacted a space mining act that is an exact replicate of the U.S. SPACE Act. Russia, having conducted research and analysis, has found an asteroid with substantial amounts of platinum resources. Planetary Resources, a U.S. company, has also identified the same asteroid for a platinum harvesting mission. With no international agreement and each with its own national law that awards the right to the resources collected, who owns the rights to the resources? Is it whoever gets there first? Currently, the U.S. is leading in space mining technologies, which means that the “U.S. and U.S. based companies could possibly be the first to lay claim to the richest and most easily accessible prospecting sites.”⁹⁶⁵ If Planetary Resources does get there first, what happens when they do not want to share the resources or the asteroid?⁹⁶⁶ This is likely going to cause political disputes and instability between the United States and Russia, which could result in a stand-off between the two countries.

Let us add another layer to the scenario above. There is a shortage of Earth’s platinum resources and the asteroid has the potential to replenish these platinum reserves for the next five years. Will the shortage in platinum resources result in further political disagreements or will this result even more drastic measures such as a military dispute between Russia and United States? Although this added layer to the scenario is not likely to happen in the near future, it is essential that the international community begin to think about this because Earth has a limited amount of resources and once they have been depleted, countries will have to find other sources. In the future, if other resources are

⁹⁶³ Tanja Masson-Zwaan, as quoted in de Selding, “New U.S. Space Mining Law’s Treaty Compliance May Depend on Implementation.”

⁹⁶⁴ Von der Dunk, as quoted in Fecht, “Is Space Mining Legal?”

⁹⁶⁵ Ramin Skibba, “Mining in Space Could Lead to Conflicts on Earth,” *Nautilus* (blog), April 19, 2016, <http://nautil.us/blog/mining-in-space-could-lead-to-conflicts-on-earth>.

⁹⁶⁶ Ibid.

limited or almost non-existent, this could result in more dangerous concerns. The arguments and scenarios provided in this section suggest that without an international regulation on space mining and the continuance of countries enacting their own national laws, political disagreements will occur in the future.

2. Most Dangerous

All forms of mining come with their own inherent risks and dangers which means that space mining should not be seen any differently.⁹⁶⁷ One of the more dangerous concerns with asteroid mining activities is it carries the risk of space debris from being mined, which inherently causes a potential for future collisions with space assets.⁹⁶⁸ Space debris is a complex threat. Hence, there is a dedicated case study to discuss these issues in this thesis.

In recent decades, the possibility of asteroid and Moon mining has increased because of advancements in scientific knowledge and technology.⁹⁶⁹ As mentioned in the potential risk section, the technology associated with asteroid and Moon mining is extremely sophisticated. Although it may not seem likely that the technology created for space mining would be used against adversary satellites, it is important to consider the technological capabilities to mine in space and their potential uses for military purposes. As illustrated in chapter III and defined in this thesis, space weapons come in many forms (including dual-use systems) and with no current legal framework halting the weaponization of space, it is essential to discuss the future possibility to stir a more dangerous concern. For example, if Russia and China feel that the passing of the U.S. SPACE Act was a display of “economic aggression,”⁹⁷⁰ what is stopping them from also thinking the technology required to mine could not be used as a weapon against their satellites? The weaponization of space and what constitutes a space weapon are very

⁹⁶⁷ Ibid.

⁹⁶⁸ Ibid.

⁹⁶⁹ Baseley-Walker, “SWMETHEMES: Space Mining: The Next Strategic Investment for Gulf Countries?”

⁹⁷⁰ Von der Dunk, as quoted in Fecht, “Is Space Mining Legal?”

complex issues. Hence, there is a chapter dedicated to that topic in this thesis. Although it is unlikely that the mining spacecraft themselves would be used to attack Russia and China, there is a potential that the capabilities gained from these assets could be added to military satellites, such as lasers or drills, which would be a more dangerous outcome. Therefore, the potential that armed conflict could occur between space-faring nations is more likely if the technology is incorporated into military satellites. In conclusion, the OST cannot adequately provide guidelines to prevent these future international instabilities that could eventually lead to military disputes.

F. CONCLUSION

Technology is and has been developed to mine the Moon and asteroids, making space mining a future reality. In addition, countries, such as the United States and Luxembourg, have established their own laws and regulations for mining in space.⁹⁷¹ This case study discussed the progression of asteroid and Moon mining through history showing the steady growth of interest over time. Mining in space was not a reality during the creation of the OST. But the international community felt it was important to protect outer space, the Moon, and celestial bodies. Yet it did not specifically ban mining in the future. This thesis also addressed the potential threat mining could pose in the 21st century and in the future, as well as discussed, the importance of evaluating the OST's ability to guide and direct space-faring nations on this issue. The analysis of the OST's capability to aid in the challenges posed by mining determined that even though certain articles could cover the issue, they are not specific enough to cover all the possible mining scenarios that could in theory occur in space and they offer no specific remedies. Therefore, in conclusion, the OST alone is unlikely to be able to prevent conflicts resulting from space mining from occurring in the 21st century.

⁹⁷¹ Baseley-Walker, "SWMETHEMES: Space Mining: The Next Strategic Investment for Gulf Countries?"

V. RECOMMENDATIONS FROM THE CASE STUDY FINDINGS FOR THE OUTER SPACE TREATY

A. INTRODUCTION

The importance of continuing to develop and strengthen space law will have a major influence on our ability to maintain and achieve “long-term sustainability (LTS)”⁹⁷² in the use of outer space.⁹⁷³ Without clearly defined and globally accepted agreements, laws, norms, policies, or codes, LTS in space may not be achievable.⁹⁷⁴ The case studies have identified the OST’s inability to adequately cover a range of potential concerns with these current and emerging 21st century issues. This chapter will summarize the findings in each of the case studies and identify the gaps within the OST. Additionally, policy recommendations will be provided that could pave the way to prevent conflicts from occurring due to the concerns with space debris, the weaponization of space, and asteroid and Moon mining. This chapter will be divided into two sections, followed by a conclusion: 1) case study findings on the gaps within the OST; and 2) potential policy recommendations.

B. CASE STUDY FINDINGS ON THE GAPS WITHIN THE OST

The case studies have identified and provided scenarios and analyses that highlight the OST’s inability to provide guidance for these important emerging problems. This section will provide a summary of the conclusions from each of the case studies and identify some of the specific gaps found in the OST during the analysis.

1. Space Debris Case Study

The analysis provided in this case study led to the conclusion that although certain articles could be interpreted as covering the current debris issue, they were not all

⁹⁷²Olga Volynskaya, “Future space is challenge for international law,” *Room: The Space Journal* 1, no. 7 (2016): <https://room.eu.com/article/future-space-is-challenge-for-international-law>.

⁹⁷³*Ibid.*; “Space Law and Policy,” Secure World Foundation, August 24, 2017, <https://swfound.org/ourfocus/space-law-and-policy>.

⁹⁷⁴*Ibid.*

encompassing and left too much to interpretation to adequately prevent conflict in the 21st century. Significant gaps within the OST contribute to its inability to cover the concerns presented by the growing problem of space debris.

The most worrisome gap in the OST is the lack of any mention of space debris mitigation or removal.⁹⁷⁵ The space debris case study identified Articles I, VI, VII, and IX of the OST as possible provisions to address issues that could arise with the continued creation of space debris, as well as mitigation and removal efforts. But the OST is regarded to be “inherently permissive in its nature,” leaving too much room for interpretation that could cause conflict amongst the State Parties to the treaty.⁹⁷⁶ Another gap is the ill-defined and often debated terminology within the treaty.⁹⁷⁷ Some of the terms include “interests of all other state parties,” “space object,” “harmful interference,” and “peaceful purposes.”⁹⁷⁸ With no clearly defined and internationally accepted definitions, this imprecise language leaves room for various interpretations. Articles VI and VII are too limited in addressing concerns associated with liability and fault, requiring an additional amount of guidance from the Liability Convention.⁹⁷⁹ Although the Liability Convention provided more effective guidelines, it was not perfect and contained gaps and limitations.⁹⁸⁰ The lack of clarity regarding the term “space object”⁹⁸¹ leads to the confusion of whether space debris falls within the provided definition.⁹⁸² Additionally, the Liability Convention cannot cover cases that involve debris that cannot be attributed to a

⁹⁷⁵Wheeler, “Space debris: The legal issues.”

⁹⁷⁶Secure World Foundation, Letter for the “Record for the hearing on Reopening the American Frontier: Exploring How the Outer Space Treaty Will Impact American Commerce and Settlement” to U.S. Senate Committee on Commerce, Science, and Transportation, May 22, 2017, https://swfound.org/media/205845/swf_letter_to_senate_may_22_2017.pdf.

⁹⁷⁷Krause, “The Outer Space Treaty turns 50.”

⁹⁷⁸*Ibid.* ‘Outer Space Treaty, U.S. State Department.

⁹⁷⁹Jakhu and Ahmad, “The Outer Space Treaty and States’ obligation to remove space debris: a U.S. perspective.”

⁹⁸⁰Roberts, “Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes.”

⁹⁸¹Resolution 2777 (XXVI).

⁹⁸²Von der dunk, “The 1972 Liability Convention: Enhancing Adherence and Effective Application.”

specific space object or nation-state.⁹⁸³ Therefore, its inability to provide support or solutions regarding damage caused by unattributable debris is a significant gap within space law.⁹⁸⁴ The gaps identified further support the case studies' conclusion, stressing the inability of the OST to prevent future conflict.

2. Weaponization of Space

The analysis provided in the weaponization of space case study led to the conclusion that the OST failed to predict the increase in space weapon technology or offer adequate guidelines to prevent the weaponization of space. Although certain articles could be interpreted as covering some of the current space weaponization issues, they are not all encompassing and leave too much to interpretation to adequately prevent conflict in the 21st century. Significant gaps within the OST contribute to its inability to cover the concerns presented by the weaponization of space.

The most troublesome gap in the OST is its lack of clarification of the term “space weapon.” The weaponization of space case study identified Articles I, IV, VI, and IX of the OST as possible provisions to address issues that could arise if nations continue to develop, test, and fund offensive and defensive space weapons. Article IV “prohibits placing nuclear weapons or any other kinds of weapons of mass destruction into orbit or permanently affixing them to a celestial body.”⁹⁸⁵ The limitation with Article IV is “that it only bans weapons of mass destruction (WMD) from orbit;”⁹⁸⁶ it fails to consider the various ground, air, and sea-based weapons that could be deployed against satellites or, even worse, against their ground-control elements.⁹⁸⁷ Another concern is the OST “does not explicitly prohibit the placement or use of other types of weapons.”⁹⁸⁸ For example,

⁹⁸³Ibid.

⁹⁸⁴Ibid.

⁹⁸⁵Outer Space Treaty, as quoted in Frey, “Defense of U.S. space assets: a legal perspective.”

⁹⁸⁶ Outer Space Treaty, U.S. State Department.

⁹⁸⁷ Union of Concerned Scientists: Science for a Healthy Planet and Safer World, “International Legal Agreements Relevant to Space Weapons,”

⁹⁸⁸ Jaramillo, “In Defence of the PPWT Treaty: Toward a Space Weapons Ban.”

the OST does not cover Earth-based weapons, such as ASATs that can target satellites.⁹⁸⁹ Additionally, Jinyuan Su identifies another gap within the OST regarding its inability to prevent an arms race in outer space.⁹⁹⁰ Another gap and issue of concern is the OST's failure to provide guidelines regarding dual-use technologies in outer space.⁹⁹¹ Some argue that dual-use satellites are considered weapons in space, others suggest "that no weapons have been placed in outer space."⁹⁹² The gaps identified further support the case studies' conclusion, stressing the inability of the OST to prevent future conflict.

3. Asteroid and Moon Mining Case Study

The analysis provided in the asteroid and Moon mining case study led to the conclusion that although certain articles could provide clarification to cover current and future asteroid and Moon mining issues, the treaty itself is not all encompassing and leaves too much to interpretation to adequately prevent conflict in the 21st century. Significant gaps within the OST contribute to its inability to cover the concerns presented with future space mining missions.

The most obvious gap in the OST is the lack of any clearly defined guidelines for commercial activities, such as space mining.⁹⁹³ Jill Stuart discusses the importance of the OST, but clearly believes it is failing in the modern era due to its primary focus on countries only and its little consideration for commercial interests in space.⁹⁹⁴ The asteroid and Moon mining case study identified Articles I, II, VI of the OST as including possible provisions to address the future concerns that could arise with commercial space mining missions. Specifically, Article VI is considered one of the only articles that establishes a "foundation on which any laws or regulations regarding commercial space activity are

⁹⁸⁹ Ibid.

⁹⁹⁰ Su, "Space Arms Control: Lex Lata and currently active proposals."

⁹⁹¹ Caldicott and Eisendrath, *War in Heaven; The Arms Race in Outer Space*, 85.; Taft, "Outer Space: The Final Frontier or the Final Battlefield."

⁹⁹² "Outer Space: Militarization, weaponization, and the prevention of an arms race," *Reaching Critical Will: A project of the Women's International League for Peace and Freedom*.

⁹⁹³ Stuart, "The Outer Space Treaty Has Been Successful."

⁹⁹⁴ Ibid.

erected.”⁹⁹⁵ This provision of the “treaty makes states responsible for the activities of nongovernmental entities, requiring authorization and continuing supervision of space activities by commercial enterprise.”⁹⁹⁶ This could be considered problematic due to the concept of direct attribution.⁹⁹⁷ During the creation of the OST, commercial interests were not a priority (as few existed then), therefore “the treaty made every nation directly responsible for any activities its citizens engaged in above Earth.”⁹⁹⁸ Thus, the treaty is missing clearly defined guidelines “for regulating and managing commercial actors in space.”⁹⁹⁹ Joanne Gabrynowicz mentions that “nongovernmental agencies is [sic] only stated once and because of that oversight, there is no U.S. agency with jurisdiction of on-orbit activity. That’s a big gap in the law.”¹⁰⁰⁰ The gaps identified further support the case studies’ conclusion, stressing the inability of the OST to prevent future conflict.

C. POTENTIAL POLICY RECOMMENDATIONS

The outcomes of the OST analyses present a challenge to the future of space law and governance. The findings here conclude that the OST is not all encompassing and it likely cannot cover several emerging problems, therefore increasing the likelihood for conflicts to occur in the 21st century. With never-ending wars continuing to plague nations on Earth, it is essential that these conflicts do not reach into outer space. Therefore, it is important to discuss policy recommendations that could aid in addressing concerns associated with space debris, the weaponization of space, and the future of space mining. This section will provide short-term policy recommendations for each case study, with the hope that in the long term, the future of space activities will find a global solution because “any considerable effort to close the existing gaps in international space law must include measures to build confidence and transparency among states.”¹⁰⁰¹

⁹⁹⁵Krause, “The Outer Space Treaty turns 50.”

⁹⁹⁶*Ibid.*; Outer Space Treaty, U.S. State Department.

⁹⁹⁷Krause, “The Outer Space Treaty turns 50.”

⁹⁹⁸*Ibid.*

⁹⁹⁹*Ibid.*

¹⁰⁰⁰Joanne Gabrynowicz, as quoted in *Ibid.*

¹⁰⁰¹Al-Rodham, “Preventing Future Conflicts in Outer Space.”

1. Space Debris: Policy Recommendations

Situational awareness is a key aspect of preventing conjunctions from occurring in outer space. As mentioned in the space debris case study in the threat section, the challenging aspect of space debris is those debris that are too small to be tracked.¹⁰⁰² NASA believes that “there are millions of pieces of debris that are so small they can’t be tracked,”¹⁰⁰³ but could damage a spacecraft due their velocity of roughly 17,500 mph.¹⁰⁰⁴ Currently, no international organization exists to track space debris and the inherent responsibility lies with each nation.¹⁰⁰⁵ The United States Air Force’s Joint Space Operation Center (JSpOC) “maintains the most complete catalog of objects in orbit”¹⁰⁰⁶ and when necessary (i.e., risk of collision) it shares that information with the affected parties.¹⁰⁰⁷ One possible course of action to lower the risk of future collisions would be to create an international “space traffic control”¹⁰⁰⁸ agency dedicated to tracking debris in outer space. First, the United States could begin transferring the responsibility of tracking non-military space debris in LEO from the military to commercial space companies. This transfer of responsibility would not remove the military from the business of tracking debris, but rather it would allow the military to focus on other areas of concern in space. For example, a potential commercial company that would have the technological capability to alleviate some of the load from JSpOC is LeoLabs. LeoLabs was created with the dedicated mission “to provide high resolution data on objects in LEO by offering foundational mapping data and services to mitigate the risks of collisions.”¹⁰⁰⁹ In the past the technology capable of providing space situational awareness (SSA) was not available

¹⁰⁰² NASA, “Space Debris and Human Spacecraft.”

¹⁰⁰³ Ibid.

¹⁰⁰⁴ Ibid.

¹⁰⁰⁵ “Space Debris FAQs,” Aerospace: Center for orbital and reentry debris studies, accessed May 31, 2018, <https://www.aerospace.org/cords/all-about-debris-and-reentry/space-debris-faq/>.

¹⁰⁰⁶ Ibid.

¹⁰⁰⁷ Ibid.

¹⁰⁰⁸ Ibid.

¹⁰⁰⁹ “LeoLabs: Our Data Services,” LeoLabs company webpage, accessed May 31, 2018, <https://leolabs.space>.

in the commercial sector nor was there a competitive market or interest in this mission. But as this technology becomes more readily available, commercial companies are seeing the potential for profit in SSA capabilities. Additionally, the current Trump administration proposed a plan to transfer the role from the Air Force to the Commerce Department.¹⁰¹⁰ The administration wants this agency to not only track space debris but “devise new, best practices to coordinate the coming profusion of thousands more commercial platforms operating in space.”¹⁰¹¹ Outreach to commercial SSA companies, like LeoLabs, could help build a robust network for more effective space traffic management. The proposed organizational structure is to have JSpOC responsible for tracking military space objects, the Department of Commerce become a civil/commercial JSpOC, and the commercial SSA companies would be available to the public (i.e., other commercial satellite companies or Department of Commerce). This could potentially alleviate the concern with data-sharing, especially in support to the Liability Convention. Currently, JSpOC is the only entity that could provide tracking data to help adjudicate cases of debris or satellite damage that might be brought by State Parties under the Liability Convention. This is problematic because the JSpOC, as a U.S. military entity, is not likely to be viewed as a neutral party. By sharing the tracking responsibility, the proposed system would allow injured parties raising cases under the Liability Convention to access public data via commercial SSA companies to assist in enforcing awards for damages. The 2010 United States National Space Policy specifically mentioned, under international cooperation, that the U.S. should “lead in the enhancement of security, stability, and responsible behavior in space.”¹⁰¹² This would not be an overnight transition, but a gradual transition over the next few years. Additionally, this policy recommendation has the potential to “build confidence and trust”¹⁰¹³ within the international community. If the United States can help provide a system of space debris

¹⁰¹⁰ Justin Bachman, “America wants to be a traffic cop for satellites and space junk,” *Chicago Tribune*, April 18, 2018, www.chicagotribune.com/news/nationworld/science/ct-commerce-department-space-junk-satellites-20180418-story.html.

¹⁰¹¹ Ibid.

¹⁰¹² “National Space Policy of the United States of America,” Obama White House Archives, June 28, 2010, Accessed June 1, 2018, https://obamawhitehouse.archives.gov/sites/default/files/national_space_policy_6-28-10.pdf, 6.

¹⁰¹³ Secure World Foundation, “Space Law and Policy.”

tracking that allows data sharing to be more accessible to the world, this would show the international community the U.S. dedication to continuing to pursue global solutions to ensuring the safety of all assets in space as well as promoting responsible behaviors in space.

A second area of concern relates to the adequacy of existing guidelines for de-orbiting of satellites. The Inter-Agency Space Debris Coordination Committee (IADC), “the international organization dedicated to addressing concerns regarding man-made and natural debris in space,”¹⁰¹⁴ issued guidelines in an “effort to provide recommendations to mitigate debris.”¹⁰¹⁵ One of the guiding principles in this document stated “this IADC and some other studies and a number of existing national guidelines have found 25 years to be a reasonable and appropriate lifetime limit.”¹⁰¹⁶ However, on May 24, 2018, Lisa Kuo, commercial programs and business development head for the Aerospace Corporation, challenged this all-encompassing rule when she asked participants at the Space Tech Expo , “What is the optimal lifespan for a satellite?”¹⁰¹⁷ Answers to the question suggested “customers want everything from CubeSats built for six-month missions to geostationary communications satellites designed to last decades.”¹⁰¹⁸ But, Brian Roberts, a robotic technologist at NASA’s Goddard Space Flight Center, “suggested ten years was the optimum lifespan for a satellite.”¹⁰¹⁹ Therefore, the proposed 25 years in the “IADC Space Debris Mitigation Guidelines” needs to be reviewed and further studied to verify if 25 years is a sufficient recommendation. This policy is targeted at addressing the current needs of a diversifying space market.¹⁰²⁰ According to Michael Gabor, SSL (formerly Space Systems/Loral, LLC) advanced programs director, “trying to look for a one-size-

¹⁰¹⁴ Inter-Agency Space Debris Coordination Committee. “IADC Space Debris Guidelines: IADC-02-01.”

¹⁰¹⁵ Ibid.

¹⁰¹⁶ Ibid.

¹⁰¹⁷ Lisa Kuo, as quoted in Debra Werner, “How long should a satellite last: five years, ten years, 15, 30?,” SpaceNews, May 24, 2018, <http://spacenews.com/how-long-should-a-satellite-last/>.

¹⁰¹⁸ Werner, “How long should a satellite last: five years, ten years, 15, 30?”

¹⁰¹⁹ Brian Roberts, as quoted in Ibid.

¹⁰²⁰ Werner, “How long should a satellite last: five years, ten years, 15, 30?.”

fits-all solution is probably the wrong thing to do,”¹⁰²¹ so this policy has the potential to create more specific guidelines regarding de-orbiting based on the missions or size of the satellite.¹⁰²²

2. Weaponization of Space: Policy Recommendations

Two rather promising, yet imperfect mechanisms have been presented to the international community to prevent the weaponization of space – the Russia-China PPWT and the International Code of Conduct (formerly known as the EU Code of Conduct). The United States has failed to support either of these proposals. In 2008, U.S. Ambassador Christine Rocca provided a point-by-point rebuttal of the PPWT and staunchly said “we continue to believe that there is no arms race in space, and therefore no problems for arms control to solve.”¹⁰²³ But, U.S. Ambassador Rocca failed to propose any innovative ideas to replace the PPWT.¹⁰²⁴ Although these proposals have provisions within them that are extremely flawed, the United States has yet to provide any substantial alternative to either of these proposals. The United States, as a world leader in space, has the unique opportunity to shape a future framework of stability and longevity in the use of outer space. In this regard, it is better served by providing positive solutions rather than just criticism: i.e., to propose new concepts to strengthen existing proposals or to offer new regulations aimed at the prevention of weaponization. For example, the United States could propose a moratorium to China and Russia to ban ASAT tests against one’s own systems as well as those of other nations. During this moratorium, the United States could initiate discussions with Russia, China, and other space-faring nations to discuss possible revisions of the PPWT or adopting restraint-based rules of the road for outer space which were proposed in the International Code of Conduct. By initiating discussions and providing positive solutions, the United States has the potential to promote trust and constructive discussion moving forward amongst space-faring nations aimed at fulfilling the U.S. goal of

¹⁰²¹ Michael Gabor, as quoted in Ibid.

¹⁰²² Ibid.

¹⁰²³ Ambassador Christina Rocca, as quoted in Jaramillo, “In Defence of the PPWT Treaty.”

¹⁰²⁴ Ibid.

“promoting responsible behavior”¹⁰²⁵ in space, as well as showing its commitment to preventing outer space from becoming weaponized.

Weaponizing space is a complex issue that is going to need the international community to work together in order to prevent outer space from becoming another warfighting domain. The OST “only bans nuclear weapons and weapons of mass destruction (WMD) from orbit,”¹⁰²⁶ but it does not consider the various ground-, air-, and sea-based weapons that could be deployed against satellites or, even worse, against their ground-control elements.¹⁰²⁷ The OST is often criticized for “its ill-defined use of the term ‘weapon’ within its provisions.”¹⁰²⁸ Since almost anything in outer space can be used as a weapon, the lack of a standing legal agreement defining space weapons increases the risk for conflict.¹⁰²⁹ Therefore, there is a need to settle the debate on what exactly is a space weapon. Rather than have a strict definition, this thesis proposes a policy dedicated to the concept of prohibiting nefarious behaviors, rather than specific weapons. This recommendation could alleviate the concerns with dual-use satellites and technology. Within the next 1–2 years, the United States should propose a multilateral agreement amongst space-faring nations to ban dual-use technology from being used to conduct nefarious activities in space, with the long-term goal of one day having an internationally accepted treaty preventing these behaviors in space, supported by an international verification mechanism. Some of the potential dual-use areas to be covered could include satellites with robotic arms or laser capabilities. Satellites that have been designed with a robotic arm are most likely conducting servicing activities and may be used on future space debris removal missions but, potentially, in a time of conflict, they could maneuver close to an adversary satellite, grab it, and either cause damage or push it so that it tumbles out

¹⁰²⁵ “National Space Policy of the United States of America,” Obama White House Archives.

¹⁰²⁶ Union of Concerned Scientists: Science for a Healthy Planet and Safer World, “International Legal Agreements Relevant to Space Weapons.”

¹⁰²⁷ Ibid.

¹⁰²⁸ Peoples, “The Securitization of Outer Space: Challenges for Arms Control.”

¹⁰²⁹ “Outer Space: Militarization, weaponization, and the prevention of an arms race,” Reaching Critical Will: A project of the Women’s International League for Peace and Freedom.

of position.¹⁰³⁰ This multilateral agreement would prohibit the use of the robotic arm against other nations' satellites, but not ban the arm itself. The long-term goal would be to have an actual treaty via UN COPUOS on detailing dual-use behaviors that could be considered nefarious and would be subject to sanctions or other punishments if violated. Additionally, NASA recently "conducted a study on the feasibility of using power-constrained pulsed lasers to remove virtually all dangerous orbital debris in the range of one to ten centimeters between 400 and 1100 kilometers in altitude."¹⁰³¹ Again, a laser could be used to cause damage to a satellite but, banning the use of lasers against spacecraft, including the testing on one's own satellites, could alleviate the concern. Additionally, within these guidelines it would be essential that if a dual-use technology was used to damage another nation's satellite, that spacecraft would no longer be protected, and a foreign country would have an inherent right to treat that spacecraft as a legitimate target.

3. Asteroid and Moon Mining: Policy Recommendations

Asteroid and Moon mining present the world with a new challenge in regard to space law. The international community should be proactive and take this unique opportunity presented to them to start the process either of defining specific agreements or establishing norms for exploitation and mining missions. Space mining is still in the beginning stages and results most likely will not be seen until 2030, which means there are more than 10 years to develop a solution to future concerns associated with mining.¹⁰³² With this in mind, the United States might be well served to get ahead of the process and instigate talks with Russia and China to re-evaluate and discuss the Moon Treaty. Currently, the U.S., Russia, and China "have neither signed, acceded, nor ratified the Moon

¹⁰³⁰ Colin Clark, "China Satellite SJ-17, Friendly Wanderer?," Breaking Defense, April 18, 2018, <https://breakingdefense.com/2018/04/china-satellite-sj-17-friendly-wanderer/>.

¹⁰³¹ Al Anzaldua, Gary Barnhard, David Dunlop, and Claude Phipps, "A path to a commercial orbital debris cleanup, power-beaming, and communications utility, using technology development missions at the ISS," The Space Review, November 6, 2017, www.thespacereview.com/article/3363/1.

¹⁰³² Charles Kieck, as quoted in Chutel, "NASA's latest mission will show if asteroid mining will be a real threat to the global platinum industry."

Treaty.”¹⁰³³ Thus, if a new treaty were to be agreed upon, it would be seen as a significant achievement for international space law. In the short term, these countries could adopt certain principles of the treaty to help establish best practices or norms for mining, with the long-term goal of conducting a full reevaluation of the treaty in order to target the provisions that cause the most debate. The first provision the United States, Russia, and China could discuss for possible adoption in the short-term might be Article 5 of the Moon Treaty, which states:

State Parties shall inform the Secretary-General of the United Nations as well as the public and international scientific community, to the greatest extent feasible and practicable, of their activities concerned with the exploration and use of the Moon. Information on the time, purposes, locations, orbital parameters, and duration shall be given in respect of each mission to the Moon as soon as possible after launch.¹⁰³⁴

This article could easily be implemented into a licensing process for companies looking to mine in outer space. For example, Moon Express would provide in detail to the United States government, or assigned agency within, the specific requirements requested in Article 5, which would then be provided to the Secretary-General of the UN. This compliance could be considered a sign of good faith to other countries that might be worried that space mining activities may interfere with their space programs. Additionally, the treaty discusses the establishment of “an international regime by the State Parties of the treaty,”¹⁰³⁵ which should be considered and addressed in the short-term discussions. It is essential, much like the Liability Convention was created to provide an amplification and arena to handle claims and liability for damage caused by space activities, that an international regime be created to monitor and provide guidance on future space mining activities. But, in the long-term, the responsibilities provided in the Moon Treaty for this international regime would need to be reevaluated and re-proposed, so that everyone is in

¹⁰³³ Listner, Michael, “The Moon Treaty: failed international law or waiting in the shadows?,” *The Space Review*, October 24, 2011, <http://www.thespacereview.com/article/1954/1>.

¹⁰³⁴ RES 34/68 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 89th plenary meeting, December 5, 1979, accessed on June 2, 2018, http://www.unoosa.org/pdf/gares/ARES_34_68E.pdf.

¹⁰³⁵ *Ibid.*, Article 11, par. 5.

agreement. For these discussions, it may be more beneficial for the United States, China, and Russia to invite other nations likely to become involved in near-term space mining to the table to draft some sort of responsibilities for this international regime.

Space lawyers, such as Joanne Gabrynowiz, state “that new legislation and regulation is the only plausible avenue for modernizing legal framework in outer space right now.”¹⁰³⁶ She is referring to national legislation to fill the gaps that international space law has yet to address adequately.¹⁰³⁷ In the past few years, the United States and Luxembourg have passed national laws to support and provide guidelines for the commercial industry. As part of this process, the United States will need to create a supervising authority specifically for space mining or Moon landings.¹⁰³⁸ Because the United States has yet to create or task an existing agency, it could be challenged by other State Parties to the OST for the lack of supervising authority for space mining activities, which could be interpreted as a U.S. failure to follow Article VI of the OST.¹⁰³⁹ Additionally, in order to prevent the problem of multiple countries enacting their own forms of national legislation--which could lead to potential disputes in the future--the United States should reach out to State Parties in the OST and begin initiating discussions, recommending that interested countries enact mirroring space mining legislation. By enacting very similar national legislation, these processes may have firmer legal standing and promote the development of best practices, which could eventually lead to a treaty. Since the United States and Luxembourg have already adopted legislation, it is essential that both countries are willing to support (or discuss) new rules or guidelines that other countries bring to the table as they create similar regulation.

¹⁰³⁶ Joanne Gabrynowiz, as quoted by Krause, “The Outer Space Treaty turns 50.”

¹⁰³⁷ Ibid.

¹⁰³⁸ Foust, “Mining Issues in Space Law.”

¹⁰³⁹ Ibid.

D. CONCLUSION

More than fifty years ago, the OST “established the foundations for the exploration and use of outer space.”¹⁰⁴⁰ Emerging concerns and new space activities in the 21st century have presented new challenges for the OST. Although the treaty has worked thus far, this thesis shows that the OST will not be able to cover many possible concerns that may come with space debris, weaponization of space, and space mining. This thesis asked the question: Can the Outer Space Treaty Prevent Conflicts in Orbit in the 21st Century? The short answer is no. Recently, Secretary of Defense James N. Mattis addressed the way forward and solving the issues with outer space, declaring

you break the problem down into bite-sized pieces, because you understand we’ve got to solve space. You know, that – that provides zero fidelity for what we have to do, but you have to do it, break down everything from what is our strategy? What are our arms control of it – almost call it initiatives for space? What are we doing to set the strategic framework there?¹⁰⁴¹

Secretary of Defense Mattis’s concept of creating “initiatives for space,”¹⁰⁴² is essential to the way forward for regulating current and emerging space activities. Furthermore, breaking space up into manageable areas and assigning issue-specific guidelines for each individual area of concern could assist in developing regulations for current and emerging space problems.¹⁰⁴³ Currently, without further legal agreements to elaborate on space debris, the weaponization of space, and asteroid and Moon mining, the OST as it stands will not be able to adequately prevent conflict in the 21st century. Therefore, the time for creative approaches and positive U.S. engagement is now.

¹⁰⁴⁰Stuart, “The Outer Space Treaty Has Been Successful So Far.”

¹⁰⁴¹ Secretary of Defense James N. Mattis, *Secretary Mattis Press Gaggle in Colorado Springs*, U.S. Department of Defense Press Operations, May 23, 2018, <https://www.defense.gov/News/Transcripts/Transcript-View/1530845/secretary-mattis-press-gaggle-in-colorado-springs/>.

¹⁰⁴² Ibid.

¹⁰⁴³ Ibid.

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