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While existing space treaties promote the free and exploratory use of space, rogue actors are intent on dominating space as a new warfighting domain through the deployment of electromagnetic pulse weapons. Global Alliance must go further in establishing international norms, treaties, and punitive sanctions to prevent the deployment, testing, and use of electromagnetic pulse weapons in space.

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SPACE DIPLOMACY:
Deterring Electromagnetic Pulse Weapons in Space

by Jessica McTigue

Special Agent, U.S. Department of State

A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by National Defense University, the Department of Defense, or the Department of State.

This paper is entirely my own work except as documented in footnotes (or appropriate statement per the Academic Integrity Policy).

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Abstract

While existing space treaties promote the free and exploratory use of space, rogue actors are intent on dominating space as a new warfighting domain through the deployment of electromagnetic pulse weapons. Global alliances must go further in establishing international norms, treaties, and punitive sanctions to prevent the deployment, testing, and use of electromagnetic pulse weapons in space.

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Table of Contents

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Chapter 1: Introduction

Since the first satellites were launched into space by the Soviet Union in 1957 followed by the U.S. in 1958, 65 years later there are 72 countries that have satellites in space.[1] Outer space may no longer be considered a sanctuary as some nations have demonstrated their intent on developing and placing weapons in space, threatening the world's near-total reliance on space assets for daily life. Ten years after the first satellite launch, the U.S., U.K., and the Soviet Union signed the first space treaty in 1967, the Outer Space Treaty. The 1967 Outer Space Treaty came at a critical time six years after both the Soviet Union and the U.S. conducted nuclear detonations in the atmosphere, in 1961 and 1962 respectively. The effects of these 1961 and 1962 two test detonations revealed the widespread danger these bombs posed and eventually led to the 1963 Partial Test Ban Treaty, signed by the U.S., U.K., and the Soviet Union, which bans nuclear testing in the atmosphere, outer space, and under water.[2]

In 1962 the four nuclear powers were: the U.S., U.K., the Soviet Union, and France. Today, 44 countries have nuclear capabilities, but only nine have nuclear weapons: U.S., U.K., Russia, France, China, India, Pakistan, Israel, and North Korea, and it is suspected that Iran is developing a nuclear weapons program.[3] Since 1945, these nine nations have conducted approximately 2,000 nuclear weapons tests.[4] Since the atmospheric tests of nuclear bombs in the early 1960s, attention to the danger of nuclear

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[1] United Nations International Telecommunications Union, "Managing Radio Frequency Spectrum Amid a New Space Race, November 12, 2021, last accessed November 27, 2022, Managing radio frequency spectrum amid a new space race - ITU Hub.

[2] U.S. National Archives, "Test Ban Treaty (1963), page last reviewed February 8, 2022, last accessed January 28, 2023, Test Ban Treaty (1963) | National Archives.

[3] Nuclear Threat Initiative, "Reducing Nuclear Weapons Risks," last accessed November 27, 2022, Reducing Nuclear Weapon Risks (nti.org).

[4] Arms Control Association, 2022, "Nuclear Testing Tally," last reviewed August 2022, last accessed November 27, 2022, The Nuclear Testing Tally | Arms Control Association.

electromagnetic pulse (EMP) weapons has been a focus of U.S. administrations. Following Russia's invasion of Ukraine in February 2022, some media reports speculate that Russia is capable of detonating a nuclear EMP-producing weapon over Ukraine.[5] Additionally, according to the 2011 declassified intelligence report dated in 2005, China conducted research into a nuclear EMP attack against Taiwan.[6] When the U.S. Government confirmed a balloon belonging to China that floated over U.S. territory in February 2023, this renewed media speculation that an EMP weapon could be detonated in the atmosphere over the U.S..[7]

With China's growing nuclear arsenal and lack of willingness to enter into nuclear treaties with the U.S. and Russia, and Russia's suspension of its participation in the renewed New Strategic Arms Reduction (START) Treaty in February 2023, lends concerns if updated space agreements can be negotiated during this increased tension between the U.S. and both Russia and China.[8][9] The 2022 U.S. Nuclear Posture Review further speculates that "new stresses on stability and new challenges for deterrence, assurance, arms control, and risk reduction" may pose new dilemmas in strategic competition between the U.S., China, and Russia.[10]

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[5] Pardo-Maurer, Roger, 2022, "Putin's Nuclear Threats May Hint at an Electromagnetic Pulse Strike," Financial Times, November 9, 2022, last accessed November 27, 2022, Putin's nuclear threats may hint at an electromagnetic pulse strike | Financial Times (ft.com).

[6] George Washington University, National Security Archive, 2011, "U.S. Intelligence Eyes Chinese Research into Space Age Weapons, last accessed November 27, 2022, U.S. Intelligence Eyes Chinese Research into Space-Age Weapons (gwu.edu).

[7] Norton, Tom, 2023, "Fact Check: Could Chinese Spy Balloons Carry EMP to Detonate Over the U.S.?," Newsweek, February 21, 2023, last accessed March 3, 2023, Fact Check: Could Chinese Spy Balloons Carry EMP to Detonate Over the U.S.? (newsweek.com).

[8] Trevelyan, Mark and Jake Cordell, 2023, "Russia Says It Will Play by Nuclear Treaty Rules Despite Suspending Deal with U.S.," Reuters, February 22, 2023, last accessed March 3, 2023, Russia says it will play by nuclear treaty rules despite suspending deal with U.S. | Reuters.

[9] U.S. President, "Nuclear Posture Review 2022," last accessed November 27, 2022, page 4, 2022-Nuclear-Posture-Review.pdf.

[10] U.S. President, "Nuclear Posture Review 2022," last accessed November 27, 2022, page 4, 2022-Nuclear-Posture-Review.pdf.

While solar events can also generate an electromagnetic pulse impact on Earth, such as the 1859 Carrington Event, this research will focus on nuclear EMP weapons and provide recommendations for stronger diplomatic engagements to prevent war in outer space. The 1859 Carrington Event was a massive geomagnetic storm on Earth caused by a burst of magnetized plasma from the sun's surface and caused telegraph systems and other electronic devices to malfunction or fail altogether.[11] With the advancement in space technology, the increase of space-faring nations, and increased reliance on space in our day-to-day living on Earth, the need to deter warfare in space is critical. This research will 1) reveal gaps in current space treaties, 2) examine shortfalls in current nuclear treaties, 3) describe current space cooperation platforms, 4) examine the U.S. government's response to the threat of nuclear EMP weapons, and 5) provide an assessment of nuclear EMP capabilities posed by Russia, China, North Korea, and Iran.

Methodology

Through an examination of current and past space and nuclear treaties, this research will identify the vagueness and gaps in these treaties where there are opportunities to re-negotiate treaty language to meet today's and tomorrow's threats in outer space. With the increase in spacefaring nations and international collaborative platforms, both military and non-military, there are opportunities to expand U.S. diplomacy on space matters to support U.S. strategy and security policies. Following the introduction in chapter 1, chapter 2 will examine space and nuclear treaties with attention to the gaps in these treaties. Chapter 3 will analyze collaborative space and nuclear

[11] May, Andrew and Daisy Dobrijevic, 2023, "The Carrington Event: History's Greatest Solar Storm," Space.com, June 24, 2022, last accessed May 3, 2023, The Carrington Event: History's greatest solar storm | Space.

platforms that offer opportunities to expand diplomacy to mitigate EMP weapon threats and deter war in space. Chapter 4 will provide a historical summary of the U.S. government's response to space warfare and nuclear EMPs, and chapter 5 will analyze the potential adversaries capable of using nuclear EMP weapons in outer space. Chapter 6 will summarize the research with conclusions and Chapter 7 will provide recommendations.

Chapter 2: Space and Nuclear Treaties

Article 51 of the UN Charter recognizes a sovereign nation's right to self-defense, and as Lambakis argues, this extends to the right of self-defense in outer space.[12] As of 2023, there are five space treaties, 11 space agreements, and four nuclear treaties deposited with the UN. Some agreements and treaties were negotiated outside the auspices of the UN but are politically binding between the party nations to those agreements, such as the renewed 2021 New START Treaty. Article 102 of UN Charter recommends that member nations register such type of treaties, those negotiated outside the UN, "as soon as possible," and that no unregistered treaty cannot be invoked before the UN.[13] Although a political commitment rather than a treaty, the 2020 Artemis Accords was registered with the UN on January 7, 2021.[14][15] While the Artemis Accords do not violate the 1967 Outer Space Treaty, there is debate on whether the Accords conflict with the 1979 Moon Treaty, as Australia is a party to both.[16] UN Treaties are regarded as international law between party nations whose governments have ratified the treaties, but this does not preclude nations from entering into bilateral agreements that

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[12] Lambakis, Steve, 2022, "Space as a Warfighting Domain: Reshaping Policy to Execute 21st Century Spacepower," July 6, 2022, Comparative Strategy, volume 41, number 4, (pp 331-369), page 332.

[13] United Nations, Article 102, Miscellaneous Provisions, last accessed March 3, 2023, Chapter XVI: Article 102 — Charter of the United Nations — Repertory of Practice of United Nations Organs — Codification Division Publications.

[14] United Nations General Assembly, 75th Session, Agenda Item 51, International Cooperation in the Peaceful Uses of Outer Space, "Letter Dated 30 December 2020 from the Permanent Representative of the United States of America to the United Nations Addressed to the Secretary-General," January 7, 2021, last accessed March 3, 2023, Letter dated 30 December 2020 from the Permanent Representative of the United States of America to the United Nations addressed to the Secretary-General.

[15] Nelson, Jack Wright, 2020, "The Artemis Accords and the Future of International Space Law", American Society of International Law Insights, Volume 24, Issue 31, December 10, 2020, last accessed November 27, 2022, The Artemis Accords and the Future of International Space Law | ASIL.

[16] Nelson, Jack Wright, 2020, "The Artemis Accords and the Future of International Space Law," American Society of International Law, Volume 24, Issue 31, December 10, 2020, last accessed November 27, 2022, The Artemis Accords and the Future of International Space Law | ASIL.

hold politically-binding status between them.[17] The UN adheres to the 1969 Vienna Convention on the Law of Treaties, which entered into force in 1980.[18] While the U.S. is a signatory to this Treaty, it has yet to be ratified by the U.S. Senate.[19] In fact, there are 37 treaties pending U.S. Senate approval as of 2019.[20] The five UN space treaties are: 1967 Outer Space Treaty, 1968 Rescue Agreement, 1972 Space Liability Convention, 1976 Space Object Registration Convention, 1979 Moon Treaty.[21] The U.S. has ratified all but the Moon Treaty.[22] The 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, Outer Space, and Under Water, also known as the Partial/Limited Test Ban Treaty (PTBT/LTBT) specifically address nuclear weapons in the atmosphere and space. See appendix 1 and 2 for the full list of UN and U.S. space and nuclear treaties. In addition to the PTBT, this research will also examine current nuclear treaties in force: the 1968 Nuclear Nonproliferation Treaty (NPT), 1963 Partial Test Ban Treaty, 1997 Comprehensive Nuclear Test Ban Treaty (CTBT), 2021 Prohibition of Nuclear Weapons Treaty (TPNW), and the renewal of the New START treaty in 2021.[23] Other nuclear and space treaties not currently in force will also be addressed.

[17] United Nations Treaty Collection, "Definition of Key Terms Used in the UN Treaty Collection," last accessed November 27, 2022, UNTC.

[18] U.S. Department of State, "Vienna Convention on the Law of Treaties," last accessed November 27, 2022, Vienna Convention on the Law of Treaties (state.gov).

[19] U.S. Department of State, "Vienna Convention on the Law of Treaties," last accessed November 27, 2022, Vienna Convention on the Law of Treaties (state.gov).

[20] U.S. Department of State, "Treaties Pending in the Senate," October 22, 2019, last accessed November 27, 2022, Treaties Pending in the Senate - United States Department of State.

[21] United Nations Office for Outer Space Affairs, Committee for the Peaceful Uses of Outer Space, last accessed November 27, 2022, COPUOS (unoosa.org).

[22] United Nations Committee on the Peaceful Uses of Outer Space, "Status of International Agreements Relating to Activities in Outer Space as of 1 January 2022," page 9, last accessed January 28, 2023, AAC105_C2_2022_CRP10E.pdf (unoosa.org).

[23] United Nations Officer for Disarmament Affairs, "Nuclear Weapons," last accessed November 27, 2022, Nuclear Weapons – UNODA.

The 1961 Soviet and 1962 U.S. tests of nuclear bombs in the atmosphere revealed widespread damage to electrical grids over the areas of detonation. The 1962 U.S. test of a nuclear EMP detonation over Johnston Island in the South Pacific unexpectedly caused power outages over 800 miles away in Hawaii.[24] The U.S.' intent for the test was to demonstrate the capability to intercept a Soviet nuclear weapon in the atmosphere before it struck the continental U.S..[25] The 1961 Soviet test took place in the Arctic, and although detonated at a lower altitude than the U.S. test, the EMP effects were felt 500 miles away.[26] Recognizing the danger that these bombs' effects presented, the U.S., U.K., and the Soviet Union ratified the PTBT in 1963 which bans nuclear testing in the atmosphere, outer space, and underwater, and as of today it has been ratified by 123 nations and an additional 11 nations are signatories but have yet to ratify it.[27][28] North Korea is not a party to the PTBT.[29] This Treaty bans the radioactive contamination of Earth outside the jurisdiction of the country from where the nuclear detonation occurs. While there were only four nuclear powers in 1962, as of 2022, 44 nations now possess nuclear capabilities, but not all of them have a nuclear weapons program: Algeria,

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[24] Huard, Paul, 2016, "The First Time the U.S. Tested an EMP Weapons Was a Doozy," Business Insider, November 8, 2016, last accessed November 27, 2022, The First Time the US Tested an EMP Weapon Was a Doozy (businessinsider.com).

[25] Huard, Paul, 2016, "The First Time the U.S. Tested an EMP Weapons Was a Doozy," Business Insider, November 8, 2016, last accessed November 27, 2022, The First Time the US Tested an EMP Weapon Was a Doozy (businessinsider.com).

[26] Huard, Paul Richard, "In 1961, Russia's Tested the Most Powerful Nuclear Weapon Ever, (But Was Completely Unusable)," National Interest, January 12, 2017, last accessed November 27, 2022, In 1961, Russia's Tested the Most Powerful Nuclear Weapon Ever (But Was Completely Unusable) | The National Interest.

[27] U.S. National Archives, "Test Ban Treaty (1963)," last reviewed February 8, 2022, last accessed November 27, 2022, Test Ban Treaty (1963) | National Archives.

[28] United Nations Committee on the Peaceful Uses of Outer Space, legal subcommittee, "Status of International Agreements Relating to Activities in Outer Space as of 1 January 2022," March 28, 2022, last accessed November 27, 2022, AAC105_C2_2022_CRP10E.pdf (unoosa.org).

[29] United Nations Committee on the Peaceful Uses of Outer Space, legal subcommittee, "Status of International Agreements Relating to Activities in Outer Space as of 1 January 2022," March 28, 2022, last accessed November 27, 2022, AAC105_C2_2022_CRP10E.pdf (unoosa.org).

Argentina, Australia, Austria, Bangladesh, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Democratic People's Republic of Korea, Democratic Republic of the Congo, Egypt, Finland, France, Germany, Hungary, India, Indonesia, Iran, Israel, Italy, Japan, Mexico, Netherlands, Norway, Pakistan, Peru, Poland, Republic of Korea, Romania, Russia, Slovakia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, U.K., U.S., and Vietnam.[30] These 44 nations are members of the UN Conference on Disarmament, the UN body that oversees the discussions and formulation of treaties governing weapons of mass destruction, including nuclear weapons.[31] As of 2022, nine countries have a nuclear weapons program: U.S., U.K., Russia, France, China, India, Pakistan, Israel, and North Korea, and it is suspected that Iran is working to develop a nuclear weapons program.[32]

Four years after the 1963 PTBT, the 1967 Outer Space Treaty entered into force, which has a total of 109 nations that have ratified the Treaty and an additional 23 countries that are signatories but have yet to ratify it, such as Iran.[33] The U.S., China, North Korea, and Russia are parties to this Treaty.[34] Article 4 in the Treaty specifically requires party nations to the Treaty "to refrain from placing weapons in space, and forbids the establishment of military bases, installations, fortifications, testing of

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[30] Nuclear Threat Initiative, "Comprehensive Nuclear Test Ban Treaty," last reviewed April 30, 2022, last accessed November 27, 2022, Comprehensive Nuclear Test Ban Treaty (CTBT) (nti.org).

[31] Nuclear Threat Initiative, "Comprehensive Nuclear Test Ban Treaty," last reviewed April 30, 2022, last accessed November 27, 2022, Comprehensive Nuclear Test Ban Treaty (CTBT) (nti.org).

[32] Arms Control Association, "Nuclear Weapons: Who Has What at a Glance," last reviewed January 2022, last accessed on November 27, 2022, Nuclear Weapons: Who Has What at a Glance | Arms Control Association.

[33] United Nations Committee on the Peaceful Uses of Outer Space, "International Agreements Relating to Activities in Outer Space as of 1 January 2022," March 28, 2022, last accessed November 27, 2022, AAC105_C2_2022_CRP10E.pdf (unoosa.org).

[34] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security In Space 2019," page 7, last accessed November 27, 2022, Space_Threat_V14_020119_sm.pdf (dia.mil).

weapons, and conduct of military maneuvers on celestial bodies," and refers to UN Resolution 1884 that obligates states "to refrain from placing nuclear weapons and any other weapons of mass destruction (WMD) in space."[35] Article 9 of the Treaty provides for mediation by member nations who believe that an activity or experiment in space may cause harm to peaceful space exploration and use of space," and refers to UN Resolution 110 that "condemns provocation of threats in space."[36] The intent of the Outer Space Treaty to maintain the peaceful uses of space is now challenged by various interpretations of what constitutes peaceful uses, as well as what defines space weapons. This will be addressed in more detail in this research.

Five years after the 1963 PTBT, the U.S., U.K., Soviet Union, and France ratified the 1968 Nuclear Nonproliferation Treaty (NPT), and since its entry into force, four additional nations with nuclear weapons have ratified the Treaty: China, India, Israel, and Pakistan.[37] As of 2023, there are a total of 191 nations party to this Treaty, but not all party nations to this treaty have nuclear weapons. North Korea was briefly a party to the NPT from 1985 to 2003, this will be described in more detail in this research.[38]

Although not necessarily specific to weapons in space, but relevant to space warfare, the 1972 Convention on International Liability for Damage Caused by Space Objects "provides that a launching State shall be liable to pay compensation for damage caused by its space objects on the surface of the Earth or to aircraft, and liable for damage

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[35] U.S. National Aeronautics and Space Administration, "Outer Space Treaty of 1967," updated October 26, 2022, last accessed November 27, 2022, Outer Space Treaty of 1967 (nasa.gov).

[36] U.S. National Aeronautics and Space Administration, "Outer Space Treaty of 1967," updated October 26, 2022, last accessed November 27, 2022, Outer Space Treaty of 1967 (nasa.gov).

[37] Herzog, Stephen, 2022, "Beyond Nuclear Deterrence," Harvard Kennedy School Belfer Center for Science and International Affairs, October 14, 2022, last accessed November 27, 2022, Beyond Nuclear Deterrence | Belfer Center for Science and International Affairs.

[38] United Nations International Atomic Energy Agency, "Fact Sheet on DPRK Nuclear Safeguards," last accessed November 27, 2022, Fact Sheet on DPRK Nuclear Safeguards | IAEA.

due to its faults in space."[39] Today, this Convention is ratified by 98 nations with an additional 19 nations that are signatories but have yet to ratify it.[40] This Convention has been of recent focus given the increasingly crowded space domain, including inoperable satellites and debris in orbit. Collisions with space debris became a large concern in 2013 when a Russian satellite was destroyed by debris caused by the earlier 2007 satellite destruction by China of one of its inoperable satellites.[41]

The 1972 Anti-Ballistic Missile Treaty (ABM) between the U.S. and the Soviet Union was dissolved following the U.S. withdrawal in 2002. The basis for the U.S. withdrawal from the ABM was due to the fact that it prevented the U.S. from defending itself against ballistic missile attacks from rogue nations.[42] The U.S. withdrawal was not a surprising consequence following the Al-Qaeda attacks on the U.S. on September 11, 2001 and the U.S. desired the option to use ballistic missiles to retaliate against terrorist safe havens in Afghanistan.[43] The ABM Treaty included among other bans: 1) a ban on the development, testing, or deployment of sea, air, space, and mobile land-based ABM systems and components, 2) the deployment of radars capable of early warning of strategic ballistic missile attack anywhere other than on the periphery of U.S. or Russian territory and oriented outward, and 3) the deployment of ABM radars capable of tracking

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[39] United Nations Office for Outer Space Affairs, "Convention on International Liability for Damage Caused by Space Objects," last accessed November 27, 2022, Liability Convention (unoosa.org).

[40] United Nations Office for Outer Space Affairs, "Convention on International Liability for Damage Caused by Space Objects," last accessed November 27, 2022ARES_26_2777E.pdf (unoosa.org).

[41] Wall, Mike and Leonard Davis, 2013, "Russia Unlikely to Sue China Over Space Junk Satellite Crash," NBC News, March 12, 2013, last accessed November 27, 2022, Russia unlikely to sue China over space junk-satellite crash (nbcnews.com).

[42] Arms Control Association, "The Anti-Ballistic Missile (ABM) Treaty at a Glance," last reviewed December 2020, last accessed November 27, 2022, The Anti-Ballistic Missile (ABM) Treaty at a Glance | Arms Control Association.

[43] Lambakis, Steve, 2022, "Space as a Warfighting Domain: Reshaping Policy to Execute 21st Century Spacepower," July 6, 2022, Comparative Strategy, volume 41, number 4, (pp 331-369), page 332.

and discriminating incoming strategic targets and guiding defensive interceptors. As a result of the 2002 U.S. withdrawal from the ABM Treaty, the prohibition against "the development, deployment, and operation of a missile defense architecture using space-based sensors and weapons" was lifted for both the U.S. and Russia.[44]

Four years after the 1972 ABM Treaty entered into force, the 1976 Convention on Registration of Objects into Outer Space established a mechanism for member states to register their space objects.[45] Today, 71 nations are party to this Treaty, including the U.S., China, Russia, and North Korea, however, Iran is only a signatory to the Treaty.[46] While registered space objects increased 50 percent from 2020, the UN estimates that only 86 percent of all current objects in space are registered."[47][48] The positive upwards trend in registration indicates some compliance with the Registration Convention, but the UN registry pales in comparison to those tracked by the U.S. Space Command's (USSPACECOM) Situational Space Awareness (SSA) program, which has 45,000 objects cataloged in their registry as of April 2022.[49] This SSA program has information-sharing agreements with 30 countries and 119 non-government space entities, and their

[44] Lambakis, Steve, 2022, "Space as a Warfighting Domain: Reshaping Policy to Execute 21st Century Spacepower," July 6, 2022, Comparative Strategy, volume 41, number 4, (pp 331-369), page 332.

[45] United Nations Office for Outer Space Affairs, "Resolution Adopted by the General Assembly 3235 (XXIX), Convention on the Registration Launched into Outer Space," last accessed November 27, 2022, Registration Convention (unoosa.org).

[46] United Nations Committee for the Peaceful Uses of Outer Space, "Status of International Agreements Relating to Activities in Outer Space as of January 1, 2022," last accessed November 27, 2022, AAC105_C2_2022_CRP10E.pdf (unoosa.org).

[47] United Nations International Telecommunications Union, "ITU Space Explorer: Satellite Frequency at Your Fingertips," September 12, 2022, last accessed November 27, 2022, ITU SpaceExplorer: Satellite frequency data at your fingertips - ITU Hub.

[48] United Nations Office for Outer Space Affairs , "United Nations Register of Objects Launched into Outer Space," last accessed November 27, 2022, United Nations Register of Objects Launched into Outer Space (unoosa.org).

[49] U.S. Department of Defense, U.S. Space Force, 18th Space Defense Squadron, updated April 2022, last accessed November 27, 2022, 18th Space Defense Squadron > Space Base Delta 1 > Display (spaceforce.mil).

registry is available to the public.[505152] The European Space Agency (ESA) also maintains an SSA program and collaborates with the U.S., South Korea, and the UN.[53] According to the 2021 USSPACECOM Annual Report, 97 percent of adversaries' satellites in orbit are dual use.[54]

Two years after the 1976 Space Object Registration Convention, the 1978 Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) requires nations to "not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to another State party" and defines environmental modification technique as "any technique for changing, through the deliberate manipulation of natural processes, the dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere, atmosphere, and of outer space." [5556] Today, 78 nations are party to this Treaty, including U.S., China,

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[50] U.S. Department of Defense, U.S. Space Command, "USSPACECOM and Sweden Sign a Space Situational Awareness Sharing Agreement, April 2, 2022, last accessed November 27, 2022, USSPACECOM and Sweden sign a Space Situational Awareness sharing agreement > United States Space Command > Article Display.

[51] U.S. Department of Defense, U.S. Space Command, "USSPACECOM and Sweden Sign a Space Situational Awareness Sharing Agreement, April 2, 2022, last accessed November 27, 2022USSPACECOM and Sweden sign a Space Situational Awareness sharing agreement > United States Space Command > Article Display.

[52] Florick, Davis, Lina Cashin, Robert A. Sims, Jason Sturch, and Patrick Dozier, "Space Situational Awareness (SSA) Sharing for the 21st Century," Space Safety Magazine, June 25, 2013, last accessed November 27, 2022, Space Situational Awareness (SSA) Sharing for the 21st Century – (spacesafetymagazine.com).

[53] European Space Agency, "SSA Programme Overview," last accessed November 27, 2022, ESA - SSA Programme overview.

[54] U.S. Department of Defense, U.S. Space Command, "Annual Report 2021," page 13, last accessed November 27, 2022, USSPACECOM_MAG_2021_WEB.PDF (defense.gov).

[55] United Nations Office for Disarmament Affairs, "Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD)," last accessed November 27, 2022, Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) – UNODA.

[56] United Nations Office for Disarmament Affairs, "Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD)," last accessed November

Russia, and North Korea, however, Iran is only a signatory to the Treaty.[57][58] As Ramey argues, the restrictions in this Convention do not prevent the deployment of space weapons "as long as space weapons do not change the outer space environment through the deliberate manipulation of natural processes, and that the ENMOD Convention is not likely to bar the deployment or use of space weapons."[59]

Ten years following the 1978 ENMOD Convention, the 1988 Intermediate Range Nuclear Forces (INF) Treaty was signed by the U.S. and the Soviet Union. This Treaty banned all nuclear and conventional ground-launched ballistic and cruise missiles with ranges of 500 to 5,500 kilometers.[60] In 2014, Russia violated the Treaty after it developed a ground-launched cruise missile. Specifically, the Treaty banned the possession, production, and flight tests of ground-launched cruise missiles, as well as the ban on the possession and production of launchers of such missiles.[61] In response, the U.S. pulled out of the Treaty in 2019, soon thereafter followed by Russia. The U.S. further justified its withdrawal from the U.S.-Soviet/Russia INF Treaty claiming concerns over China's increased intermediate-range missile capabilities.[62] While China was never a party to the

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27, 2022, Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) – UNODA.

[57] United Nations Office for Disarmament Affairs, "Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD)," last accessed November 27, 2022, Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) – UNODA.

[58] United Nations Office for Disarmament Affairs, "Status of the ENOMD Treaty," January 12, 2022, last accessed November 27, 2022, UNTC.

[59] Ramey, Robert A., 2000, "Armed Conflict on the Final Frontier: The Law of War in Space," January 2000, Air Force Law Review, (pp 1-158), page 58.

[60] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 9, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[61] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 9, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[62] McKeon, James and Mark Malemed, "Engaging China to Reduce Nuclear Risks," Nuclear Threat Initiative, page 38, last accessed November 27, 2022, Engaging_China_to_Reduce_Nuclear_Risks_-_McKeon_Melamed_Excerpt.pdf (nti.org).

INF Treaty, China has refused U.S. attempts to negotiate a trilateral U.S.-Russia-China nuclear INF agreement.[63]

Just over 30 years after the PTBT, the 1997 Comprehensive Nuclear Test Ban Treaty (CTBT) also referred to by the acronym NTBT, was adopted by the UN but has not entered into force pending ratification by the remaining eight of the 44 nuclear-capable countries, China, Egypt, India, Iran, Israel, North Korea, Pakistan, and the U.S..[6465] Although these countries are signatories to the CTBT, North Korea, India, and Pakistan have not signed the CTBT.[66] The CTBT also bans the production of nuclear fissile material for anything other than peaceful use. The 2022 U.S. Nuclear Posture Review (NPR) states that the U.S. is committed to seeing the CTBT entered into force, emphasizing that "once the CTBT is entered into force, Russia and China would have an obligation to comply with the Treaty's "zero-yield" standard under which nuclear explosive tests are not permitted under the Treaty."[67]

In 2008, Russia submitted a draft treaty on the Prevention of an Arms Race in Space (PAROS) to the UN Conference on Disarmament as the first to provide specificity to the Outer Space Treaty. Also in 2008, both China and Russia submitted another draft treaty, Prevention of Placement of Weapons in Outer Space and The Threat or Use of

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[63] McKeon, James and Mark Malemed, "Engaging China to Reduce Nuclear Risks," Nuclear Threat Initiative, page 35, last accessed January 28, 2023, Engaging_China_to_Reduce_Nuclear_Risks_-_McKeon_Melamed_Excerpt.pdf (nti.org).

[64] Nuclear Threat Initiative, "Comprehensive Nuclear Test Ban Treaty," last reviewed April 30, 2022, last accessed November 27, 2022, Comprehensive Nuclear Test Ban Treaty (CTBT) (nti.org).

[65] Nuclear Threat Initiative, "Comprehensive Nuclear Test Ban Treaty (CTBT) Fact Sheet," September 2019, last accessed November 27, 2022, nti-factsheet-treaties--ctbt-02e.

[66] Nuclear Threat Initiative, "Comprehensive Nuclear Test Ban Treaty (CTBT) Fact Sheet," September 2019, last accessed November 27, 2022, nti-factsheet-treaties--ctbt-02e.

[67] U.S. President, U.S. Nuclear Posture Review 2022, page 18, last accessed November 27, 2022, 2022-Nuclear-Posture-Review.pdf.

Force Against Outer Space Objects (PPWT), later revised in 2014 by Russia.[68][69][70] Both draft treaties called for the prevention of placing other weapons besides already-prohibited weapons of mass destruction into space, as a means of aiming to prevent an arms race in space, both treaties remain pending in the UN Conference on Disarmament.[71] The U.S. refused to accept the terms in both the 2008 PAROS and the 2014 PPWT based on the lack of compliance verification mechanisms in these draft treaties.[72]

The U.S.-led 2020 Artemis Accords reinforce tenets of the Outer Space Treaty for the peaceful use of outer space, adding a clause addressing the deconfliction of space activities. The Artemis Accords specifically require party states to "commit to refraining from any intentional actions that may create harmful interference with each other's use of outer space in their activities, including the area wherein notification and coordination will be implemented to avoid harmful interference in a designated safety zone, the area in which nominal operations of a relevant activity could reasonably cause harmful interference."[73] The Accords require that party nations "commit to respect reasonable safety zones to avoid harmful interference with operations under the Accords, including by providing prior notification to and coordinating with each other before conducting

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[68] Space Security Index, "Space Security and the Conference on Disarmament," April 2020, last accessed November 27, 2022, Space Security and The Conference on Disarmament – Space Security Index.

[69] Nuclear Threat Initiative, "Paros Treaty," last accessed November 27, 2022, PAROS Treaty (nti.org).

[70] Listner, Michael and Rajeswari Pillai Rajagopalan, 2014, "The 2014 PPWT: a New Draft but with the Same and Different Problems," The Space Review, last accessed November 27, 2022, The Space Review: The 2014 PPWT: a new draft but with the same and different problems.

[71] Nuclear Threat Initiative, "Paros Treaty," last accessed November 27, 2022, PAROS Treaty (nti.org).

[72] Gertz, Bill, 2014, "U.S. Opposes New Draft Treaty from China and Russia Banning Space Weapons," Washington Free Beacon, June 19, 2014, last accessed November 27, 2022, U.S. Opposes New Draft Treaty from China and Russia Banning Space Weapons (freebeacon.com).

[73] U.S. National Aeronautics and Space Administration, "Artemis Accords," last accessed November 27, 2022, Artemis-Accords-signed-13Oct2020.pdf (nasa.gov).

operations in a safety zone."[74] As of October 2022, there are 21 party nations to the Artemis Accords: Australia, Bahrain, Brazil, Canada, Colombia, France, Israel, Italy, Japan, Luxembourg, Mexico, New Zealand, Poland, Romania, Saudi Arabia, Singapore, South Korea, Ukraine, United Arab Emirates, and the U.K. However, Iran, North Korea, China, Russia, Pakistan, and India are not party to the Artemis Accords.[75]

The 2021 Prohibition of Nuclear Weapons Treaty (TPNW) was entered into force in January 2021 and has 68 party nations and an additional 91 signatory nations.[76] The party nations and signatories to this Treaty do not have a nuclear weapons program. This Treaty prohibits the participation in all nuclear weapons activities, including "not to develop, test, produce, acquire, possess, stockpile, use or threaten to use nuclear weapons; prohibits the deployment of nuclear weapons on national territory and the provision of assistance to any nation in the conduct of prohibited activities; and obliges nations to prevent and suppress any activity prohibited under the TPNW undertaken by persons or on territory under its jurisdiction or control.[77] The TPNW poses complications for nations that want to enter into a defense alliance with a nuclear power or if a nuclear power seeks basing or port calls with a nation party to the TPNW, in which "stationing, installation or deployment of any nuclear weapons or other nuclear explosive devices in its territory or at any place under its jurisdiction or control" is prohibited under the

[74] U.S. National Aeronautics and Space Administration, "Artemis Accords," last accessed November 27, 2022, Artemis-Accords-signed-13Oct2020.pdf (nasa.gov).

[75] U.S. Department of State, "Celebrating Two Years of the Artemis Accords," October 13, 2022, last accessed November 27, 2022, Celebrating Two Years of the Artemis Accords - United States Department of State.

[76] United Nations Officer for Disarmament Affairs, "Treaty on the Prohibition of Nuclear Weapons," last accessed November 27, 2022, UNODA Treaties.

[77] United Nations Office for Disarmament Affairs, "Treaty on the Prohibition of Nuclear Weapons," last accessed November 27, 2022, Treaty on the prohibition of nuclear weapons – UNODA.

TPNW.[78] Several island nations in the South Pacific and in Southeast Asia are members, potentially complicating the U.S. nuclear deterrence strategy against China and North Korea.

The 2021 extension of the New START Treaty, originally signed by the U.S. and the Soviet Union in 1991, further limits the number of strategic warheads and delivery systems for both the U.S. and Russia.[79][80] The 1991 START Treaty was later revised in 2000 for another 10 years, renamed START II, but after the U.S. Senate refused to ratify it combined with the 2002 U.S. withdrawal from the ABM Treaty, Russia dissolved its commitment to the START II Treaty.[81] By 2011, the 10-year New START Treaty was signed and ratified by the U.S. and Russia and was renewed in 2021 for an additional five years, which will end in 2026.[82][83] Nonstrategic nuclear weapons are not covered by the renewed 2021 New START treaty, in which "Russia currently has an active stockpile of up to 2,000 of these weapons."[84] Nonstrategic weapons are generally categorized as nuclear weapons not delivered by an intercontinental ballistic missiles (ICBM),

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[78] United Nations Treaty on the Prohibition of Nuclear Weapons, January 22, 2021, last accessed on March 3, 2023, UNODA Treaties.

[79] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 10, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[80] U.S. Department of State, "Strategic Defense Initiative (SDI), 1983," last accessed November 27, 2022, Strategic Defense Initiative (SDI), 1983 (state.gov).

[81] Nuclear Threat Initiative, "START II," last reviewed January 29, 2021, last accessed November 27, 2022, START II (nti.org).

[82] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 11, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[83] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 16, last accessed November 27, 2022, 2022-Nuclear-Posture-Review.pdf.

[84] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 11, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

submarine-launched ballistic missiles (SLBM), and heavy aircraft bombers, nonstrategic weapons may include nuclear mines, artillery, and torpedoes.[85]

While the treaties addressed in this research were designed for peaceful use of outer space, there are new calls for specificity in what constitutes peaceful use of outer space and clarity on what defines a space weapon. Existing space treaties do not prohibit 1) the use of military personnel in space, 2) the use of space-based remote sensors in support of combat or other military purposes, 3) the use of space-based communication, navigation, and meteorological systems for combat or other military purposes, 4) the deployment and non-aggressive use of conventional space weapons, and 5) the transiting of nuclear or other weapons of mass destruction in non-orbital trajectories.[86] However, as a point of clarification to nuclear powered space objects, nuclear power is commonly used to power space systems, and the UN recognized this in its 1992 Principles Relevant to the Use of Nuclear Power Sources in Outer Space (NPS Principles) and the UN International Atomic Energy Agency (IAEA) issued the Safety Framework for Nuclear Power Source Applications in Outer Space in 2009.[87]

In tandem with space treaties, nuclear treaties need to be updated to meet the technological delivery systems that can deliver payloads faster, more accurately, and more conspicuously. Additionally, the U.S. must engage with China on nuclear issues, because "China's nuclear and missile defense program is developing beyond a defensive posture, and there is an increasing risk that the U.S. and China, along with Russia, will

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[85] Center for Arms Control and Nonproliferation, "Fact Sheet: U.S. Nonstrategic Nuclear Weapons," updated March 2022, last accessed March 3, 2023, Fact Sheet: United States Nonstrategic Nuclear Weapons - Center for Arms Control and Non-Proliferation (armscontrolcenter.org).

[86] Ramey, Robert A., 2000, "Armed Conflict on the Final Frontier: The Law of War in Space," January 2000, Air Force Law Review, (pp 1-158), page 157.

[87] United Nations Office for Outer Space Affairs, "Nuclear Power Sources," last accessed November 27, 2022, Topics: NPS (unoosa.org).

enter further into a dangerous and destabilizing hypersonic weapon arms race."[88] Lastly, reinvigorating negotiations on the proposed 1995 Fissile Material Cutoff Treaty (FMCT), which remains pending in the UN Conference on Disarmament, would impose new restrictions on the eight nations with nuclear weapons that are party to the NPT, taking into account that North Korea is no longer a party to the NPT.[89][90] While the U.S. has maintained a unilateral moratorium on the production of fissile material for use in nuclear weapons since the early 1990s, the U.S. continues to encourage all nuclear-capable countries to also declare a unilateral moratorium.[91]

Chapter 3: International Space Cooperation

One year after the Soviet Union launched its first satellite into space in 1957, the UN Office for Outer Space Affairs (UNOOSA) was formed in 1958 and adopted its first resolution addressing the peaceful use of space in December 1958.[92] UNOOSA oversees the UN Committee on the Peaceful Uses of Outer Space (COPUOS), formed a year later in 1959, and was responsible for creating the current five space treaties.[93] In 1962, UNOOSA began a registry of objects launched into outer space and in 1976 and the UN General Assembly adopted UN Resolution 3235, the Convention on Registration of

[88] McKeon, James and Mark Melamed, "Engaging China to Reduce Nuclear Risks," Nuclear Threat Initiative, page 40, last accessed November 27, 2022, Engaging_China_to_Reduce_Nuclear_Risks_-_McKeon_Melamed_Excerpt.pdf (nti.org).

[89] Arms Control Association, "Fissile Material Cut-Off Treaty (FMCT) at a Glance," June 2018, last accessed November 27, 2022, Fissile Material Cut-off Treaty (FMCT) at a Glance | Arms Control Association.

[90] Arms Control Association, "Fissile Material Cut-Off Treaty (FMCT) at a Glance," June 2018, last accessed November 27, 2022, Fissile Material Cut-off Treaty (FMCT) at a Glance | Arms Control Association.

[91] U.S. President, "Nuclear Posture Review 2022," page 19, 2022-Nuclear-Posture-Review.pdf.

[92] United Nations Office for Outer Space Affairs, last accessed November 27, 2022, UNOOSA.

[93] United Nations Office for Outer Space Affairs, Committee on the Peaceful Uses of Outer Space, last accessed November 27, 2022, COPUOS (unoosa.org).

Objects into Outer Space.[9495] Since its founding in 1959 by the U.S. and the Soviet Union, member nations in COPUOS have grown to 100, with China joining in 1980. COPUOS also oversees the UN Space-based Platform on Information for Disaster Management and Emergency Response program (UN-SPIDER) founded in 2006.[96]

The International Space Station (ISS) celebrated its 20th anniversary in 2020 and has hosted 240 astronauts from 19 countries in its 20 years in space.[97] The principal members of the ISS are: U.S., Russia, Japan, Canada, and the European Space Agency (ESA). However, the ISS will be retired in 2031 with no plans for a second ISS.[98] China's space station, the Tiangong, was completed in late 2022.[99100101] Russia also aims to launch a space station in 2030.[102]

The European Space Commission (ESC) operates under the auspices of the European Union (EU) and is the governing body that formulates and implements EU

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[94] United Nations Office for Outer Space Affairs, "United Nations Register of Objects Launched into Outer Space," last accessed November 27, 2022, United Nations Register of Objects Launched into Outer Space (unoosa.org).

[95] United Nations Office for Outer Space Affairs, "Resolution Adopted by the General Assembly 3235 (XXIX) Convention on Registration of Objects Launched into Outer Space," last accessed November 27, 2022, Registration Convention (unoosa.org).

[96] United Nations Office for Outer Space Affairs, "UN-SPIDER Knowledge Portal," last accessed November 27, 2022, Startpage | UN-SPIDER Knowledge Portal.

[97] U.S. National Aeronautical and Space Administration, "20 Years on the International Space Station," last accessed November 27, 2022, skye (nasa.gov).

[98] Hunt, Katie, 2022, "The International Space Station to be Retired and Crashed into the Pacific Ocean," CNN, February 2, 2022, last accessed November 27, 2022, The International Space Station to be retired and crashed into the Pacific Ocean | CNN.

[99] Jones, Andrew, 2023, "China to Send Two Astronaut Crews, One Cargo Ship to Tiangong Space Station This Year," Space.com, February 19, 2023, last accessed March 3, 2023, China to send 2 crews, 1 cargo ship to Tiangong space station in 2023 | Space.

[100] Jones, Andrew, 2021, "China's Tiangong Space Station," Space.com, August 24, 2021, last accessed November 27, 2022, China's Tiangong space station | Space.

[101] David, Leonard, 2018, "China's Space Station Will be Open to Science from All UN Nations," Space.com, May 29, 2018, last accessed November 27, 2022, China's Space Station Will Be Open to Science from All UN Nations | Space.

[102] Jenkins, Cameron, 2021, "Russia Says It Will Launch Own Space Station After Leaving ISS," The Hill, April 23, 2021, last accessed November 27, 2022, Russia says it will launch own space station after leaving ISS | The Hill.

policies on outer space. All 27 EU member nations have a designated commissioner assigned to the ESC to address space policies to enhance economic, health, environmental, and communication interests but has not yet addressed policy matters on space weapons and space warfare.[103] Also under the EU, the European Space Agency (ESA) is comprised of 22 nations and collaborates with the ESC to develop and deploy systems in space.[104] In 2016, the ESA built and launched Galileo, an independent global satellite navigation system for Europe.[105] ESA is similar to the U.S. equivalent, National Aeronautics and Space Administration (NASA), focusing on space exploration, research, and crewed space missions.[106]

The North Atlantic Treaty Organization's (NATO) Space Program made great strides in addressing space as a warfighting domain in 2019 when it released its first space policy, declaring space as an operational domain and that attacks to, from, and within outer space that threaten NATO member assets and interests may invoke Article 5 of the NATO Treaty.[107] NATO currently has a space center at Allied Air Command in Ramstein, Germany, and has plans to develop a strategic space situational awareness system at NATO headquarters to support the Allied Air Command in Ramstein.[108][109]

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[103] European Commission, Defense Industry and Space, "What the Commission is Doing," last accessed November 27, 2022, Space | European Commission (europa.eu).

[104] European Space Agency, last accessed November 27, 2022, European Space Agency (esa.int).

[105] European Space Agency, last accessed November 27, 2022, European Space Agency (esa.int).

[106] European Space Agency, last accessed November 27, 2022, European Space Agency (esa.int).

[107] North Atlantic Treaty Organization, "NATO's Approach to Space," last updated October 6, 2022, last accessed November 27, 2022, NATO - Topic: NATO's approach to space.

[108] North Atlantic Treaty Organization, "NATO's Approach to Space," last updated October 6, 2022, last accessed November 27, 2022, NATO - Topic: NATO's approach to space.

[109] North Atlantic Treaty Organization, "NATO and Luxembourg Boost Alliance Space Situational Awareness," last updated June 15, 2021, last accessed November 27, 2022, NATO - News: NATO and Luxembourg boost Alliance Space Situational Awareness, 14-Jun.-2021.

The UN International Telecommunication Union (ITU) was founded in 1865 to facilitate international connectivity in global communications networks, nearly 30 years after the electromagnetic telegraph was invented in 1837, but nearly 10 years before the telephone was invented in 1876.[110] The ITU allocates global radio spectrum satellite orbits, develops technical standards for global interconnectivity, and is responsible for maintaining and periodically updating the Radio Regulations Treaty that regulates radio communication services and the utilization of radio frequencies worldwide.[111][112] The ITU is relevant in the discourse of space warfare because foreign militaries monitor ITU regulatory updates to avoid signal interference with the commercial spectrum regulated by the ITU.[113]

In February 2022, the U.S., Australia, Canada, France, Germany, New Zealand, and the U.K. released a strategy to "foster responsible military behaviors in space and prevent conflicts extending to and originating in space" called the Combined Space Operation Vision 2031 (CSpO).[114] Its vision is to "seek and prepare to protect and defend against hostile space activities in accordance with applicable international law."[115] And its objectives are: to prevent conflicts, information sharing, establish an interoperable

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[110] United Nations International Telecommunications Union, last accessed November 27, 2022, ITU: Committed to connecting the world.

[111] United Nations International Telecommunications Union, "Managing Radio Frequency Spectrum Amid a New Space Race," November 12, 2021, last accessed November 27, 2022, Managing radio frequency spectrum amid a new space race - ITU Hub.

[112] United Nations International Telecommunications Union, "ITU Space Explorer: Satellite Frequency Data at Your Fingertips," September 12, 2022, last accessed November 27, 2022, ITU SpaceExplorer: Satellite frequency data at your fingertips - ITU Hub.

[113] Ramey, Robert A., 2000, "Armed Conflict on the Final Frontier: The Law of War in Space," January 2000, Air Force Law Review, (pp 1-158), pages 118-119.

[114] U.S. Department of Defense, "DOD and Partners Release Combined Space Operations Vision 2031," February 22, 2022, last accessed November 27, 2022, DoD and Partners Release Combined Space Operations Vision 2031 > U.S. Department of Defense > Release.

[115] U.S. Department of Defense, "Combined Space Operations Vision 2031," last accessed November 27, 2022, Combined Space Operations Vision 2031 (defense.gov).

space infrastructure, and defense and protection of national interests in space.[116] One of its lines of effort is to foster responsible military behaviors in space.[117] Thus far, there have not been further developments beyond the vision document.

The Group on Earth Observations (GEOSS), started in 2005, is comprised of 114 nations that work to integrate Earth Observation data-sharing through members' space systems.[118] The U.S. participates in GEOSS through the Federal Geographic Data Committee, chaired by the U.S. Secretary of the Interior, and whose participants include U.S. government agencies with geospatial activities in their agencies.[119] China, Iran, and Russia are also members of GEOSS, but North Korea is not a member.[120]

The UN Office for Disarmament Affairs (UNODA) was founded in 1982 and oversees the UN Conference on Disarmament (CD). The 65-member nation CD focuses on the prevention of an arms race in outer space, among other nuclear disarmament-related matters, through consensus.[121][122]

The Asia Pacific Space Cooperation Organization (APSCO), led by China, oversees a space surveillance project known as the Asia-Pacific Ground-Based Optical Space Object Observation System (APOSOS). As part of the project, China provided

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[116] U.S. Department of Defense, "Combined Space Operations Vision 2031," last accessed November 27, 2022, Combined Space Operations Vision 2031 (defense.gov).

[117] U.S. Department of Defense, "Combined Space Operations Vision 2031," last accessed November 27, 2022, Combined Space Operations Vision 2031 (defense.gov).

[118] Group on Earth's Observations, last accessed November 27, 2022, last accessed November 27, 2022, GEO (earthobservations.org).

[119] U.S. Federal Geographic Data Committee, last accessed November 27, 2022, last accessed November 27, 2022, The Federal Geographic Data Committee — Federal Geographic Data Committee (fgdc.gov).

[120] Group on Earth's Observations Members, last accessed November 27, 2022, last accessed November 27, 2022, GEO Member Countries (earthobservations.org).

[121] United Nations Office for Disarmament Affairs, Conference on Disarmament, last accessed November 27, 2022, Conference on Disarmament – UNODA.

[122] United Nations Office for Disarmament Affairs, Conference on Disarmament, "History," last accessed November 27, 2022, About Us – UNODA.

telescopes to Iran, Pakistan, and Peru that can track objects in low Earth orbit and geosynchronous Earth orbit.[123] All tasked data collection from these telescopes and all subsequent observational data is sent to the Chinese Academy of Science's National Astronomical Observatory of China.[124] APSCO maintains ground stations in Argentina, Australia, Brazil, Canada, Chile, Ethiopia, France, Greenland, Kenya, Kiribati, Namibia, Norway, Pakistan, South Africa, Spain, and Sweden, as well as four sites in Antarctica. Current members of APSCO are Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey.[125]

The International Scientific Optical Network (ISON), led by Russia, is the largest foreign network of ground-based optical space surveillance sensors, approximately 100 ground-based optical sensors across 16 countries: Australia, Bolivia, China, Georgia, Germany, Italy, Kyrgyzstan, Mexico, Moldova, Mongolia, Spain, Switzerland, the U.S., Uzbekistan, four locations in Ukraine, and seven locations throughout Russia.[126][127]

Not only is U.S. diplomacy on space matters critical in the UN, but the U.S. Department of State Office of Space Affairs, the Department of State Bureau of International Security and Nonproliferation, and the Bureau of Arms Control Verification and Compliance are key stakeholders in the execution of diplomatic priorities in the

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[123] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022," page 16, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[124] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022," page 16, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[125] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022," page 16, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[126] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022, page 27, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[127] United Nations Office for Outer Space Affairs, "International Scientific Optical Network (ISON)," last accessed November 27, 2022, Презентация PowerPoint (unoosa.org).

Space Priorities Framework issued by the White House in December 2021.[128][129][130] Furthermore, the Department of State oversees bilateral space treaties with the ESA, Germany, and Japan.[131] Increasingly, the Department of State advocates for peaceful uses of outer space and appears on major bilateral and multilateral agendas, particularly in advocating for nations to join the Artemis Accords, initially signed by the U.S. and seven other nations, and now with a total of 21 party nations.[132] Outer space issues were amplified in 2022, including the U.S. Secretary of State's public statement on the "peaceful uses of outer space" at the February 2022 Quad Cooperation meeting alongside the governments of Australia, India, and Japan.[133] Additionally, USSPACECOM announced in April 2022 that Space Attachés will soon be staffed at key U.S. Embassies.[134]

Chapter 4: U.S. Government Response to Space Warfare and Nuclear EMPs

USSPACECOM was created in 1982 and originally fell under the authority of the U.S. Air Force, and in 2002, it was merged with the newly created U.S. Strategic

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[128] U.S. Department of State, Office of Space Affairs, last accessed November 27, 2022, Office of Space Affairs - United States Department of State.

[129] U.S. Department of State, Bureau of International Security and Nonproliferation, last accessed November 27, 2022, Bureau of International Security and Nonproliferation - United States Department of State.

[130] U.S. Department of State, Bureau of Arms Control, Verification, and Compliance, last accessed November 27, 2022, Bureau of Arms Control, Verification and Compliance - United States Department of State.

[131] U.S. Department of State, "Treaties in Force Supplement 2020-2021," last accessed November 27, 2022, TIF-Supplement-2022.pdf (state.gov).

[132] U.S. Department of State, "First Meeting of the Artemis Accords Signatories," September 19, 2022, last accessed November 27, 2022, First Meeting of Artemis Accords Signatories - United States Department of State.

[133] U.S. Department of State, "Joint Statement on Quad Cooperation in the Indo-Pacific," February 11, 2022, last accessed November 27, 2022, Joint Statement on Quad Cooperation in the Indo-Pacific - United States Department of State.

[134] Hadley, Greg, 2022, "Space Force Looks to Put Space Attaches in Embassies," Air and Space Forces Magazine, April 1, 2022, last accessed November 27, 2022, Space Force Looks to Put Space Attaches in Embassies | Air & Space Forces Magazine (airandspaceforces.com).

Command (USSTRATCOM).[135] The timing of this merger followed earlier efforts to examine the U.S. role in space defense that started with the 2001 Space Commission, established by the U.S. Congress, that identified the need for a more unified approach to space within the Department of Defense.[136][137][138] By 2019, USSPACECOM was moved out from under USSTRATCOM and declared the 11th Unified Combatant Command, along with the 2019 creation of the U.S. Space Force (USSF).[139][140][141]

The 1983 Reagan administration's Strategic Defense Initiative (SDI) was a strategy to strengthen the U.S.' role in deterring war in space.[142] However, the SDI program was a concern for the Soviet Union and Gorbachev felt it was antithetical to the INF and START treaties. While the Soviet Union finally agreed to the INF Treaty, only after Reagan agreed to delink defense and intermediate-range forces from the Treaty, the START treaty was not signed by the Soviet Union until 1991 during the George H.W.

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[135] U.S. Department of Defense, U.S. Strategic Command, "History," current as of January 2018, last accessed November 27, 2022, History (stratcom.mil).

[136] U.S. National Aeronautical and Space Administration, "Report of the Commission to Assess U.S. National Security Space Management and Organization, Executive Summary," January 11, 2001, last accessed November 27, 2022, o45795427.pdf (nasa.gov).

[137] U.S. Department of Defense, "Secretary Rumsfeld Announces Major National Security Space Management and Organizational Initiative, May 8, 2001, last accessed November 27, 2022, SecDef Announces Major Nat'l. Security Space Mgmt. and Organizational Initiative (fas.org).

[138] U.S. Government Accountability Office, "Defense Space Activities: Organizational Changes Initiated, but Further Management Actions Needed," April 2003, last accessed November 27, 2022, GAO-03-379 Defense Space Activities: Organizational Changes Initiated, but Further Management Actions Needed.

[139] U.S. Department of Defense, U.S. Air Force, U.S. Air Force Space Command, "History," last accessed November 27, 2022, AFSPC History.

[140] U.S. Department of Defense, "Department of Defense Establishes U.S. Space Command," August 29, 2019, last accessed November 27, 2022, Department of Defense Establishes U.S. Space Command > U.S. Department of Defense > Release.

[141] U.S. Department of Defense, U.S. Space Force, "History," last accessed November 27, 2022, History (spaceforce.mil).

[142] U.S. Department of State, "Strategic Defense Initiative (SDI), 1983," last accessed November 27, 2022, Strategic Defense Initiative (SDI), 1983 (state.gov).

Bush administration.[143][144] During his administration, George H.W. Bush took the SDI program further when he initiated the Brilliant Pebbles space-based interceptor system under the Global Protection Against Limited Strikes (GPALS) program, but this was later dissolved and re-programmed in 1993 as the Ballistic Missile Defense Organization (BMDO).[145] In 2002, the BMDO was renamed the Missile Defense Agency under the U.S. Department of Defense.[146]

The EMP Commission, created in the 2001 National Defense Authorization Act (NDAA), submitted its final report to Congress in 2019.[147] The Commission researched both the impacts of natural EMP occurrences and nuclear EMP detonations in the atmosphere.[148] The Commission produced both classified and unclassified reports, and the U.S. Congress held numerous public hearings in both the House of Representatives and the Senate since 2001. In the 2014 House of Representatives hearing, Congressman Scott Perry stated that "the nations of Russia and China have the technology to launch an EMP attack, and it is speculated that Iran and North Korea may be developing EMP

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[143] U.S. Department of State, "Strategic Defense Initiative (SDI), 1983," last accessed November 27, 2022, Strategic Defense Initiative (SDI), 1983 (state.gov).

[144] U.S. Department of the Interior, National Park Service, "Strategic Arms Reduction Treaty of 1991," last updated October 20, 2020, last accessed November 27, 2022, Strategic Arms Reduction Treaty of 1991 (U.S. National Park Service) (nps.gov).

[145] Cooper, Henry F., 2018, "President George H.W. Bush's Gift to the SDI Program," December 3, 2018, Newsmax, last accessed November 27, 2022, President George H. W. Bush's Gift to the SDI Program | Newsmax.com.

[146] U.S. Department of Defense, Missile Defense Agency, "History," last updated April 8, 2021, last accessed November 27, 2022, MDA History.

[147] U.S. Congress, U.S. House of Representatives, Committee on Homeland Security, Sub-Committee on Cyber-Security, Infrastructure Protection, and Security Technology, "House Hearing: Electromagnetic Pulse (EMP): Threat to Critical Infrastructure," May 8, 2014, last accessed November 27, 2022, ELECTROMAGNETIC PULSE (EMP): THREAT TO CRITICAL INFRASTRUCTURE | Congress.gov | Library of Congress.

[148] U.S. Commission to Assess the Threat to the U.S. from Electromagnetic Pulse (EMP) Attack, last accessed November 27, 2022, Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack (empcommission.org).

weapons technology."[149] In that same hearing, Peter Pry testified that "EMP technology is a clear and present danger, and during the 2013 nuclear crisis with North Korea in which Kim Jong-un's threatened nuclear strikes against the U.S., Pyongyang apparently practiced an EMP attack with a satellite that passed over the Washington, D.C.-New York City corridor."[150] In a subsequent House of Representatives hearing in 2017, Peter Pry again testified that a second North Korean satellite orbited over the U.S. in 2017 that evaded U.S. detection systems.[151] In a companion hearing in the U.S. Senate also in 2017, Ambassador Henry Cooper testified that "EMP attacks are known to be included in the doctrine and planning of Russia, China, North Korea, and Iran, indicating that these nations have information on how to build low-yield EMP weapons whose effects are similar to that of a high-yield nuclear weapon and that both Iran and North Korea could deliver an EMP attack on the U.S. via a nuclear payload carried by one of their satellites as it passes over the U.S.."[152]

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[149] U.S. Congress, U.S. House of Representatives, Committee on Homeland Security, Sub-Committee on Cyber-Security, Infrastructure Protection, and Security Technology, "House Hearing: Electromagnetic Pulse (EMP): Threat to Critical Infrastructure," May 8, 2014, last accessed November 27, 2022, ELECTROMAGNETIC PULSE (EMP): THREAT TO CRITICAL INFRASTRUCTURE | Congress.gov | Library of Congress.

[150] U.S. Congress, U.S. House of Representatives, Committee on Homeland Security, Sub-Committee on Cyber-Security, Infrastructure Protection, and Security Technology, "House Hearing: Electromagnetic Pulse (EMP): Threat to Critical Infrastructure," May 8, 2014, last accessed November 27, 2022, ELECTROMAGNETIC PULSE (EMP): THREAT TO CRITICAL INFRASTRUCTURE | Congress.gov | Library of Congress.

[151] U.S. Congress, U.S. House of Representatives, Committee on Homeland Security, Subcommittee on Oversight and Management Efficiency, "House Hearing: Empty Threat or Serious Danger: Assessing North Korea's Risk to the Homeland," Statement for the Record, page 4, October 12, 2017, last accessed November 27, 2022, HHRG-115-HM09-Wstate-PryP-20171012.pdf (house.gov).

[152] U.S. Congress, U.S. Senate Committee on Energy and Natural Resources, "Hearing on the Threat Posed by Electromagnetic Pulse and Policy Options to Protect Energy Infrastructure and to Improve Capabilities for Adequate System Restoration," May 4, 2017, last accessed November 27, 2022, S.Hrg. 115-284 — THE THREAT POSED BY ELECTROMAGNETIC PULSE AND POLICY OPTIONS TO PROTECT ENERGY INFRASTRUCTURE AND TO IMPROVE CAPABILITIES FOR ADEQUATE SYSTEM RESTORATION | Congress.gov | Library of Congress.

The U.S. National Space Council was re-established in 2017 by the Trump administration following a 25-year hiatus after it was dissolved in 1993.[153][154] By 2020, the White House released its National Space Strategy, updated from the previous 2010 National Space Strategy released by the Obama administration.[155][156] The on-and-off history of the Space Council dates back to its first iteration from 1958 to 1973 under NASA, and again from 1989 to 1993 under the White House.[157]

The Defense Intelligence Agency (DIA) published its first Challenges to Security in Space report in 2019 as a result of increasing threats in space by China, Russia, Iran, and North Korea.[158] The 2022 DIA Challenges to Security in Space Report states that Russia's and China's combined operational space fleets have grown 70 percent from 2019-2021, following a 200 percent increase from 2015-2018, whereas Iran and North Korea are focused on denying and degrading the U.S.' space-based platforms through electronic warfare technologies.[159] Preceding these DIA reports, the Department of Defense and the Office of the Director of National Intelligence (DNI) jointly published a

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[153] Lambakis, Steve, 2022, "Space as a Warfighting Domain: Reshaping Policy to Execute 21st Century Spacepower, July 6, 2022, Comparative Strategy, volume 41, number 4, (pp 331-369), page 342.

[154] Clark, Stephen, 2017, "Trump Signs Order Reviving Long-Dormant National Space Council," Space Flight Now, June 30, 2017, last accessed November 27, 2022, Trump signs order reviving long-dormant National Space Council – Spaceflight Now.

[155] U.S. President, "National Space Policy 2020, last accessed November 27, 2022, National-Space-Policy.pdf (archives.gov).

[156] U.S. President, "National Space Policy 2010, last accessed November 27, 2022, national_space_policy_6-28-10.pdf (archives.gov).

[157] Clark, Stephen, 2017, "Trump Signs Order Reviving Long-Dormant National Space Council," Space Flight Now, June 30, 2017, last accessed November 27, 2022, Trump signs order reviving long-dormant National Space Council – Spaceflight Now.

[158] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022," page iii, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[159] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022," pages iii-iv, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

National Security Space Strategy in 2011, but no updated strategy has been published since then.[160]

Other key U.S. government reports address the threat posed by nuclear EMPs, such as the U.S. NPR and the DNI Global Trends Report. The NPR has been published by each administration since 1994, and the latest NPR, published in October 2022, emphasized the importance for the U.S. to harden electronic systems against EMP threats.[161] The DNI Global Trends report has been published every four years since 1997. The latest report, issued in March 2021, titled Global Trends 2040, states that "national space assets will be particularly coveted as the U.S. government remains concerned about the possibility that commercial or government space services could be denied in conflict."[162] The earlier 2012 DNI report, titled Global Trends 2030, stated "countries with nuclear weapons could be tempted to explode a nuclear device to wipe out their opponent's ability to maintain connectivity, and that many current systems will not survive a hostile electromagnetic or radiated environment."[163]

In 2019, the White House issued an executive order (EO) to address the threat of EMP attacks against the U.S..[164] This EO elevated EMP issues under the jurisdiction of the National Security Council's Office of Science and Technology, and issued directives

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[160] U.S. Office of the Director of National Intelligence, 2011 National Security Space Strategy, last accessed November 27, 2022, National Security Space Strategy (dni.gov).

[161] U.S. President, "Nuclear Posture Review 2022," page 22 and 24, last accessed November 27, 2022, 2022-Nuclear-Posture-Review.pdf.

[162] U.S. Office of the Director of National Intelligence, "Global Trends 2040," March 2021, page 62, last accessed November 27, 2022, Office of the Director of National Intelligence - Global Trends (dni.gov).

[163] U.S. Office of the Director of National Intelligence, "Global Trends 2030," December 2012, page 67, last accessed November 27, 2022, Global Trends 2030 (dni.gov).

[164] U.S. President, Executive Order 13865, "Coordinating National Resilience to Electromagnetic Pulse," Code of Federal Regulations, 84 FR 12041, March 26, 2019, pages 12041-12046, last accessed November 27, 2022, Federal Register :: Coordinating National Resilience to Electromagnetic Pulses.

to the U.S. Department of State and Defense.[165] The EO directs the U.S. Department of Defense to "provide early warning and identification of an EMP, including one affecting our space systems, and to conduct research and share technical expertise with other agencies, and designated the Department of State as the lead in all EMP efforts in coordination with our allies."[166]

Since its founding in 1998, the Defense Threat Reduction Agency (DTRA) contributed to the Department of Defense's space mission through the study of radiation effects on satellites in low earth orbit and continues to develop methods of hardening satellites against the effects of a potential nuclear explosion in space.[167] The Department of Defense Missile Defense Agency deploys systems to sense and intercept missile launches that threaten the U.S..[168] The U.S. Department of Energy (DOE) also plays a key role in detecting nuclear detonations both in the atmosphere and in space since 1963, when the DOE first launched satellite detectors to monitor Soviet compliance with the 1963 Partial Test Ban Treaty.[169] The U.S. National Nuclear Administration (NNSA), in coordination with the U.S. Department of Homeland Security (DHS) deploys gamma ray

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[165] U.S. President, Executive Order 13865, "Coordinating National Resilience to Electromagnetic Pulses," Code of Federal Regulations, 84 FR 12041, March 26, 2019, pages 12041-12046, last accessed November 27, 2022, Federal Register :: Coordinating National Resilience to Electromagnetic Pulses.

[166] U.S. President, Executive Order 13865, "Coordinating National Resilience to Electromagnetic Pulses," Code of Federal Regulations, 84 FR 12041, March 26, 2019, pages 12041-12046, last accessed November 27, 2022, Federal Register :: Coordinating National Resilience to Electromagnetic Pulses.

[167] U.S. Department of Defense, Defense Threat Reduction Agency, "High Altitude Nuclear Detonations Against Low Earth Orbit Satellites, April 2001, pages 4, 8-14, 16, 22, 24, 26, 29, 31-32, last accessed November 27, 2022, ASCO HALEOS brief 2, for PA&E 17-04-01 (fas.org).

[168] U.S. Department of Defense, Missile Defense Agency, "The Ballistic Missile Defense System (BMDS)," last accessed November 27, 2022, MDA - The Ballistic Missile Defense System.

[169] U.S. Department of Energy, National Nuclear Security Administration, "NNSA Delivers Enduring Space-Based Nuclear Detonation Detection Capability," March 22, 2018, last accessed November 27, 2022, NNSA delivers enduring space-based nuclear detonation detection capability | Department of Energy.

detectors throughout the U.S..[170] The National Space Defense Center (NSDC), founded in 2015, is an interagency effort between the Department of Defense, the Intelligence Community (IC), and the commercial industry to develop tactics and doctrine to deal with potential attacks on space systems.[171][172]

Chapter 5: Potential Participants in a Space War Using Nuclear EMPs

Lastly, this research will cover the space weapons capabilities of Russia, China, North Korea, and Iran, specifically addressing their nuclear EMP weapons capabilities. The 2018 U.S. National Defense Strategy (NDS) was the first NDS that declared space a warfighting domain, and multiple U.S. government reports now dedicate attention to space warfare capabilities by Russia, China, North Korea, and Iran.[173] The 2022 NDS further emphasizes warfare in the space domain stating that space warfare potentially changes how kinetic conflict is defined, but also how space warfare will impact daily life.[174] The 2022 NDS adds that next generation nuclear command, control, and communications (NC3) will require resilient approaches from EMP threats.[175]

Russian military doctrine and authoritative writings demonstrate that Russia considers space as a warfighting domain and that "achieving supremacy in space will be a

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[170] U.S. Department of Energy, National Nuclear Security Administration, "Gamma Rays: Small But Mighty," April 15, 2017, last accessed November 27, 2022, Gamma Rays: small but mighty | Department of Energy.

[171] U.S. Congressional Research Service, "Space as a Warfighting Domain: Issues for Congress," August 10, 2021, page 1, last accessed November 27, 2022, IF11895 (congress.gov).

[172] U.S. Department of Defense, "New Joint Interagency Combined Space Operations Center to be Established," September 11, 2015, last accessed November 27, 2022, New Joint Interagency Combined Space Operations Center to be established > U.S. Department of Defense > Release.

[173] U.S. Department of Defense, "Summary of the National Defense Strategy 2018," page 3 and 6, last accessed November 27, 2022, Summary of the 2018 National Defense Strategy.

[174] U.S. Department of Defense, "2022 National Defense Strategy," page 4, last accessed March 3, 2023, 2022 National Defense Strategy, Nuclear Posture Review, and Missile Defense Review.

[175] U.S. Department of Defense, "2022 National Defense Strategy," page 22, last accessed March 3, 2023, U.S. Department of Defense, "2022 National Defense Strategy, Nuclear Posture Review, and Missile Defense Review

decisive factor in winning future conflicts."[176] While Russia continues to pursue space arms control agreements, Russia is developing counter-space capabilities, but there is no confirmation of nuclear EMP weapons development.[177] Furthermore, Russia's nuclear weapons doctrine appears to lower the threshold for first use, in that low-yield nuclear weapons could be used versus the high-yield nuclear weapons controlled under existing nuclear treaties to which Russia is a party to.[178] Unfortunately, Russia unexpectedly postponed its participation in the scheduled New START renewal negotiations that were set to begin on November 29, 2022.[179]

China has launched more rockets into space than any other country.[180] And, in a 2005 U.S. National Ground Intelligence Center (NGIC) classified report, later declassified in 2011, U.S. intelligence agencies reported that China was developing EMP weapons for use over Taiwan.[181] This declassified report described China's research into the altitude levels in which an EMP weapon would dismantle all electricity and electronics on the island of Taiwan while causing the least harm to humans.[182] The Report further suggests that China seeks to detonate an EMP weapon over Taiwan that

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[176] U.S. Department of Defense, "Challenges to Security in Space 2022," page 21, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[177] U.S. Department of Defense, "Challenges to Security in Space 2022," last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[178] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 10, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[179] Williams, Abigail and Phil McClausland, 2022, "Russia Postpones Nuclear Arms Control Negotiations with the U.S.," NBC News, November 28, 2022, last accessed December 1, 2022, Russia postpones nuclear arms control negotiations with the U.S. (nbcnews.com).

[180] Lambakis, Steve, 2022, "Space as a Warfighting Domain: Reshaping Policy to Execute 21st Century Spacepower, July 6, 2022, Comparative Strategy, volume 41, number 4, (pp 331-369), page 336.

[181] George Washington University, National Security Archive, "U.S. Intelligence Eyes Chinese Research into Space-Age Weapons," July 21, 2011, last accessed November 27, 2022, U.S. Intelligence Eyes Chinese Research into Space-Age Weapons (gwu.edu).

[182] George Washington University, National Security Archive, "U.S. Intelligence Eyes Chinese Research into Space-Age Weapons," July 21, 2011, last accessed November 27, 2022, U.S. Intelligence Eyes Chinese Research into Space-Age Weapons (gwu.edu).

would fall under the threshold for a U.S. military response, including a U.S. nuclear response.[183] In fact, the 2021 EMP Commission Report revealed that China's military doctrine considers EMP weapons as "deserving highest priority as the most likely kind of future warfare, and as a means of prevailing in a war against the U.S.."[184] China's hypersonic vehicles can reach optimal altitude for an EMP detonation, between 40 to 400 kilometers above sea level, which China first tested in 2021.[185][186][187] China also claims that its satellites can orbit over the U.S. undetected.[188] With regards to China's nuclear weapons capability, the U.S. assesses that "China maintains an operational nuclear warhead stockpile in the low hundreds and has the most active and diverse ballistic missile development program in the world, with 75 to 100 ICBMs capable of reaching U.S. territory."[189][190] In 2021, China launched approximately 135 ballistic missiles, equaling to more ballistic launches than the rest of the world combined.[191] And by 2035,

[183] George Washington University, National Security Archive, "U.S. Intelligence Eyes Chinese Research into Space-Age Weapons," July 21, 2011, last accessed November 27, 2022, U.S. Intelligence Eyes Chinese Research into Space-Age Weapons (gwu.edu).

[184] Pry, Peter Vincent, 2020, "China: EMP Threat, The People's Republic of China's Military Doctrine, Plans, and Capabilities for Electromagnetic Pulse Attack," June 10, 2020, last accessed November 27, 2022, Microsoft Word - CHINAempTHREAT2020logo.docx (centerforsecuritypolicy.org).

[185] Pry, Peter Vincent, 2020, "China: EMP Threat, The People's Republic of China's Military Doctrine, Plans, and Capabilities for Electromagnetic Pulse Attack," June 10, 2020, last accessed November 27, 2022, Microsoft Word - CHINAempTHREAT2020logo.docx (centerforsecuritypolicy.org).

[186] McNeill, Jena Baker and Richard Weitz, 2008, "Electromagnetic Pulse (EMP) Attack: A Preventable Homeland Security Catastrophe," Heritage Foundation, October 20, 2008, Electromagnetic Pulse (EMP) Attack: A Preventable Homeland Security Catastrophe | The Heritage Foundation.

[187] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022," last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[188] Pry, Peter Vincent, 2020, "China: EMP Threat, The People's Republic of China's Military Doctrine, Plans, and Capabilities for Electromagnetic Pulse Attack," June 10, 2020, pages 7-9, last accessed November 27, 2022, Microsoft Word - CHINAempTHREAT2020logo.docx (centerforsecuritypolicy.org).

[189] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 15, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[190] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 16, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[191] U.S. Department of Defense, Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2022," page VII, last accessed January 14, 2023, China Military Power Report (defense.gov).

the U.S. estimates that China's nuclear arsenal could reach 1,500 by 2035.[192] While China has been consistent with proclaiming its no-first-use policy, its rapid technological advancement to deliver nuclear weapons faster and more precisely concerns the U.S., but China has repeatedly rejected U.S. efforts to engage China on nuclear treaties claiming its arsenal is too small in comparison to the U.S. and Russia to be included in nuclear negotiations.[193][194]

The 2021 EMP Commission Report revealed that North Korea possesses nuclear EMP weapons and describes North Korea's three tests (2010, 2011, and 2012) of low-yield nuclear EMP weapons, weighing six to nine kilotons, but whose payload produced a large amount of gamma rays that jammed air traffic control systems, communications systems, and vehicles in South Korea.[195] This Report also cited a South Korean media report about a North Korean missile test detonated at 72 kilometers above sea level, which drew suspicion that it was testing a missile launch specifically to deliver a nuclear EMP weapon at an altitude that would have maximum effect on the power grid of its intended target.[196] As previously addressed in this research, the two North Korean satellites that orbited over the U.S. undetected by sophisticated U.S. detection systems demonstrate that North Korea has the capability and the intent to use a nuclear EMP

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[192] U.S. Department of Defense Annual Report to Congress, "Military and Security Developments Involving the People's Republic of China 2022," page 94, last accessed December 1, 2022, 2022 China Military Power Report (CMPR) (defense.gov).

[193] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 16, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[194] McKeon, James and Mark Melamed, "Engaging China to Reduce Nuclear Risks," Nuclear Threat Institute, page 35, last accessed November 27, 2022, Engaging_China_to_Reduce_Nuclear_Risks_-_McKeon_Melamed_Excerpt.pdf (nti.org).

[195] Pry, Peter Vincent, "North Korea: EMP Threat, North Korea's Capabilities for Electromagnetic Pulse (EMP) Attack," June 6, 2021, page 1, last accessed November 27, 2022, REPORTempthreatNK21A.pdf (emptaskforce.us).

[196] Pry, Peter Vincent, "North Korea: EMP Threat, North Korea's Capabilities for Electromagnetic Pulse (EMP) Attack," June 6, 2021, page 5, last accessed November 27, 2022, REPORTempthreatNK21A.pdf (emptaskforce.us).

weapons against the U.S..[197][198][199] North Korea is the world's foremost threat today having launched a record number of missiles in 2022.[200] In 2017, Kim Jung-un revealed in 2015 that North Korea developed a hydrogen bomb able to reach the U.S., and as recent as November 18, 2022, North Korea launched what it claims is a "new kind of ICBM."[201][202][203]

With assistance from North Korean missile technology, Iran has space launch vehicles to launch microsatellites into low Earth orbit.[204][205] Iran has four satellites in space, with the first launched by Russia in 2005, and the last two are Iran Revolutionary Guard Corps (IRGC) military satellites launched in 2020 and 2022.[206] Iran's counter-space capabilities appear to be limited to jamming communications and global positioning satellites, but there appears to be no evidence that Iran has developed nuclear

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[197] U.S. Department of Defense, Defense Intelligence Agency, "North Korea Military Power 2021," pages 23-24, last accessed November 27, 2022, NKMP.pdf (dia.mil).

[198] Pry, Peter Vincent, "North Korea: EMP Threat, North Korea's Capabilities for Electromagnetic Pulse (EMP) Attack," June 6, 2021, pages 5-6, last accessed November 27, 2022, REPORTempthreatNK21A.pdf (emptaskforce.us).

[199] Pry, Peter Vincent, "North Korea: EMP Threat, North Korea's Capabilities for Electromagnetic Pulse (EMP) Attack," June 6, 2021, last accessed November 27, 2022, REPORTempthreatNK21A.pdf (emptaskforce.us).

[200] Episkopos, Mark, 2022, "Inevitable Threat: North Korea Conducts Ballistic Missile Test," National Interest, November 17, 2022, last accessed November 27, 2022, 'Inevitable Threat': North Korea Conducts Ballistic Missile Test | The National Interest.

[201] Council on Foreign Relations, "North Korean Nuclear Negotiations 1985-2022," last accessed November 27, 2022, Timeline: North Korean Nuclear Negotiations (cfr.org).

[202] Hanna, Jason, Tim Hume, and James Griffiths, 2015, "North Korea Claims it has H-Bomb as UN Discusses Human Rights Abuses," CNN, December 12, 2015, last accessed November 27, 2022, North Korea claims it has hydrogen bomb - CNN.

[203] Bae, Gawon, Junko Ogura, Brad Lendon, and Rhea Mogul, 2022, "North Korea Claims Friday's Launch Was a New Kind of Intercontinental Ballistic Missile," CNN, November 18, 2022, last accessed November 27, 2022, North Korea claims Friday's launch was a 'new kind of intercontinental ballistic missile' | CNN.

[204] U.S. Department of Defense, Defense Intelligence Agency, "Challenges to Security in Space 2022," page 31, last accessed November 27, 2022, Challenges_Security_Space_2022.pdf (dia.mil).

[205] U.S. Department of Defense, Defense Intelligence Agency, "Iran Military Power 2019," page 37, last accessed November 27, 2022, Iran_Military_Power_LR.pdf (dia.mil).

[206] Krzyzaniak, John, 2022, "Part 1: Explainer – Iran's Space Program," U.S. Institute of Peace, August 9, 2022, last accessed November 27, 2022, Part 1: Explainer - Iran's Space Program | The Iran Primer (usip.org).

EMP weapons.[207] Despite Iran having ratified the NPT in 1970, by 2011 the U.S. Department of State reported that Iran's nuclear developments violate the NPT.[208][209][210] More concerning, the IAEA confirmed in 2019 that Iran exceed the limits on enriched uranium under the terms of the 2015 Joint Comprehensive Plan of Action (JCPOA).[211] Under the JCPOA, Iran agreed "not to seek, develop, or acquire nuclear weapons, and limits Iran's uranium enrichment capabilities until at least 2026."[212] Today, JCPOA negotiations remain stalled and uranium enrichment in Iran remains a high concern to the international community.[213]

Chapter 5: Conclusion

The examination of space and nuclear treaties reveals outdated language to meet today's threats. While the space and nuclear treaties are intended to prevent future wars, today's technologies far exceed the speed and altitude of weapons delivery systems imagined at the time of the implementation of those treaties. However, existing treaties provide an ideal platform to engage space-faring nations on the needed clarity and specificity to match today's weapons technologies and perhaps even the warfare technologies of tomorrow. With the 10-fold increase in nuclear-capable countries over

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[207] U.S. Department of Defense, Defense Intelligence Agency, "Iran Military Power 2019," page 38, last accessed November 27, 2022, Iran_Military_Power_LR.pdf (dia.mil).

[208] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 26, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[209] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 25, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[210] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 26, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[211] U.S. Department of Defense, Defense Intelligence Agency, "Iran Military Power 2019," page 21, last accessed November 27, 2022, Iran_Military_Power_LR.pdf (dia.mil).

[212] U.S. Department of Defense, Defense Intelligence Agency, "Global Nuclear Landscape 2018," page 25, last accessed November 27, 2022, Global_Nuclear_Landscape_2018.pdf (dia.mil).

[213] Robinson, Kali, 2022, "What is the Iran Nuclear Deal?," Council on Foreign Relations, July 20, 2022, last accessed November 27, 2022, What Is the Iran Nuclear Deal? | Council on Foreign Relations (cfr.org).

the past 50 years, there is urgency to negotiate new nuclear treaties to avert a future nuclear war, especially since the February 2023 suspension of Russia's participation in the 2021 New START Treaty. When the earliest nuclear treaties were negotiated, nuclear power technology was relatively nascent, but today, nuclear power can be compacted as small as a briefcase. More dangerously, compact nuclear bombs can orbit over intended targets inconspicuously until remotely detonated, which received recent media speculation following the discovery of a balloon belonging to China floated over U.S. territory.

When the 2020 U.S. Department of Defense Space Strategy identified "China and Russia have weaponized space as a means to reduce U.S. and allied military effectiveness and challenge our freedom of operation in space," it reinforced the advantages for the U.S. to engage within the numerous military and non-military space and nuclear partnerships that exist today.[214] Not only is there a larger collective of spacefaring nations, but also non-spacefaring nations who benefit from space data, thus, the collective interest to protect space from nuclear EMP weapons. The worldwide attention to threats in space is greater today than ever before, particularly when the UN held its first Open-Ended Working Group on Reducing Space Threats in May 2022 and again in September 2022.[215][216] The ensemble of space and nuclear treaties, as well as the numerous cooperative space platforms demonstrate a vast collective interest by space-faring and

[214] U.S. Department of Defense, "Defense Space Strategy Summary 2020," page 1, last accessed November 27, 2022, 2020 Defense Space Strategy Summary.

[215] United Nations News, 2022, "Unity Among Nations, in Push for Greater Space Security at UN-led Talks," May 13, 2022, last accessed November 27, 2022, Unity among nations, in push for greater space security at UN-led talks | UN News.

[216] United Nations Office for Disarmament Affairs, "Overview, Open-Ended Working Group on Reducing Space Threats Through Norms, Rules, and Principals of Responsible Behaviors," last accessed November 27, 2022, Open-Ended Working Group on Reducing Space Threats (2022) | United Nations (unoda.org).

non-space-faring nations to formulate new agreements and treaties to prevent EMP weapons in space.

Chapter 6: Recommendations

Recommendation 1: U.S. should seek further opportunities to work with China on deterring North Korea's nuclear development, testing, and provocations. This is especially important given North Korea's recent advancement in missile altitude and reach, and their satellite-delivered nuclear EMP ambitions.

Recommendation 2: U.S. should seek confidence-building measures that provide incentives for China's nuclear weapons arsenal not to exceed limits under current nuclear treaties, whether it is a party thereto or not.

Recommendation 3: Re-negotiate missile treaties to account for hypersonic and scramjet technologies.

Recommendation 4: Re-negotiate space treaties to clarify the terms of deployment of kinetic and non-kinetic space weapons, as well as treaty language to clarify the terms of the transiting of nuclear or other weapons of mass destruction in non-orbital trajectories.

Recommendation 5: the U.S. Department of State should publish regular public reports updating progress on space diplomacy, including existing partnerships and treaties, both within the UN and outside the UN, and how its efforts support U.S. space strategies and policies.

Appendix 1

UN Space Treaties:

1967 Outer Space Treaty

1968 Rescue Agreement

1972 Space Liability Convention

1976 Space Object Registration Convention

1979 Moon Treaty

1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space

1971 Agreement Relating to the International Telecommunications Satellite Organization (ITSO)

1971 Agreement on the Establishment of the INTERSPUTNIK International System and Organization of Space Communications

1974 Convention Relating to the Distribution of Program-Carrying Signals Transmitted by Satellite

1975 Convention for the Establishment of a European Space Agency (ESA)

1976 Agreement of the Arab Corporation for Space Communications (ARABSAT)

1976 Agreement on Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes (INTERCOSMOS), 1976 Convention on the International Mobile Satellite Organization (IMSO)

1982 Convention Establishing the European Telecommunications Satellite Organization (EUTELSAT)

1983 Convention for the Establishment of a European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)

1992 International Telecommunication Constitution and Convention and Under Water

2008 Prevention of Placement of Weapons in Outer Space and The Threat or Use of Force Against Outer Space Objects (PPWT)

2014 Prevention of an Arms Race in Space (PAROS)

U.S.-led Space Agreements:

2020 Artemis Accords

Appendix 2

UN Nuclear Treaties:

1968 Nuclear Nonproliferation Treaty (NPT)

1963 Partial/Limited Test Ban Treaty (PTBT or LTBT)

1972 Anti-Ballistic Missile Treaty (AMB) **dissolved in 2002

1988 Intermediate Range Nuclear Forces Treaty (INF) **dissolved in 2019

1997 Comprehensive Nuclear Test Ban Treaty (CTBT) **not yet entered into force

2021 Prohibition of Nuclear Weapons Treaty (TPNW)

U.S. Nuclear Treaties:

2021 New START **expires in 2026

UN Missile Treaties:

1987 Missile Control Technology Regime

1991 UN Register of Conventional Arms (UNROCA)

2002 Hague Code of Conduct Against Ballistic Missile Proliferation (HCOC)

2004 UN Security Council resolution 1540 Non-proliferation of weapons of mass destruction

2014 Arms Trade Treaty (ATT)

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