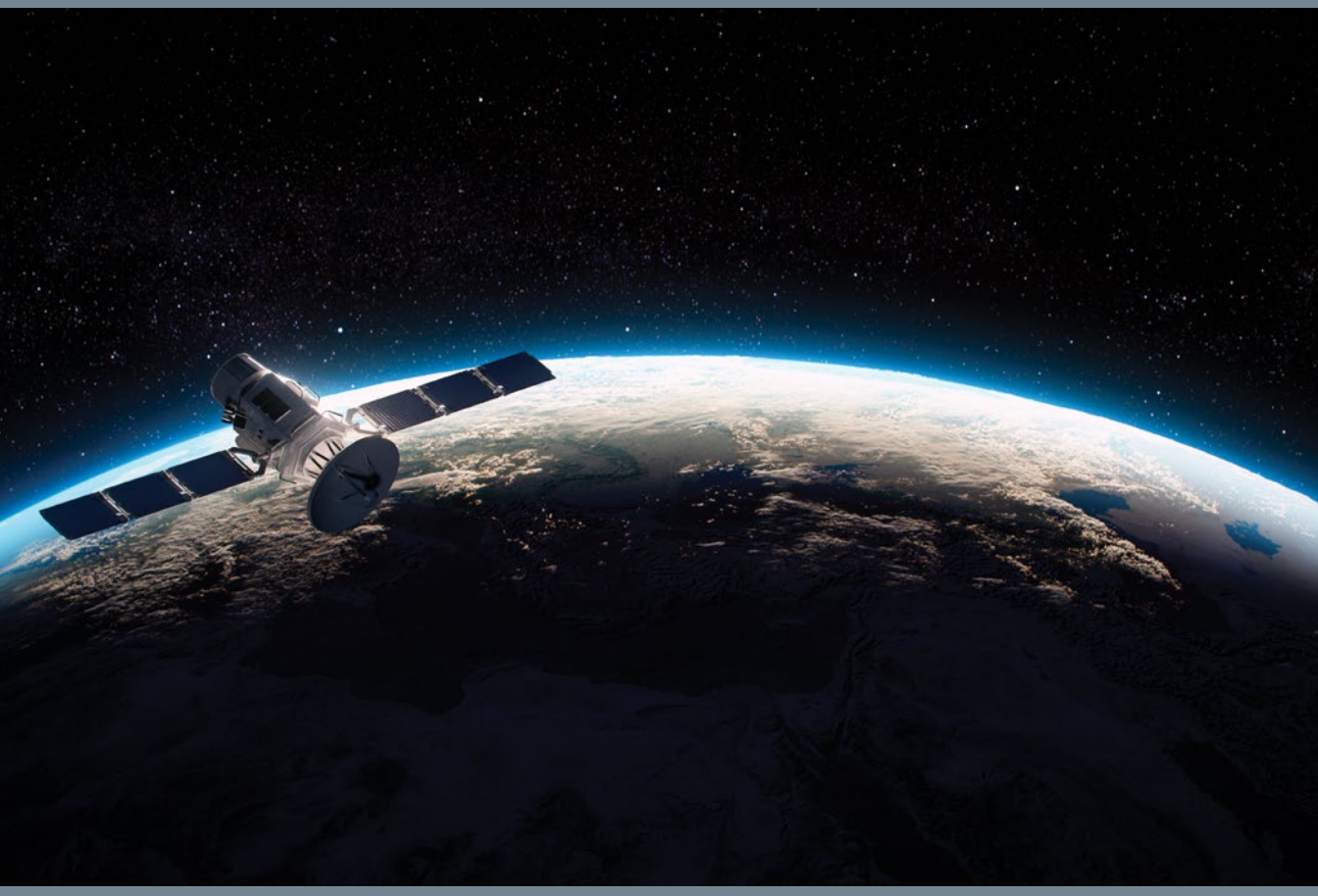
Minimizing the Negative Effects of Advances in Military-Relevant Space Capabilities on Strategic Stability



Nancy W. Gallagher and
Jaganath Sankaran

AMERICAN ACADEMY OF ARTS & SCIENCES

ARTIUM ET SCIEN
SUB LIBERTATE FLORENT
MDCCLXXX

Minimizing the Negative Effects of Advances in Military-Relevant Space Capabilities on Strategic Stability

Nancy W. Gallagher and
Jaganath Sankaran

AMERICAN ACADEMY OF ARTS & SCIENCES
Cambridge, Massachusetts

© 2023 by Nancy W. Gallagher, Jaganath Sankaran, the University of Maryland, and Carnegie Corporation of New York.
All rights reserved.

ISBN: 0-87724-159-7

This publication is available online at www.amacad.org/project/promoting-dialogue-arms-control-disarmament.

Suggested citation:
Nancy W. Gallagher and Jaganath Sankaran, *Minimizing the Negative Effects of Advances in Military-Relevant Space Capabilities on Strategic Stability* (Cambridge, Mass.: American Academy of Arts and Sciences, 2023).

Cover image:
iStock.com/imaginima

This publication is part of the American Academy's project on Promoting Dialogue on Arms Control and Disarmament. The statements made and views expressed in this publication are those held by the authors and do not necessarily reflect the views of the Officers and members of the American Academy of Arts and Sciences.

Please direct inquiries to:
American Academy of Arts and Sciences
136 Irving Street
Cambridge, MA 02138
Telephone: 617-576-5000
Fax: 617-576-5050
Email: aaas@amacad.org
Web: www.amacad.org

Contents

Introduction

We are pleased to share this monograph published under the American Academy of Arts and Sciences' project *Promoting Dialogue on Arms Control and Disarmament*. The current nuclear age is characterized by a simultaneous collapse of arms control agreements and the absence of strategic dialogue among the United States, Russia, and China—the three main nuclear players. As we know from the Russia-Ukraine War, today's era is showing worrisome trends for the stability and security of the global nuclear order. As demonstrated during the Cold War, the creation of platforms for innovative brainstorming on areas of common ground is an essential step to reduce tensions, minimize the potential risks of nuclear escalation and arms racing, and promote a more cooperative international environment.

The Promoting Dialogue on Arms Control and Disarmament project brings together nuclear experts to discuss areas of opportunity and policy recommendations. One strand of the project's work consists of a series of Track 2 dialogues among experts and former policy-makers from the United States, Russia, and China that is designed to identify critical short-term goals in arms control. A second strand of work builds on the Academy's prior experience organizing educational sessions on a range of topics for the United States Congress. Through a series of engagements with members of Congress and their staffs, the project fosters knowledge on key issues and challenges facing the United States.

A third strand of work weaves the project's expert discussions and policy recommendations together to produce publications on critical debates within nuclear arms control. This co-authored monograph features scholarly contributions from two experts who explore how advances in space capabilities by Russia, China, and the United States over the last two decades are likely to affect strategic stability. In *Minimizing the Negative Effects of Advances in Military-Relevant Space Capabilities on Strategic Stability*, **Nancy W. Gallagher**, Director of the Center for International and Security Studies at Maryland (CISSM) and a Research Professor at the University of Maryland's School of Public Policy, and **Jaganath Sankaran**, Assistant Professor in the Lyndon B. Johnson School of Public Affairs at The University of Texas at Austin, suggest that the most destabilizing effects of technological advances in major power space capabilities are coming from how each country reacts to what they perceive others might do, and not from a sober assessment of how new capabilities necessarily impact every dimension of strategic stability.

These destabilizing effects may include incentives to start a war by choice that could involve other major powers, preempt a crisis or conventional conflict, or engage in arms racing, as well as lead to a deterioration of broader political relations among Russia, China, and the United States. The Biden administration was considering these effects when Russia launched its full-scale invasion of Ukraine in February 2022. That war and U.S. fears that Beijing might try a similar tactic with Taiwan have heightened concerns about strategic stability and distracted analytical attention away from how advances in space capabilities, in practice, may affect strategic stability. The war in Ukraine and China's responses to the visit of former Speaker of the U.S. House of Representatives Nancy Pelosi to Taiwan and Taiwanese President Tsai Ing-Wen's visit to the United States have also precluded most official dialogue about how each country's concerns about space and strategic stability could be addressed cooperatively through arms control, especially as Russia, China, and the United States move forward with space activities that others deem destabilizing.

While both authors highlight the dangers of the United States, Russia, and China disregarding each other's interests and concerns in military space capabilities and space diplomacy, there is an opportunity to shape and impact the field of advances in space weaponization and strategic stability at a critical time in history. More importantly, Washington, Moscow, and Beijing need to indicate their willingness to consider cooperative measures, and experts should start to explore concrete cooperative measures they each could take.

These lessons about the importance of bilateral discussions, transparency, and unambiguous messages are deeply relevant to the challenges we face today. The authors remind us of the increasing dangers if the United States, Russia, and China do not communicate. The Academy will continue its work to bring together experts from these countries under the Promoting Dialogue project's series of Track 2 meetings and publication series that are designed to highlight critical goals in arms control.

The Academy has played a crucial role in the nuclear field, particularly when a viable path to cooperation and collective governance was not clear. In 1959, at the height of the Cold War and the nuclear standoff between the United States and the USSR, members of the American Academy, including Donald Brennan, Thomas Schelling, and Henry Kissinger, among others, gathered at the Academy to rethink the framework that had governed relations between the two superpowers following World War II and to offer a new model of global interaction. The work of this group, in partnership with contemporaneous policy-makers, helped pave the way for the adoption of a new American nuclear posture based on strategic stability and arms reduction, rather than on arms accumulation. Since then, the

American Academy has conducted more than a dozen projects focused on arms control and nuclear policy topics, ranging from the future of submarine-based deterrents, to international arrangements for nuclear fuel reprocessing, to weapons in space. Our work continues to shape the dialogue in the nuclear field.

We have no doubt that this publication will serve as an important contribution to contemporary thinking about approaches to strategic stability in the space frontier. The Academy will present and share this publication through a series of outreach activities, and it will be translated into Russian and Chinese for dissemination to policy-makers and the arms control communities in Moscow and Beijing.

We would like to thank Allan Myer, Belinda Frankel, and the Raymond Frankel Foundation for their generous support of the Promoting Dialogue project. We also want to thank Doreen Horschig, Melissa Chan, and Michelle Poulin in the Academy's Global Security and International Affairs program area for their diligent work.

David W. Oxtoby
President, American Academy of Arts and Sciences

Steven E. Miller
Chair, American Academy's project on Promoting Dialogue on Arms Control and Disarmament

Minimizing the Negative Effects of Advances in Military-Relevant Space Capabilities on Strategic Stability

Nancy W. Gallagher and Jaganath Sankaran

In 2007, China used a ground-based missile to destroy one of its own aging weather satellites, confirming what had long been suspected—that China could hold at risk low-earth orbit (LEO) satellites that support U.S. military and economic activity and serve other functions. Since then, China and Russia have been developing a wider array of space capabilities, including ones that can operate at much higher altitudes, enabling interference with global positioning satellites, nuclear early warning satellites, and other vital and expensive U.S. spacecraft that were previously considered safe from attack.

Americans often interpret these advances as asymmetrical efforts to offset U.S. military superiority. Some see even more nefarious ambitions, as illustrated by a 2010 quotation in *Wired* from a retired Russian general urging greater investment in this field because "who owns space, owns the world."[1] A 2014 review concluded that U.S. efforts to encourage reciprocal strategic restraint had failed and that the United States should no longer view space as a sanctuary for critical satellites.[2] After the review, the United States significantly increased its national security space investments without sufficient understanding of why China and Russia are developing these advanced space capabilities, what the greatest dangers are, and how they should be managed.

This paper explores how advances over the last two decades in space capabilities by Russia, China, and the United States are likely to affect strategic stability, broadly defined. This includes incentives to start a war of choice that could involve other major powers, attack preemptively in a crisis or conventional conflict, and engage in arms racing or arms control, as well as broader political relations among these three countries. The Biden administration was starting to consider this question when Russia launched its full-scale invasion of Ukraine in February 2022. That war, and

U.S. concerns that Beijing might try something similar with Taiwan, have simultaneously made concerns about strategic stability more important and diverted analytical attention from considering how advances in space capabilities impact it. The war in Ukraine and China's response to House Speaker Nancy Pelosi's August 2022 visit to Taiwan have also precluded most official dialogue about how each country's concerns about space and strategic stability could be addressed cooperatively, as all three move forward with space activities that others deem destabilizing.

We start by reviewing continuity and change in U.S. views on the complex relationship between space and strategic stability over time. We then summarize the recent technological advances in Russian and Chinese space capabilities that are of greatest concern among U.S. officials and experts, contrasting their interpretations with those of their Russian and Chinese counterparts. To demonstrate how worst-case assumptions about others' motives are a major justification for accelerating one's own work in all three countries, we also review recent research on Russian and Chinese perceptions of and responses to U.S. military space activities. We argue that the most destabilizing effects of technological advances in major-power space capabilities arise from each country's reaction to what it perceives the others might do, not from a sober assessment of how new capabilities necessarily impact each dimension of strategic stability.

What is most needed now is more complete and accurate information about who is doing what in space, why, what concerns such capabilities and actions raise for others, and how those concerns might be addressed. That is easier said than done. Even when political relations have been relatively good, the United States has often tried to promote reciprocal restraint in space through tacit bargaining and shared norms of behavior, cooperative strategies that can be misperceived or misconstrued. When relations are tense and mistrust is high, all three countries become less willing to share information, and may signal displeasure by refusing to talk.

Some channels for discussing space and strategic stability with Russia and China do remain open despite the war in Ukraine, and the Biden administration seems seriously interested in fostering norms for responsible uses of space. For that effort to make more progress than it did during the Obama administration, though, the United States will first need to be more transparent about its own military space activities to facilitate a more informed discussion with Congress and nongovernmental experts about which aspects of U.S. military space programs will truly enhance strategic stability, broadly defined, and which are unnecessarily destabilizing. The Biden administration must also be careful to approach the norm-building process in an inclusive manner, with mutual reassurance as the primary objective, rather than trying to promulgate the rules for space security by

itself or with like-minded countries (i.e., seeking diplomatic progress without Russia and China or seeking strategic advantage vis-à-vis them).

Space and Strategic Stability

"Strategic stability" means different things to different analysts.[3] We use a broad conception with four dimensions. Given the historical preoccupation with deterring a nuclear attack or large-scale conventional war between two or more major powers, one important aspect of strategic stability is keeping the desirability and feasibility of one party initiating a bolt-from-the-blue attack, or a war of choice, as low as possible. Once both superpowers had secure retaliatory capabilities, some analysts assumed that the probability of deliberate nuclear deterrence failure would henceforth remain quite low because nothing that might realistically be gained by attacking the other superpower would be worth risking nuclear annihilation. Others still worried that an adversary willing to take big risks to advance a revolutionary agenda might conduct some type of limited nuclear attack (e.g., on a U.S. ally or on intercontinental ballistic missile silos) and then demand major concessions in the expectation that U.S. leaders would acquiesce rather than retaliate if their own cities could be destroyed in return.[4]

A second aspect of strategic stability is minimizing the chances of inadvertent deterrence failure—that is, closing various pathways to a nuclear war that nobody wanted to happen. One route involves incentives to reduce how much damage an opponent can do to you by preemptively striking military and leadership targets in an escalating crisis or early phase of a war. These incentives are partly a function of force structure characteristics (optimized for rapid, high-accuracy attacks on hard targets or for surviving a first strike and retaliating later). They also reflect beliefs about nuclear war. Could some combination of preemption and missile defense give high confidence that damage suffered in a nuclear war could be limited to an "acceptable" level? Once any nuclear weapons have been used, how difficult would it be to control escalation and terminate a conflict on acceptable terms rather than fighting to the finish? Pathways to inadvertent nuclear war also include problems with nuclear command, control, communication, and intelligence (C3I), such as false warning of an impending attack, unauthorized launch, accidental detonation, miscommunication, and much more.

A third dimension of strategic stability involves incentives for arms acquisition versus arms control. New technologies can make unilateral arming or bilateral arms racing more or less attractive, depending on whether military applications are expected to shift the strategic balance in favorable or unfavorable ways. Some might be thought to offer whichever country

masters them first a significant, even decisive advantage. Others might be viewed as merely a marginal improvement over existing weapons. Proponents for heavy investment in new types of military capabilities often argue that, if the United States gets far enough ahead, it will be able to lock in a major first-mover advantage, either by denying potential competitors information, materials, and equipment needed to have comparable capabilities or by dissuading other countries from even trying to compete because they know that the United States will remain far ahead no matter what they do.[5] These types of unilateral denial or dissuasion strategies rarely work well for long, and they often fuel threat perceptions and resentment in target countries that intensify efforts to circumvent export controls and accelerate indigenous technology development. Incentives to engage in unilateral or reciprocal restraint in weapons acquisition or to negotiate arms control go up when governments feel pressured to avoid spending scarce resources on new military capabilities that they view as destabilizing, ineffective, or irrelevant to the most important security challenges.

Strategic stability also has a fourth dimension that is political rather than military. Thomas Schelling and Morton Halperin's classic definition of arms control involves "all the forms of military cooperation between potential enemies in the interests of reducing the likelihood of war, its scope and violence if it occurs, and the political and economic costs of being prepared for it."[6] But the ultimate objective of security policy is not only to reduce the costs and risks of war; it is also to reduce the role that threats and use of force play in relations among countries and global society writ large. Russia, China, and many U.S. allies have historically placed more emphasis on the political dimension of strategic stability than the United States has. During the Cold War, for example, the United States tried to increase strategic stability primarily by negotiating different types of controls on military capabilities, without putting much stock in documents that spelled out agreed principles for superpower relations sought by the Soviets, or the Helsinki process to promote more peaceful coexistence in Europe.

Insufficient attention to the political dimension of strategic stability has also been a problem for U.S. efforts to establish a strategic stability dialogue with China, similar to those it has had with Russian officials over the years. Chinese experts have questioned whether practices developed to promote stable military relations between two roughly equal nuclear superpowers were appropriate for advancing its desired end state—peaceful diplomatic, economic, and military relations among major powers—particularly since nuclear weapons play a much smaller role in China's security strategy than they do for the United States and Russia.[7] When the Chinese discuss measures that would increase "strategic trust" (a term that emphasizes the political dimension of strategic stability), they place more

weight on nuclear no-first-use declarations and other doctrinal principles than their U.S. interlocutors do, and they are more cautious about what forms of transparency would enhance predictability instead of vulnerability.[8] Perhaps the clearest way for U.S. experts to understand the political dimension of strategic stability is to consider how much more dangerous a false alarm from an early warning system or a collision involving military personnel from Russia or China and from the United States or an allied country would be while war in Ukraine is raging and tensions over Taiwan are rising than the same incident would be if peaceful political relations made war unthinkable.

Making Space a Sanctuary to Enhance Strategic Stability

Views on the relationship between space and strategic stability have changed significantly over time.[9] Early in the space age, U.S. officials sought to legitimate and protect vulnerable national security space assets by emphasizing how information collected by satellites can help stabilize deterrence. Sometimes they tried tacit bargaining strategies to elicit reciprocal restraint from the Soviets, or they negotiated nonbinding norms of behavior for outer space activities, because the U.S. military or other important domestic actors did not want to foreclose future options. At other times, U.S. officials explained explicitly what types of reciprocal restraint they sought and negotiated formal agreements. Efforts to define space as a sanctuary from certain aspects of Cold War competition, such as orbiting nuclear weapons in space or interfering with the use of satellites for arms control verification, did produce important legal prohibitions and a norm against deliberately destroying other countries' satellites that has never been violated. The less explicit communication was between the superpowers, the harder it was to know whether actions intended to signal interest in some form of contingent cooperation have had the desired effect or were missed, misinterpreted, ignored, or deemed irrelevant. The more the United States did to hedge its bets or to underscore U.S. willingness to outcompete the Soviets in space if they did not refrain from threatening actions, the more unstable superpower space cooperation became.

The Eisenhower administration wanted to establish the norm that outer space was different from national airspace so that the United States could orbit reconnaissance satellites over the Soviet Union without it having legal justification to shoot them down. Although the United States had classified satellite programs that were more advanced than Soviet efforts, the president decided that the first U.S. launch should be clearly peaceful: an earth-orbiting satellite on a civilian rocket for a scientific mission.[10] The USSR scored a propaganda victory by launching the world's first satellite on

a booster that it had used a few months earlier to launch the world's first intercontinental ballistic missile (ICBM). Eisenhower's critics in Congress attacked him for allowing the United States to fall behind the Soviets not only in space and missile capabilities, but also in science and strategic weapons development more generally.[11] Democratic Senator Lyndon Johnson, then the majority leader in Congress, held hearings to underscore how Eisenhower's desire to keep excessive Cold War military spending from weakening the U.S. economy had given the Soviets a lead. Johnson's subcommittee on military preparedness popularized the view of the superpowers being in a "space race" for the ultimate prize. "Control of space means control of the world," it declared, because "from space, the masters of infinity would have the power to control the earth's weather, to cause drought and flood, to change the tides and raise the levels of the sea, to divert the gulf stream and change temperate climates to frigid."[12]

Once the superpowers had ballistic missiles, they also had latent anti-satellite (ASAT) weapons, but they generally exercised restraint in developing dedicated ASAT capabilities and never used them against each other. The first U.S. ASAT R&D project, SAINT, was initiated after *Sputnik 1* to develop a co-orbital system capable of inspecting Soviet satellites, determining whether they carried nuclear weapons, and destroying them if necessary. The project was cancelled in 1962. In the 1950s and 1960s, nuclear-tipped interceptors were being developed for missile defense because accuracy was not yet good enough for kinetic "hit-to-kill" systems. The United States tested these missiles as direct-ascent air-launched ASATs a few times, generating electromagnetic radiation that damaged electronics not only on the target satellite but also on operational U.S. satellites in the line of sight. It maintained—but never needed to use—a rudimentary capability to conduct this type of ASAT operation from a base on Johnston Island if the Soviets deployed some type of space weapon.[13] The Soviets also developed nuclear-tipped interceptors for missile defense that could be used in ASAT mode, and they worked on a co-orbital ASAT system capable of destroying spacecraft at lower altitudes (below 2,000 kilometers) by releasing shrapnel nearby.[14] These latent ASAT capabilities and exploratory ASAT programs were meant more as a deterrent and a hedge, though, than as a dedicated effort to achieve and use counterspace weapons.[15]

After President John F. Kennedy and Vice President Johnson entered office, they briefly accelerated ASAT development, then resumed efforts to advance reciprocal restraint in space. The Kennedy administration soon embraced the emerging view that intercontinental ballistic missiles and thermonuclear warheads created an inescapable level of mutual vulnerability that gave the superpowers a strong shared interest in limited forms of arms control to lower nuclear risks and deterrence costs. Thomas Schelling,

Morton Halperin, and others associated with the arms control logic developed by a group centered in Cambridge, MA, argued that everybody could benefit from formal and informal cooperation to ensure that both superpowers had secure nuclear retaliatory systems and reliable C3I capabilities, not arsenals optimized for so-called damage limitation (e.g., preemptive attack and missile defenses that might reduce the destruction caused by a retaliatory strike to an "acceptable" level).[16]

Interest in approaching the Soviets about measures to promote mutual restraint in space arose after a U.S. Department of Defense (DOD) review concluded that the USSR had not made as much technological progress toward a militarily effective ASAT as previously feared.[17] Most senior security officials had come to accept the assessment of Eisenhower's scientific advisor that delivering nuclear weapons from space would be "clumsy and ineffective," but they anticipated strong domestic pressure to put nuclear weapons in orbit or on celestial bodies if the Soviets did so.[18] They considered trying to negotiate a legal prohibition to preclude this undesirable development, but the Joint Chiefs of Staff did not want to foreclose completely an option they might want someday.[19] Therefore, U.S. officials tried to signal to the Soviets that reciprocal restraint was their preferred way to address the two most likely sources of strategic instability in space: inadvertent deterrence failure and arms racing.

A simultaneous preference for reciprocal restraint and a willingness to compete if necessary are hard to convey without explicit, detailed discussion, particularly when foreign counterparts are inclined to weigh the willingness to compete more heavily than the interest in cooperation. In September 1962, the U.S. deputy secretary of defense said that keeping the nuclear arms race from expanding into space was highly desirable and that the administration was doing everything feasible to achieve that objective but would take "such steps as are necessary to defend ourselves and our allies if the Soviet Union forces us to do so."[20] The next month, William Foster, director of the Arms Control and Disarmament Agency, indicated to Soviet officials U.S. interest in an agreement to preclude stationing weapons of mass destruction in outer space. Tensions were running high: the Cuban Missile Crisis occurred soon after this meeting. Foster's overture was initially rebuffed because the Soviets assumed he was alluding to some new version of long-standing Western proposals first made in 1957 that would include ballistic missiles and require inspections. The Soviets responded favorably a year later, however, after Raymond Garthoff, then a State Department official, clarified that the United States was really proposing something that covered only weapons placed in orbit or stationed in outer space, not ballistic missiles that transited briefly through space without completing a full orbit, and that it was willing to rely solely on

national technical means of verification.[21] This message was more credible because the superpowers had recently agreed (with the United Kingdom) on another narrowly defined arms control agreement without inspections, the Limited Test Ban Treaty, which prohibited nuclear tests in outer space, among other environments, thus ruling out further testing of nuclear-tipped ASAT weapons.

In 1966, the Soviets agreed to support a 1963 United Nations General Assembly (UNGA) resolution urging all states to refrain from introducing weapons of mass destruction into outer space.[22] The agreement then evolved into the 1967 Outer Space Treaty (OST), and was ratified the following year by the United Kingdom, United States, and USSR.[23] That accord is best known for its legally binding prohibitions on orbiting weapons of mass destruction or placing them on celestial bodies (but not on ballistic missiles that transit through space without completing a full orbit). The OST also codified the principle that all countries had a right to use space freely for mutually beneficial purposes and in accordance with international law (Article I). This provision has been understood to include national security satellites used for early warning, crisis management, arms control verification, and other "peaceful purposes," in contrast to those that support or conduct active war-fighting operations.

The Nixon administration pursued what Steve Weber characterizes as an "enhanced contingent restraint" policy on ASAT development and added to some détente-era arms control agreements explicit protections for satellites performing stabilizing functions. Near the end of the Johnson administration, the Soviets had conducted several tests involving two satellites in co-orbital tracks, with one exploding when it came close to the other. The DOD warned that the Soviets had successfully tested a "hunter-killer satellite," but an interagency study group determined that the Soviet co-orbital tests were most likely a limited probe of U.S. restraint in space rather than "an intensive effort to develop militarily significant ASAT capabilities" that posed "an immediate and serious threat to U.S. security interests" necessitating a concerted response.[24] Instead of accelerating their own ASAT development efforts, U.S. officials took steps to reduce satellite vulnerability. They also initiated low-level research on hit-to-kill technology for the Miniature Homing Vehicle (MHV) to maintain "a minimum ASAT development lead time" for a nonnuclear option that could be ramped up if a more significant Soviet ASAT threat materialized.[25]

The DOD put the Johnston Island ASAT system on standby for military and economic reasons in 1970. Some U.S. officials hoped this move would help restore reciprocal restraint by underscoring that the United States would rely on latent options rather than developing, testing, or using dedicated ASAT capabilities, on the condition that the Soviets did the

same. When the USSR stopped testing its co-orbital ASAT in 1971, U.S. officials believed that their tacit bargaining strategy had worked.[26] The tests apparently stopped for some other reason, though. A 1972 Soviet military appraisal described the Johnston Island system and another nuclear-tipped ASAT endeavor (Program 505) that had been cancelled as "active operation systems" and also mentioned U.S. R&D on more advanced ASAT capabilities (presumably the MHV program).[27]

The 1972 Anti-Ballistic Missile (ABM) Treaty and the Interim Strategic Arms Limitation Talks (SALT I) agreement signed the same year started the practice of prohibiting interference with national technical means of verifying compliance with treaty obligations, much of which is done from space. The ABM Treaty also ruled out space-based missile defense interceptors. Garthoff argues that these two agreements could have been greatly strengthened by including a ban on testing or deploying both ABM and ASAT systems, including a U.S. commitment to dismantle the Johnson Island ASAT facility in return for the USSR removing the rudimentary nuclear-tipped missile defense system near Moscow. "Responsible Soviet officials" told him in the early 1980s that, because they saw the U.S. ASAT program as more advanced than their own, they felt too weak to propose such provisions but would have eagerly agreed if the United States had offered. The Nixon administration never explored that possibility with the Soviets, though, because it preferred informal reciprocal restraint to legal commitments that would foreclose military options that might become more attractive in the future.[28]

Space as a Domain for Strategic Advantage

U.S. policy regarding space and strategic stability began to change in the mid-1970s as critics of détente argued that the Soviets had been pursuing decisive military advantages in space while the United States was preoccupied with war in Vietnam and lulled by arms control. As U.S. and Soviet military space capabilities improved in ways that offered war-fighting advantages, U.S. policies moved from promoting reciprocal restraint, to threatening ASAT escalation unless the Soviets agreed to U.S. terms for arms control, to embracing competition during the Reagan administration. Critics of détente argued that the Soviets were never seriously interested in reciprocal restraint in space (or any other arena for Cold War competition), while the Soviets maintained that they were merely responding to U.S. military space advances.

The view that space should preferably be a sanctuary for national security satellites began to shift during the Ford administration, driven by growing concerns about how the USSR might use recent advances in space

technology for nuclear war fighting, not deterrence. The Soviets had begun to launch satellites, collect imagery of force deployments in regional crises, and then recover the satellites after a short period. This method of collecting timely intelligence for tactical purposes was less sophisticated than the soon-to-be-launched U.S. Keyhole-11 (KH-11) satellite, which could provide near-real-time digital imagery, but the United States thought that the Soviets were violating an unspoken norm by sometimes sharing tactical intelligence with a client.[29] At the same time, the Soviets were developing radar ocean reconnaissance satellites (RORSATs) that could potentially be used to track movements of U.S. naval carrier groups at sea. Some U.S. analysts also believed that the Soviets had begun testing a ground-based laser ASAT, although the DOD determined that the light flares had probably been caused by a gas pipeline fire.[30] After the Soviets resumed testing of their co-orbital ASAT system in early 1976, the Ford administration accelerated MHV development with an eye to near-term deployment of a highly sophisticated kinetic energy ASAT system. Although the co-orbital tests did not demonstrate that the Soviets had mastered a militarily significant new capability, the Ford administration interpreted them as Soviet rejection of reciprocal ASAT restraint and concluded that the United States needed a useable ASAT weapon to deter future Soviet ASAT attacks.[31]

The Carter administration adopted what Weber calls a "contingent escalation" strategy by publicly committing both to develop an air-launched ASAT and to negotiate an ASAT ban.[32] At this time, the cost of launching a single satellite averaged about $20 million and scaled with weight, so the U.S. national security community tried to put as much capability as it could on each satellite and to omit weight-adding protective features like shielding and extra fuel for maneuvering.[33] Since the United States relied more heavily on satellites than the Soviets did, it stood to gain more from protective agreements and lose more from ASAT warfare. The United States had started thinking about using NASA's space shuttles as lower-cost launch vehicles so that it could distribute capabilities currently combined on a single satellite across numerous less expensive satellites to complicate Soviet efforts to gain a significant advantage through ASAT attacks. This would be a viable strategy, though, only if the number of Soviet ASATs was kept well below the number of satellites in a distributed architecture that would need to be destroyed to achieve the desired effect.[34] Some parts of the administration supported accelerating MHV development as a bargaining chip, while others thought that the United States needed dedicated nonnuclear ASAT options that could destroy Soviet military-support satellites. The latter group ensured that the U.S. negotiating position was narrowly tailored so that it would not foreclose desirable options. The Soviets suspended ASAT tests during negotiations, and agreement was reached on

some basic points, like not using ASAT weapons against each other's satellites during peacetime. But incompatibilities in other parts of the two sides' negotiating positions precluded a successful outcome before talks were suspended after the Soviet invasion of Afghanistan, while MHV development moved ahead.[35]

The Reagan administration embraced the view that technological improvements in Soviet strategic capabilities indicated their intent to initiate nuclear war, and thought that deterring a war of choice required convincing Soviet leaders that the United States had the offensive and defensive capabilities needed not only to limit damage to an acceptable level but to "prevail"—that is, to achieve a meaningful victory in an all-out nuclear war.[36] Near total emphasis on this conception of the first dimension of strategic stability produced a massive increase in U.S. military spending, deployment of highly accurate ICBMs and submarine-launched ballistic missiles, a commitment to deploy an operational ASAT at the "earliest practical date," and the Strategic Defense Initiative (SDI).[37] Reagan officials argued that leaving the ABM Treaty and building a space-based missile defense system would enhance strategic stability, initially by "complicating" purported Soviet plans to destroy U.S. ICBMs in the first stage of the "window of vulnerability" scenario, and eventually by providing comprehensive protection against Soviet nuclear weapons.

Soviet leaders, by contrast, saw U.S. development of a new type of ASAT and ambitions for space-based missile defense as highly destabilizing. They introduced their first Prevention of an Arms Race in Outer Space (PAROS) resolution in the United Nations in 1981, before Ronald Reagan's surprise SDI announcement, and declared a unilateral moratorium on ASAT testing in 1983. After coming into office in 1985, Mikhail Gorbachev soon concluded that SDI would not undermine the Soviet nuclear deterrent, but still vigorously opposed Reagan's efforts to remove ABM Treaty constraints. Soviet scientists convinced Gorbachev that deploying more offensive missiles carrying a combination of nuclear warheads, decoys, and other penetration aids would always be cheaper than fielding enough U.S. missile defense interceptors to keep destruction caused by Soviet retaliation to an acceptable level, even if a U.S. first strike destroyed many Soviet ICBMs. But Gorbachev still considered SDI to be highly destabilizing because it repudiated the concept of a bipolar security order based on mutual nuclear vulnerability.[38] Moreover, Soviet military experts anticipated that U.S. technological innovations developed for SDI would find more practical applications in ASAT weapons and the burgeoning use of digital information technology to facilitate the type of rapid and seamless combined arms operations that came to be known as "the revolution in miliary affairs (RMA)."

Ash Carter's 1985 analysis of satellites and ASATs illustrates how ideas about space and strategic stability were changing among strategists who supported some forms of damage limitation rather than a purely retaliatory U.S. nuclear posture, and who also thought that some controls on ASAT capabilities could benefit both superpowers.[39] His analysis is worth reviewing in some detail as an early effort to make a realistic, scientifically informed assessment of how Russian advances in military space capabilities affected strategic stability and what types of unilateral or cooperative U.S. responses would reduce negative effects.

Carter argued against those who thought that anything in the "heavens" should be safe from attack, on the grounds that some military functions performed by satellites are too threatening to deserve sanctuary and too easily disrupted (e.g., by natural hazards, inadvertent interference, technology with dual-use capabilities, or dedicated ASAT weapons) for a ban on ASAT attacks to be verifiable. He noted a basic paradox of ASAT arms control: "to the extent that ASAT development is suppressed and the vulnerability of spacecraft masked, the superpowers will be more and more tempted to deploy threatening spacecraft. And to the extent they do, pressure will in turn build to set aside the treaty and deploy ASATs."[40] Luckily, satellites performing more stabilizing functions, such as early warning, might not need negotiated protections because they were at higher altitudes. The Soviet co-orbital ASAT could theoretically reach them but only through a "conspicuous and protracted process" that would allow for evasive maneuvers. Moreover, successful Soviet disruption of U.S. early warning signals would provide a different form of early warning, since the only reason for such a disruption would be as a precursor to attack.

Carter cautioned against two common analytical errors: speculating about how hypothetical future Soviet ASAT advances could disable or destroy current U.S. satellites rather than the systems likely to be in use by the time those foreign capabilities were deployed; and sounding alarms about current Soviet capabilities that could be used to attack valuable U.S. military satellites when the Soviets had no strategically sound reason to do so. He argued that the United States should develop dedicated ASAT weapons capable of attacking satellites in LEO that the Soviets might use for military advantage, such as next-generation RORSATs and a future Soviet equivalent of SDI battle stations. At the same time, he urged unilateral restraint regarding U.S. development of high-altitude ASAT weapons because the military benefits would not be worth the costs and most of those satellites served "benign" or stabilizing functions (the main exception being the Global Positioning System, or GPS, navigation satellites then under development for various uses, including precision guidance to U.S. forces in wartime).

Carter judged that a narrowly tailored ban on direct-ascent intercepts above 3,000 kilometers and stationing directed-energy weapons above 1,000 kilometers would be mutually beneficial and verifiable. Given the hostility in U.S.-Soviet relations at that time, though, he expressed no hope that such an ASAT ban might be negotiated anytime soon. He also recommended various unilateral steps the United States could take to enhance its own security in space without increasing threats to Soviet space systems, including better space surveillance and tracking capabilities, reducing temptations to target U.S. space systems through redundancy (having back-up satellites and nonspace alternatives that could perform the same military mission), and minimizing use of the same satellites to perform both stabilizing and war-fighting missions. Finally, Carter observed that another way to solve the ASAT problem would be to refrain from deploying inherently vulnerable satellites that the Soviets would find particularly threatening, such as space-based radars and other components of SDI.

Cooperative Security in Space

The Cold War ended, the Soviet Union dissolved a few years later, and the context for assessing how developments in space would affect strategic stability fundamentally changed. Instead of viewing space as a venue for strategic competition and decisive advantage in a superpower war, U.S. and Russian officials approached space as another venue for cooperative threat reduction. During the Clinton administration, as Russian early warning and nuclear command and control systems atrophied, the United States and Russia agreed to build a Joint Data Exchange Center (JDEC) to reduce the likelihood of a false alarm or unintended ballistic missile launch leading to unintended war.[41] They also initiated the Russian-American Observation Satellites (RAMOS) program, whose primary technical objective was to improve space-based early warning and reduce false alarms, and they discussed cooperative missile defense, without much progress.[42] The Russian Federal Space Agency, design bureaus, and defense companies that specialized in satellites, launch vehicles, and long-range missiles were in dire financial straits, so arms control, not arms racing, was considered mutually beneficial. Because the United States and Russia had complementary areas of expertise in space technology, their collaboration on the International Space Station became a potent symbol of the former adversaries' now much closer political relationship, which appeared to be headed toward some type of strategic partnership. By the 1990s, many other countries could also build and launch civilian satellites, the commercial space industry was growing rapidly, and space technologies originally developed for U.S. military use, like GPS signals, were increasingly available to other

users. Taken together, these developments led many analysts to expect that space was rapidly becoming an environment where state and nonstate actors routinely cooperated to maximize beneficial uses while minimizing shared risks from space debris, satellite collisions, overuse of limited resources like orbital slots in GEO, and other collective-action problems.

Clinton administration officials advanced a cooperative security rationale for continuing to invest heavily in U.S. military space capabilities as a public service that the sole remaining superpower must provide in the new world order. Before becoming secretary of defense, William Perry had argued that most transborder aggression could either be deterred by credible United Nations threats of collective military action or resoundingly defeated if coalition action was organized around the impressive "reconnaissance strike capability used by the United States in Desert Storm."[43] That capability encompassed an interconnected "system of systems"—enhanced situational awareness on the battlefield, precision-guided munitions, and defense suppression capabilities—all of which used space-based surveillance, communication, and navigation assets. U.S. superiority in critical communication, information processing, and integration technologies gave it a valuable "information edge" in hard and soft power, with the former relying partly on classified assets and partly on commercial products available worldwide. After leaving the Clinton administration, Joseph Nye and William Owens cautioned that globalization meant that other countries could match U.S. military achievements, albeit at great effort and expense. They were, however, more likely to concentrate on commercial applications of digital information technologies so long as the United States refrained from military activities that threatened them, shared intelligence so they did not need their own "exquisite" satellites, and remained a healthy democracy admired around the world.[44]

Comprehensive U.S. Space Dominance to Preserve Strategic Stability

During the latter years of the Clinton administration, some military RMA proponents began making plans based on a much less benign view of the evolving post–Cold War security environment and a more unilateralist perspective on how the United States should use and preserve its military preeminence. In 1997, U.S. Space Command (SPACECOM) issued its *Vision for 2020*, which depicted the global expansion of space utilization as a threat rather than an opportunity and advanced a stark conception of national military space power.[45] SPACECOM claimed that a competitive "gold rush" was occurring in space, a lawless frontier like the nineteenth-century American Wild West.[46] It asserted that war in space was inevitable because

the "space 'playing field' is leveling rapidly" and satellites are vulnerable, high-value targets.[47] The United States could maintain "full spectrum dominance" only if it had offensive and defensive "control of space"— that is, the ability to access and use space freely for its own purposes, to protect its own space assets, and to deny the use of space to others when necessary. *Vision for 2020* sought to integrate space-based observation with "the application of precision force from, to, and through space . . . to achieve the same level of joint operations between space and the other mediums of warfighting as land, sea, and air currently enjoy today."[48]

Senior officials across the Clinton administration neither publicly endorsed nor rejected the SPACECOM vision, but lower-level officials at the DOD managed to advance some parts of this agenda, laying the groundwork for the next administration to claim that it was simply building on its predecessor's policies. For example, the Clinton administration had been willing to talk about space arms control in the Conference on Disarmament (CD) but not to negotiate on the PAROS topic, despite widespread international support for such negotiations. Its reluctance to negotiate any new legally binding agreements related to space increased after Republicans gained control of the Senate in 1994. In 1998, the U.S. ambassador to the CD justified the U.S. stance by saying that PAROS negotiations would be an unnecessary distraction from more important arms control priorities. "There is no arms race in outer space. We have an unprecedented degree of international cooperation" there. The existing OST ban on emplacement of weapons of mass destruction in outer space was enough, he said, because "we don't anticipate any other problems."[49] The next year, U.S. policy changed to oppose allowing even informal discussion of space arms control on the CD's agenda.[50] Ambassador Grey objected to this shift strenuously but unsuccessfully through interagency channels. He later concluded that the "then beleaguered Clinton administration may have decided to appease the neo-con Star Wars proponents by throwing them a small bone."[51]

The George W. Bush administration, in 2001, embraced SPACECOM's vision and the rest of the RMA concept for maintaining strategic stability by ensuring that the United States had the superior military capabilities needed to deter or defeat potential attacks by nonstate actors, proliferators, or major powers. Before joining the Bush administration, Defense Secretary Donald Rumsfeld had chaired a congressionally mandated commission on national security space programs. The commission depicted war in space as a "virtual certainty" and warned that the only way to avoid a "space Pearl Harbor" was to ramp up U.S. efforts to maintain military space superiority.[52] Doing so was integral to Secretary Rumsfeld's plans to transform U.S. military capabilities and operations "to defend [the United States] against the unknown, the uncertain, the unseen, and the unexpected."[53] In

place of the cooperative prevention strategies promoted by Perry, Carter, Owens, and others in the Clinton administration, Rumsfeld, Chairman of the Joint Chiefs of Staff Richard Meyers (formerly head of SPACECOM), and other Bush officials favored unilateral action. The National Security Strategy shifted emphasis from deterrence to coercive prevention, using a combination of export controls, intelligence, precision military strikes, and missile defense to keep hostile states and terrorist organizations from threatening the United States and its allies, particularly with weapons of mass destruction.

The Bush administration tried to develop the space capabilities needed to implement this national security strategy while also fighting wars in Afghanistan and Iraq for five years before finally releasing an unclassified version of its National Space Policy (NSP).[54] That 2006 document repeated vague language used by previous administrations that took on more ominous meaning in the new context. For example, it directed the secretary of defense to "maintain the capabilities to execute the space support, force enhancement, space control, and force application missions," which DOD doctrinal and planning documents interpreted to require more offensive capabilities than they had during the Clinton years. The Bush administration's NSP also repeated the directive to "develop capabilities, plans, and options to ensure freedom of action in space, and, if directed, deny such freedom of action to adversaries."[55] It dropped language from the Clinton NSP requiring such efforts to be "consistent with treaty obligations" and stipulating that they could include diplomatic and legal measures, as well as military means.[56] Instead, the 2006 NSP made opposition to arms control into official policy: "the United States will oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access to or use of space. Proposed arms control agreements or restrictions must not impair the rights of the United States to conduct research, development, testing, and operations or other activities in space."[57]

Implementing this unilateral security strategy necessitated the development and deployment of numerous, very expensive satellites, often involving technological advances well beyond anything even the United States could then do. Advocates for comprehensive U.S. space dominance did not view satellite vulnerability as a reason not to spend large amounts of money on space capabilities that would threaten potential adversaries. Russia's space program was still in disarray, and no country besides the United States with ballistic missiles capable of reaching LEO had ever tested them in ASAT mode.[58] Those who thought warfare in space was inevitable called for more investment in hardening satellite systems and development of so-called "bodyguard" satellites. Rumsfeld maintained, though, that, if the United States invested enough in transformative offensive and

defensive capabilities, it could lock in perpetual military superiority, not by continually outcompeting its adversaries but by dissuading them from developing weapons that they knew would be no match for what the United States already had. This envisioned strategic stability and global security as a form of Pax Americana in which potential adversaries decided not to build ballistic missiles, nuclear warheads, space mines, or underground hiding places because they knew that the United States could destroy or defend against them.

The Bush administration made organizational, legal, and diplomatic moves to advance its ambitious objectives. It merged SPACECOM with STRATCOM to integrate management of space assets needed for precision strike and missile defense with nuclear weapons and other global capabilities.[59] It reduced legal restrictions on military space activities by withdrawing from the ABM Treaty and narrowly interpreting the OST to restrict only WMD in orbit and military operations on celestial bodies, ignoring Article III's specification that all space activities must be in accordance with international law, including the UN Charter's rules regarding permissible use of force.[60] It continued to oppose the inclusion of PAROS discussions on the CD agenda because "there is no arms race in outer space." Instead of emphasizing unprecedented international cooperation in space, Bush officials implied that the United States had no peer competitor there and wanted to be free to prepare for whatever threats it might face.

The Bush administration also invested heavily in space as part of a much larger military buildup. Annual reports to Congress show that DOD spending on space doubled during Bush's eight years in office, from $12.9 billion in fiscal year (FY) 2000 to $26.5 billion for FY 2009.[61] These figures substantially underestimate U.S. military space spending because they do not include money spent on space by the Missile Defense Agency, some intelligence activities in space, and other classified programs in the "black budget." Most of the funding went to programs categorized as "space support" (e.g., launch services) and "force enhancement" (e.g., uses of space to support terrestrial war fighting, nuclear deterrence, and other earthbound military operations). Many of these programs were replacements for existing capabilities started by previous administrations that were significantly over budget and behind schedule. Smaller amounts went toward developing new capabilities for "space control" (ASATs, plus other means of protecting U.S. space assets and preventing unwanted foreign uses of space). These projects included a kinetic energy ASAT, a ground-based laser that could be used to blind satellites, an experimental reusable space plane (the X-37B), and rendezvous and proximity operations (RPO) involving microsatellites that can maneuver close to other satellites and perform missions such as in-orbit repairs and refueling to extend a satellite's service life. Little

was spent on "force application" capabilities (weapons in space that can hit targets on earth) beyond some experiments related to space-based missile defense interceptors and work on small rockets that could eventually be used to launch a hypersonic space bomber.[62] A detailed analysis of the FY 2006 budget request found that unclassified spending on ASAT weapons, space-based missile defense interceptors, and space-based strike weapons totaled less than $300 million, mostly for long-term technology development, "suggesting that Bush administration support for these programs was more rhetorical than real."[63]

Some of the Bush administration's technological accomplishments related to space were also more rhetorical than real, particularly the president's assertion during his 2004 reelection campaign that the United States finally had an operational national missile defense system. Efforts to enhance U.S. space control capabilities gained greater urgency in 2007, when China used a direct-ascent ASAT to destroy one of its own aging weather satellites in LEO, generating a substantial amount of space debris at an altitude where most of it would remain for decades.[64] After China was widely criticized for polluting the space environment and endangering other spacecraft, the Bush administration tried to show that it was a responsible space power by destroying the malfunctioning USA-193 satellite at a much lower altitude, obviating a small risk of the fuel-tank surviving reentry intact and releasing noxious gases near people on earth, without generating long-lasting space debris. Regardless of whether human safety was the main motivation, Operation Burnt Frost also demonstrated how quickly and easily the United States could reconfigure a sea-based missile defense interceptor into a direct-ascent ASAT.[65]

The Bush administration made important incremental advances in U.S. national security space capabilities but fell far short of achieving its most transformational objectives. A 2008 assessment of how the SPACECOM vision for comprehensive space dominance matched up with what had been accomplished argues that for physical, technical, economic, and strategic reasons, "no plausible multiple of current U.S. military space spending . . . is likely to produce 1) a space radar constellation that can track moving targets; 2) a revolutionary approach to space launch that can put satellites of many different sizes into space on short notice at a fraction of the current cost; 3) a constellation of space-based boost-phase missile defense interceptors; *and* 4) all the other capabilities needed for total space dominance."[66]

The authors of that assessment concluded that the Bush administration's unilateralist approach to space policy had had a net negative effect on U.S. and global security. The administration's ambitious rhetoric and willingness to spend huge amounts of money to advance space dominance

objectives motivated Russia, China, and other countries to make a more concerted effort to find ways to offset or emulate whatever the United States might be trying to do. The Chinese ASAT test, the culmination of a lengthy development effort, was the most obvious indication that, if the United States was going to use space in ways that other countries perceived as threatening, they would not be dissuaded from developing the means to attack vulnerable satellites if their own security depended on being able to do so. The Bush administration had weakened existing international agreements and institutions that had been historically used to reduce risks to space operations, while also blocking efforts to negotiate any additional rules for cooperative space security. U.S. actions were making space a more dangerous place without providing the transformational capabilities needed to deal with those dangers unilaterally.

Ambiguous Cooperation to Encourage Reciprocal Strategic Restraint in Space

When the Obama administration took office, it moved quickly to reassure the rest of the world that the United States was returning to a more cooperative security policy, including in space. The official White House website was initially updated to include the objective of ensuring "freedom in space" by seeking a worldwide ban on weapons that "interfere with military and commercial satellites."[67] The president's April 2009 speech in Prague promised U.S. leadership of a global effort to eliminate nuclear weapons, starting with a bilateral agreement to reduce U.S. and Russian deployed strategic offensive weapons (New START) and other long-standing items on the nuclear risk reduction agenda.[68] The United States also changed its position toward PAROS discussions in the CD, enabling that forum to agree after a decade of gridlock on a work program covering fissile material controls, nuclear disarmament, negative security assurances, and space arms control.[69]

Obama's 2010 NSP had a much more cooperative tone than the Bush administration's version.[70] Its principles for international cooperation reaffirmed provisions of the OST that the Bush administration had ignored, declaring that "there shall be no national claims of sovereignty over outer space or any celestial bodies. The United States considers the space systems of all nations to have the rights of passage through, and conduct of operations in, space without interference." The main source of strategic instability in space was not deliberate asymmetrical attacks on vulnerable U.S. space assets but irresponsible actions that inadvertently caused "mishaps, misperceptions, and mistrust."[71] The description of the space environment as "congested, competitive, and contested" became a staple of

Obama administration speeches about space and strategic stability but was not included in the 2010 NSP. It was, however, a foundational premise of the 2001 Space Posture Review (SPR) and the 2011 National Security Space Strategy that informed how the DOD and intelligence community intended to implement the top-level guidance from the NSP.[72]

That difference between the NSP and the SPR raised questions about which aspects—other than rhetoric—of U.S. national security space policy had changed from the Bush approach. The official who led the review that produced the 2010 NSP was a holdover from the Bush White House. He said the main differences were not substantive but involved how Obama officials would describe and implement Bush-era programs.[73] As before, the Obama NSP directed the DOD to "maintain the capabilities to execute the space support, force enhancement, space control, and force application missions." It implied that the Obama administration would emphasize defensive aspects of space control by directing the DOD to "develop capabilities, plans, and options to deter, defend against, and, if necessary, defeat efforts to interfere with or attack U.S. or allied space systems."[74] It also dropped language about being able to deny adversaries the ability to use space in the same ways the U.S. military did. Without access to classified documents, though, outsiders could not know whether Bush-era efforts to develop offensive space control capabilities had been permanently ended, continued at a slower pace, or were being pursued more vigorously, effectively, and quietly than before. It became even harder to assess how much work was still being done on offensive space capabilities after the Pentagon changed how it categorized space-related program elements and moved some into the black budget. This caused the figure reported to Congress for DOD spending on space to drop from $30 billion for FY 2012 to $10.8 billion the following year.[75] It is unclear how much was due to sequestration-imposed across-the-board budget cuts on the DOD versus new accounting practices.

The Obama NSP said nothing about seeking a worldwide ASAT ban, but did restore language dropped in Bush-era national space policies about being open to legally binding space arms control proposals that were "equitable, effectively verifiable, and enhance the national security of the United States and its allies."[76] U.S. officials recycled Bush-era objections to Russia and China's proposed Prohibition on the Placement of Weapons in Outer Space Treaty (PPWT), without offering a counterproposal that would meet their criteria for desirable arms control.[77] They insisted that the dual-use nature of many space capabilities made it impossible to ban anything that could be used as a weapon without precluding many peaceful and beneficial uses of space. They also objected that the PPWT verification provisions were weak and the terms unfair because they would ban space-based missile

defense interceptors, an option some American decision-makers wanted to keep open, but not deployment of ground-based ASATs like the Chinese had recently tested (although their use against space objects would be banned).

The Obama NSP replaced the Bush version's anti-arms-control principle with a pledge to "pursue bilateral and multilateral transparency and confidence-building measures (TCBMs) to encourage responsible actions in, and the peaceful use of, space."[78] Voluntary transparency measures included exchange visits to space installations and sharing more information about U.S. space policies with Russia and other major space-faring nations. Americans were particularly interested in getting China to be more transparent about the motives driving rapid advances in dual-use space capabilities and the institutional arrangements to control their use.

President Obama and Chinese President Hu Jintao agreed in 2009 to start a dialogue on space cooperation, including human spaceflight, peaceful uses, and mutual security.[79] When NASA administrator Charles Bolden Jr. visited China in late 2010 to discuss potential civil space cooperation, the military officials who ran China's space program showed him some of their new facilities.[80] Defense Secretary Robert Gates went to China a few months later and suggested that the two countries establish a dedicated bilateral military-to-military dialogue on sensitive issues including space, but Chinese military officials were not ready to include that on the agenda for the first meeting in May 2011. By then, Congress had passed legislation sponsored by Representative Frank Wolf (R-VA) that reduced American officials' ability to gain insights into China's space program by engaging with their counterparts. The legislation prohibited NASA, the White House Office of Science and Technology Policy (OSTP), and the National Space Council from using government funds to collaborate with Chinese entities on space issues without Federal Bureau of Investigation certification that the collaboration would have no intelligence or human rights risk. Congress also required that it be prenotified of these types of efforts.[81] This prevented further Chinese involvement with the International Space Station and motivated China to build its own space station, which was finished in October 2022.[82]

Because the United States has better data than any other country on space objects that could collide with satellites or launch vehicles, damaging expensive equipment, creating more debris, and potentially killing astronauts, one of the Obama administration's signature TCBMs involved sharing more of this information with foreign space agencies and companies. In 2008, Intelsat, a multinational telecommunications service provider, could not get the Bush administration to share the coordinates of a Russian satellite operating near one of its own satellites, making it harder to avoid a collision.[83] Two months later, an active Iridium communications satellite

was struck by an inactive Russian communications satellite, generating two thousand pieces of space debris. After Obama took office, the DOD's Joint Space Operations Center (JSpOC) began providing more frequent warnings about potential conjunctions, although it still did not provide precise location information.[84] This fit into a broader effort to improve space situational awareness (SSA), including a "neighborhood watch" concept involving new U.S. satellites patrolling at altitudes near geostationary orbit (GEO).[85] Commercial satellite operators, who track their own spacecraft much more closely than the JSpOC system does, developed their own association for exchanging data, plus a Space Data Center to facilitate information sharing with U.S. government officials.[86]

U.S. decisions to increase transparency in space served multiple purposes. Improving all space users' SSA would reduce "mishaps, misperceptions, and mistrust"—major sources of inadvertent instability in space. Improving the U.S. military's SSA relative to that of potential adversaries would enhance comprehensive U.S. space dominance. Declassifying information about the previously highly classified Geosynchronous Space Situational Awareness Program (GSSAP) was also a way for the United States to send a message to China and Russia that "anything you do in geosynchronous orbit we will know about. Anything."[87]

Parts of the U.S. national security space community opposed including basic information about classified satellites in JSpOC's public catalog of the space objects it tracked, even though many classified satellites could be seen by amateur astronomers. The military also worried that sharing too much information about the location and movements of less sensitive satellites might make it easier for adversaries to target them or hide nefarious activities when they passed overhead. Therefore, STRATCOM established a tiered system for sharing SSA information. JSpOC worked most closely with "Five Eyes" allies, provided intermediate amounts of data to space agencies and companies in friendly countries, and warned Russia and China about potential conjunctions without providing detailed enough information for them to know whether and where they should move an endangered satellite to avoid a debris-generating collision.[88]

Obama officials and space experts close to the administration agreed on the value of advancing norms of responsible behavior in space but not what those norms should be nor why they should be promoted. As with efforts to improve SSA, officials and experts had various motives for wanting the United States to endorse the Code of Conduct for Outer Space Activities that had emerged from a European Union (EU)–led process started during the Bush administration. Some hoped that widespread adherence to the code would promote best practices, minimize space debris, reduce collision risks, and prevent other types of inadvertent instability in space.[89]

Others were more cynical about using ambiguous and unverified rules about what the United States and likeminded countries defined as "responsible" space behavior for strategic advantage. They doubted that China would change how it operated in space even if it bowed to international pressure and endorsed the EU code. Since the United States had more advanced SSA capabilities than any other country, it could make assertions about misdeeds in space that would generate international opprobrium but would not be independently verifiable.[90]

Despite such arguments from the DOD and State Department in favor of the EU-proposed code, after receiving a negative letter signed by thirty-seven Republican senators, the Obama administration determined that the EU code was "too restrictive" as it stood.[91] The proposed code would not have been legally binding, but the senators still worried that the United States might decide not to proceed with some current or future national security space activities because they could be considered inconsistent with the code's principles, while the People's Republic of China would not be similarly constrained by international norms and negative public opinion.[92] Secretary of State Hillary Clinton announced that the United States would help draft an international code of conduct for space operations based on the EU draft but modified in unspecified ways to not restrict U.S. national security space activities.[93] Several meetings occurred, but no multilateral agreement resulted.

In bilateral relations with Russia and China, Obama officials also preferred reassurance and reciprocal restraint rather than legally binding limits on space capabilities and behaviors. After New START entered into force, Russia maintained that further nuclear reductions required corresponding restrictions on other strategic systems, particularly missile defense and space, which it considered highly destabilizing.[94] U.S. officials tried to reassure Moscow that their European Phased Adaptive Approach to missile defense would not impact Russia's nuclear deterrent. They offered a few modest transparency measures to confirm those claims but no legally binding limits on how far U.S. and allied missile defense systems might eventually evolve nor sufficiently close cooperation to assuage Russian concerns.[95] The Obama administration had strategic and political reasons not to agree that further nuclear cuts be coupled with limits on space-enabled conventional capabilities: it routinely told Congress and allied countries that the reason why the United States could safely reduce its reliance on nuclear weapons was because it had overwhelming superiority in precision conventional weapons that could now carry out many missions that previously required nuclear weapons.[96]

Since the United States and China had no shared history of bilateral arms control treaties, many experts assumed that Chinese officials had no

real interest in legally binding limits on nuclear or space weapons. U.S. analysts with a range of political views accused China of being an arms control "free rider" since it would not negotiate legally binding limits on its own strategic nuclear weapons because it had many fewer than the United States and Russia and none of them were operationally deployed.[97] The Chinese military's initial reluctance to accept Secretary of Defense Gates's invitation to discuss space issues was also interpreted as a general lack of willingness to talk about cooperative steps to enhance space security rather than as an indicator that the Chinese officials needed more time to agree internally on engagement, or preferred to use a diplomatic rather than military-to-military forum, or favored different types of cooperative measures than those Gates wanted to discuss.[98] Some argued, though, that China's desire for U.S. acknowledgment of mutual nuclear vulnerability and adoption of a categorical nuclear no-first-use doctrine like China's could be a model for reciprocal strategic restraint in the nuclear, space, and cyber domains.[99] The Obama administration urged China to show restraint and provide reassurances regarding how it intended to use its growing power.[100] But no official has publicly indicated that official Sino-American strategic stability dialogues ever discussed in detail or reached shared understandings about what reciprocal strategic restraint in space should entail.

One U.S. priority for these dialogues was a commitment from China not to conduct any more debris-generating ASAT tests.[101] In 2008, a senior Chinese Ministry of Foreign Affairs official promised that China would not test this way again, but U.S. officials wanted a more reliable form of reassurance because Chinese diplomats had seemed genuinely surprised when the Chinese military had destroyed a satellite the previous year.[102] Chinese political and military leaders had little strategic incentive to endorse normative proscriptions on their new ASAT capabilities without corresponding restrictions on U.S. missile defense or other military uses of space that China found most threatening, so the State Department official leading diplomatic efforts to engage China on space TCBMs made little headway at first.

When the first bilateral space and security dialogue convened in May 2016, participants agreed they would try to get Presidents Obama and Xi Jinping to issue a joint statement pledging to refrain from activities that create long-lasting space debris, similar to their 2015 joint statement expressing a common understanding to not "conduct or knowingly support" cyber espionage and intellectual property theft for commercial gain.[103] Had the People's Liberation Army (PLA) agreed to support this initiative before Obama's visit to China in September 2016, the two countries would have invited others to endorse the norm through a UN resolution that fall. The fact sheet prepared for the presidential visit simply noted that, as two permanent members of the UN Security Council with major space

programs, the United States and China would "intensify cooperation to address the common challenge of space debris."[104] Senior officials have since confirmed that, when the Chinese government was ready to make a joint statement pledging not to create long-lasting space debris, the Trump administration rejected the overture.

This bilateral diplomatic activity did not stop Russia or China from taking actions in space that some in the U.S. national security space community saw as seeking military advantage rather than showing strategic restraint. Both countries tested maneuverable satellites in LEO, a dual-use capability that previously only the United States had. Then, in May 2013, China sent what it described as a "science mission" up almost to GEO, reaching an altitude at which multi-billion-dollar U.S. intelligence satellites and nuclear early warning satellites had been assumed to be safe since the end of the Cold War.

Evidence of China's advancing ASAT capabilities, combined with its broader military modernization, covert cyber operations, and aggressive actions in territorial disputes, plus Russia's 2014 annexation of Crimea, convinced top DOD officials that the Obama administration efforts to "reset" relations with Russia, use economic engagement to liberalize China, and cultivate reciprocal strategic restraint in space had failed. They asserted that, while the United States was embroiled in the Global War on Terror, Russia and China had quietly increased the technological proficiency of their war-fighting systems, including ASAT and counterspace technologies.[105] They claimed that the U.S. lead in missiles, space systems, guided munitions, and other technologies needed for traditional forms of power projection had eroded to the point where "U.S. armed forces may be forced to fight for theater access and freedom of maneuver in ways not seen since World War II."[106] Robert Work and other leading thinkers associated with the Third Offset strategy for using advanced technology to stay ahead of potential adversaries assumed that major powers would stay clear of direct combat with other nuclear-weapons states, but that Russia or China might (mis)perceive that they had reached regional parity with U.S. conventional forces in one or more critical military technologies and start a war of choice against a U.S. ally or partner. They also argued that norms of human behavior developed to avoid crises and prevent escalation during times of tension would be less likely to prevent inadvertent war between countries relying heavily on unmanned and autonomous systems.[107] Since space-based communications systems, sensors, and navigation systems would play critical roles in robotic combat, the United States must prepare for space warfare as an "inevitable" part of renewed great-power competition.

Work's confirmation as deputy secretary of defense in April 2014 further fueled interagency debate about how to adjust the U.S. space posture.

Senior national security officials were divided over whether China and Russia should now be viewed primarily as strategic competitors, what mix of new offensive and defensive capabilities was needed to preserve U.S. techno-military superiority, and how best to capitalize on commercial innovations in cyber, space, artificial intelligence, and many other emerging technologies. President Obama finally had to take the unusual step of weighing in personally on the U.S. response to advances in Chinese and Russian space capabilities, which led to a DOD Strategic Space Portfolio Review in summer 2014.[108]

The DOD identified three categories of policy options to ensure that the U.S. national security community could still fulfill various missions despite growing foreign counterspace capabilities: active and passive defenses for satellites, rapid replacement of damaged satellites, and increased resilience through disaggregating, distributing, or diversifying satellite capabilities.[109] Christopher Chyba argued that policy-makers should consider not only how well each option could keep ASAT attacks from hampering U.S. military operations but also what their effect would be on strategic stability.[110] Members of the national security space community began debating whether to reduce adversaries' incentives to attack mission-critical satellites by complementing existing constellations composed of a small number of expensive, multipurpose satellites with distributed architectures involving constellations with much larger numbers of single-purpose satellites that would be easier to build, launch, repair, or replace as needed.[111] This response option would have been relatively stabilizing, but it encountered bureaucratic resistance from members of the intelligence community who were reluctant to change their way of business.

Some DOD officials wanted to see more rapid and muscular U.S. steps to counter advances in Chinese and Russian military capabilities, particularly after both countries undertook military reorganization in 2015 that consolidated responsibilities for space operations in the PLA's Strategic Support Force (which also includes cyber and electronic warfare) and the Russian Aerospace Force.[112] General John Hyten, commander of Air Force Space Command, announced an ambitious Space Enterprise Vision that integrated existing and additional sources of space-based information for war fighters with new means of defending U.S. and allied space assets from attack, although the additional funding needed to make this more than a vision was not added to the budget for several years.[113] The DOD made organizational changes to improve interagency coordination within the interagency, with allies, and with private industry. It also established the Joint Interagency Combined Space Operations Center (JICSpOC) to "perform battle management and command and control of the [U.S.] space constellation under threat of attack." Work called this "the first step

in the third offset to start to readdress and to extend our margin of operational superiority," but classification barriers kept it from functioning as intended.[114]

Unconstrained Great-Power Competition in Space

The Trump administration's national security policy and space posture aligned with the more competitive version of Third Offset thinking. Its rhetoric mixed Bush-era language about the importance of comprehensive U.S. military space superiority with Reaganesque exhortations about preparing for space warfare to deter or defeat great-power aggression. It put more emphasis than previous administrations had on development of the U.S. commercial space industry, particularly potential resource extraction from space. At the same time, it publicly released even less information than its predecessors had about how much it was spending on military space capabilities and how it planned to use them, rarely talked about strategic stability, and largely ignored space diplomacy as a tool for managing great-power competition and inadvertent problems caused by increased commercial space operations.

In early 2018, the White House released a one-page unclassified summary of the new "America first among the stars" space strategy, which returned to the Bush administration's peace-through-strength approach to space security.[115] Declaring publicly that "our competitors and adversaries have turned space into a warfighting domain," it asserted that the United States must strengthen its space-deterrence and war-fighting capabilities in addition to building a more resilient space architecture.[116] The 2018 National Defense Strategy prioritized investments in space forces that can "deploy, survive, operate, maneuver, and regenerate in all domains while under attack" from adversaries.[117]

The Trump administration took a series of visible steps that underscored its view of space as a critical war-fighting domain. It revived the National Space Council soon after taking office to improve interagency coordination, although purely national security space policy issues remained under the purview of the National Security Council. It renamed JICSpOC the National Defense Space Center to streamline operations and avoid confusion with JSpOC.[118] Despite adamant objections from DOD and Air Force leadership, it created the U.S. Space Force—the first new branch of the U.S. armed forces in seventy-three years—by partnering with members of Congress who thought that the Air Force had not been spending enough of its budget on space to counter Chinese and Russian advances.[119] It also stood up the Space Development Agency (SDA) to accelerate deployment of distributed small satellite constellations by harnessing advances made

by the commercial space industry and using spiral development methods. Overcoming bureaucratic resistance to increasing resiliency by reducing reliance on a small number of expensive legacy satellites was the main motivation, but the SDA website describes a more bellicose mission: "to create and sustain lethal, resilient, threat-driven, and affordable military space capabilities that provide persistent, resilient, global, low-latency surveillance to deter or defeat adversaries."[120]

Publicly available information suggests that the Trump administration increased military space spending at a slightly faster rate than the rest of the defense budget. Budget analyst Mike Tierney determined that Congress provided $8.1 billion for unclassified military space procurement, research, and development in FY 2019 and about $4 billion more for personnel, operations, and maintenance.[121] As in previous years, most of this military space spending went toward launch services and space-based military support services like communications and GPS, not space control or force projection. The FY 2019 appropriation represented about a 25 percent increase in funding for unclassified efforts to improve U.S. military space capabilities since the Obama administration's 2016 reorientation of U.S. space policy, with further spending increases projected in the Five-Year Defense Plan even as Trump sought large cuts in other areas of government spending.

The main new unclassified initiative was the National Defense Space Architecture, envisioned as a multilayered, on-orbit mesh battle network that would give U.S. war fighters on earth more information and analytical products so they could make decisions and take actions faster than any adversary could. This ambitious project was an outgrowth of RMA and Third Offset ideas about leveraging commercial space technologies to increase the speed, resilience, and interoperability of U.S. and allied military forces. Such concepts sound appealing but have proven difficult to implement in practice.[122] One innovative component of this endeavor, which also increased its complexity, involved making the U.S. space architecture more resilient by building proliferated constellations of small satellites performing the same missions as legacy military systems composed of only a few much more expensive satellites. Mike Griffin, undersecretary of defense for research and engineering during the Trump administration, noted, "we don't want to perpetuate a constellation of juicy targets. We want to confound the adversary."[123]

Officials who had worked on space security during the Obama administration tried, with no success, to convince their replacements in the Trump administration to continue some diplomatic initiatives that they considered stabilizing. Douglas Loverro, who had been the deputy assistant secretary of defense for space policy, urged the Trump administration to reassert U.S. leadership in space diplomacy to head off "wrongheaded and

disingenuous" proposals from Russia and China meant to keep the United States from making full use of its "immense lead" in the use of space for security, economic, and scientific purposes. The best way to counter them, he maintained, would be for the Trump administration to vigorously advocate for cooperative agreements that reflected U.S. interests and principles, such as banning ASAT weapons that generate long-lasting space debris, setting space traffic management standards to avoid collisions and unauthorized close-proximity maneuvers, and establishing procedures for debris removal and resource extraction in space.[124] Trump officials, though, saw nothing to be gained from leadership in space diplomacy. Instead, they showed their disdain by voting "no" on all four space-related resolutions in the UNGA in 2018, including one reiterating support for a set of space-transparency and confidence-building measures agreed to by a UN Group of Governmental Experts in 2013. The U.S representative justified this reversal of long-standing U.S. policy by blaming Russia and China for "aggressively developing and deploying technologies that have transformed space into a warfighting domain."[125]

U.S. views on space and strategic stability have varied dramatically over time, for reasons that have as much to do with different U.S. administrations' overall national security strategies as they do with the relative development of U.S., Russian, and Chinese space capabilities. Throughout the Cold War, the Soviet Union was considered a peer competitor in space, but the U.S. approach changed from seeing reciprocal restraint in space as enhancing mutual deterrence stability to fearing that the Soviets would initiate a war of choice unless the U.S. military could use space for strategic advantage in a nuclear war. The United States had unchallenged space superiority after the Cold War, and efforts to ensure strategic stability in space were replaced first by various forms of cooperative security, then by the Bush administration's quest for comprehensive U.S. military space dominance. That proved quixotic, as China and Russia demonstrated the ability to do things in space that hitherto only the United States could do. What those capabilities are, what motivates them, and how the Biden administration should minimize their destabilizing effects are addressed below.

Assessing Advances in Russian and Chinese Space Capabilities

A February 2022 global threat assessment from the U.S. director of national intelligence assesses that "Beijing is working to match or exceed U.S. capabilities in space to gain the military, economic, and prestige benefits that Washington has accrued from space leadership" and that it has already fielded both destructive and nondestructive ASAT weapons. The

assessment also warns that "Russia will remain a key space competitor" capable of fielding a wide array of counterspace measures and actively training its military for space combat.[126] This section provides more detail on the Russian and Chinese space activities most commonly cited as evidence that they have developed and tested a broad spectrum of space weapons over the past two decades while the United States was focusing on counterterrorism and the wars in Iraq and Afghanistan. It contrasts U.S. assessments of the strategic rationales driving these programs with explanations from Russian and Chinese sources. The implications for strategic stability depend not only on the technical characteristics of emerging space capabilities but also on the motives assumed to be driving their development.

Recent Developments Fueling Concerns about Russian and Chinese ASAT Weapons

As of this writing, Russia's most recent test of a direct-ascent anti-satellite (DA-ASAT) weapon designed to intercept satellites in LEO occurred in November 2021. The test of the Nudol ASAT missile against an inactive Russian satellite—Kosmos-1408—created a debris field of more than 1,500 trackable objects, twice prompting crew on the International Space Station to shelter in place.[127] Russia had tested that system successfully eight times since 2015 without a debris-generating intercept, so the choice to do so while massing troops on Ukraine's border was interpreted by some as a warning.[128] This interpretation gained credence after a Russian news anchor claimed incorrectly that it showed Russia could destroy all thirty-two U.S. GPS satellites, which operate at a much higher altitude.[129]

Russia has conducted various dual-purpose space operations that could be used for co-orbital ASAT weapons. In 2014, Russia deployed a satellite, Olymp-K or Luch, into GEO that engaged in several orbital rendezvous and proximity operations, demonstrating potential ASAT capabilities. The satellite occupied fourteen orbital positions in a congested region of the GEO belt. In one instance, it placed "itself in a narrow window" between two satellites belonging to Intelsat.[130] In another, it approached "a bit too closely" to the Athena-Fidus satellite, a military satellite jointly owned by France and Italy.[131] Analysts have speculated that the action of Olymp-K "demonstrates the possibility of placing a dormant co-orbital payload into orbit, and later activating and maneuvering the payload into kill-proximity of a target when needed."[132] That same year, another Russian space object cataloged as Object 2014-28E exhibited erratic behavior. It was presumed to be space debris from the launch of three Russian military communication satellites by a Briz launch vehicle until it maneuvered "towards other Russian space objects" and performed orbital rendezvous with the Briz-KM upper stage.[133]

In October 2017, three Russian satellites—Kosmos-2519, Kosmos-2521, and Kosmos-2523—engaged in high-velocity orbital maneuvers. Kosmos-2519 was launched in June 2017. Two months later, it deployed subsatellites Kosmos-2521 and Kosmos-2523. U.S. Space Force Commander Gen. John Raymond described these orbital experiments as a "Russian nesting doll" demonstrating advanced weapons capabilities.[134] In January 2020, Russia's Kosmos-2542 and Kosmos-2543 satellites performed coordinated close approach orbital maneuvers in the vicinity of an American KH-11 reconnaissance satellite. The Kosmos satellites had assumed orbital positions that enabled them to "observe one side of the KH-11" when it first came into the sunlight.[135] Six months later, the Kosmos-2543 satellite fired a high-velocity projectile into outer space, mimicking a weapon designed to collide with another satellite and incapacitate it.[136]

Russia has deployed a ground-based laser weapon, the Peresvet, intended for dazzling of electro-optical satellites.[137] It also is investing in the development of the Sokol-Echelon ASAT laser system. The system is considered airborne and designed to disable optical sensors mounted on U.S. reconnaissance satellites. In addition to these counterspace weapons, Russia has used ground-based jamming systems to disrupt satellite services used in Syria and Ukraine.[138] The Murmansk-BN jammer can potentially target satellite communications between U.S. and North Atlantic Treaty Organization (NATO) ships and aircraft at a distance of up to 5,000 kilometers.[139] The RB-109A Bylina is an electronic warfare weapon system under development for automated electronic warfare operation at the brigade level.[140] Another system under development is the Krasukha-2/4, a radio signal interference system intended to jam reconnaissance assets such as the JSTARS and similar space-based radar systems.[141] Russia also has a mobile satellite communication jammer, Tirada-2S.[142]

Like Russia, China has demonstrated several DA-ASAT capabilities. In 2007, an SC-19 ASAT missile hit and destroyed the Fengyun-1C weather satellite. On May 13, 2013, a Chinese ASAT missile, DN-2, reached an altitude above 30,000 kilometers. According to the DOD, "the missile was not on a trajectory appropriate for deploying satellites into geosynchronous orbit, and its payload did not attempt to do so. Nor was the trajectory useful for any scientific purpose . . . the most likely purpose for the launch was to test a counter space capability against satellites in geosynchronous orbit."[143] A U.S.-China Economic and Security Review Commission report notes that China may operationally deploy the DN-2 in 2020–2025.[144] China also has electronic warfare and directed-energy capabilities that could be used for counterspace purposes.[145]

China has performed multiple co-orbital experiments. In January 2022, China's Shijian-21 (SJ-21) satellite performed a complex maneuver to approach a nonfunctioning Chinese Beidou satellite and then used a grappler to capture and reposition it from GEO to a graveyard orbit.[146] ExoAnalytic Solutions, an American commercial space situational awareness firm, observed the maneuvers of the SJ-21 and made them public.[147] Earlier, in November 2021, the SJ-21 was observed alongside another space object, eliciting speculation that the maneuver was "part of potential counterspace operations tests."[148] The Chinese, however, described the satellite's mission as testing and verifying "space debris mitigation technologies."[149]

China has conducted several other RPO missions. In 2007, the Shenzhou 7 human spaceflight mission was accompanied by small satellite RPO demonstration exercises in LEO.[150] In 2010, the newly launched SJ-12 satellite performed "non-cooperative robotic rendezvous" maneuvers with the two-year-old SJ-06F.[151] In July 2013, a secret Chinese launch placed in orbit three satellites—Chuang Xin-3, Shiyan Weixing-7, and Shijian-15—speculated to test RPO capabilities.[152] Over several years, the SJ-17 satellite has conducted a series of maneuvers in GEO. For instance, in 2018, SJ-17 maneuvered and occupied orbital slots from 37.7° East to 180° East.[153] In testimony, Gen. James Dickinson, commander of SPACECOM, noted that SJ-17's robotic arm could be repurposed "in a future system for grappling other satellites" as part of a space attack system.[154]

China has also developed a "secretive re-usable spaceplane" that released a mysterious object in October 2022 during its second flight.[155] During the 276 days in orbit, the spaceplane is suspected to have conducted several RPO and docking operations.[156] Additionally, private firms and nongovernmental organizations in China have started to conduct space missions that can, in principle, also have military applications. For instance, in April 2021, a Long March 6 satellite launch vehicle deployed three satellites, two developed by the Shandong Institute of Industrial Technology offering remote sensing services to Chinese industry and the third developed by the Shanghai ASES Spaceflight Technology Co. Ltd.[157]

U.S. Assessment of Geopolitical Motives Driving Russian and Chinese Advances

Top Biden administration officials see large Russian and Chinese investments in developing the gamut of ASAT capabilities as evidence of aggressive intent, arguing they could be used to offset the military advantages that the United States currently enjoys in space, destabilizing deterrence by leading Russia and China to (mis)perceive that they could prevail in conventional regional conflicts involving U.S. allies or partners. For example,

Dickinson characterized Russia's November 2021 test of its Nudol DA-ASAT as a destabilizing attempt to obtain the means to deny military space capabilities by the United States and its allies.[158] A 2022 Defense Intelligence Agency (DIA) report entitled *Challenges to Security in Space* makes the broader assertion that "Russia perceives the U.S. dependence on space as its Achilles' heel . . . [and] is therefore pursuing counterspace systems to neutralize or deny U.S. space-based services, both military and commercial, as a means of offsetting a perceived U.S. military advantage."[159]

The 2022 DIA report also asserts that China's PLA views counterspace capabilities as a means to dissuade American involvement in a regional contingency involving Taiwan, among other uses.[160] Some U.S. officials read China's recent space advances as clear evidence it seeks global hegemony, not just regional dominance.[161] After China's August 2021 test of a fractional orbital bombardment system that uses a hypersonic glide missile for reentry, Michael Gallagher, a Republican member of the House Armed Services Committee, declared, "This test should serve as a call to action. If we stick to our current complacent course . . . we will lose the New Cold War with Communist China within the decade. The People's Liberation Army now has an increasingly credible capability to undermine our missile defenses and threaten the American homeland with both conventional and nuclear strikes."[162]

There is bipartisan consensus among policy-makers that the United States must spend substantially more on military space capabilities than it did during the Trump administration to keep pace with the rapidly evolving threat. In June 2021, the secretary of the Air Force justified a large increase for the Space Force and SDA in the Biden administration's first budget request by warning Congress that "we cannot afford to lose space" but that such an outcome would be a "distinct possibility," given rapidly evolving Russian and Chinese capabilities, if the United States "continue[d] on a path of incremental modernization."[163] Congress responded by appropriating $1.3 billion above the FY 2022 request.[164] Biden's FY 2023 budget added another $5 billion for Space Force and SDA, calling the combined $24.5 billion request a threat-driven necessity.[165] The National Defense Authorization Act that was passed in early December 2022 indicates that Congress wanted to "plus up" this request by more than a billion dollars, but the final amount will depend on what happens with the FY 2023 appropriations bill.[166]

These assessments assume that all Russian and Chinese scientific and technological work with potential military space applications will seek to achieve those capabilities as quickly as possible and be used in ways that threaten U.S. interests. In reality, several of the missions described above may be primarily intended to support civilian Chinese space missions.[167]

For example, in January 2022, a large robotic arm on the Tiangong space station—in an operation similar to those conducted by the International Space Station—"grasped and maneuvered" the Tianzhou 2 cargo spacecraft in a trial exercise to prepare for future docking operations.[168] Shi Jixin, an engineer involved in the Tiangong space station project, characterized these maneuvers as "a technology in which we must achieve a breakthrough in the course of building the entire space station."[169] Had Congress not prohibited most forms of civilian space cooperation with China, Americans might have a better understanding of these technology development efforts.[170] China's ability to operate its own space station might then be seen as a new venue for scientific cooperation rather than as a military and geopolitical threat.[171]

Even when the Russian and Chinese militaries make progress in space that seems clearly intended to emulate or offset U.S. space capabilities, their motives are not necessarily nefarious. Efforts to predict how technological advances will impact strategic stability often try to assess how the resulting capabilities could affect incentives to strike first in a crisis, escalate rapidly, or seek a quantitative or qualitative advantage in an arms race.[172] Whether acquiring some new capability would change behavior in line with predictions is a harder question that receives much less attention. Motives for technology acquisition are often murky, mixed, and malleable, yet they matter for strategic stability too. Many space capabilities have both military and civilian uses. Moreover, the main motive for improving national security space capabilities could be to strengthen deterrence, to defend against attack, or to initiate offensive action to gain some type of strategic advantage. If Americans believe that other countries should not feel threatened by U.S. military space dominance because U.S. intentions are benign, they should at least consider what reasons other countries give for developing their own military space capabilities.

Russian and Chinese Strategic Perceptions

Whereas Americans see current Russian and Chinese space activities as having negative effects on all four aspects of strategic stability, Russia and China depict their counterspace activities as an unfortunate but necessary response to U.S. efforts to use space for military purposes that harm their interests and threaten their security.[173] After the Cold War, U.S. officials had hoped that other countries would stick to civilian and commercial uses of space technology so long as the United States, while investing heavily in space assets as a critical component of its "reconnaissance strike complex," shared valuable information gathered by its satellites and used space-enabled precision strike capabilities only in ways that met international approval.

Russian and Chinese perceptions of U.S. military space activities grew more ominous after 1999, when NATO airstrikes against Yugoslavia forced Slobodan Milošević, the Serbian leader and Russian ally, to hand Kosovo over to UN peacekeepers. These strikes occurred despite Russian and Chinese vetoes against UN intervention in the civil conflict. One strike damaged the Chinese embassy in Belgrade and killed three Chinese nationals. The United States said this happened accidentally, but many Chinese decision-makers believed it must have been intentional because U.S. military experts depicted Kosovo as the first successful demonstration of the RMA principle that space-enabled precision airstrikes could achieve major military and political objectives without a ground campaign.[174]

Contrary to Bush officials' hopes, Russia and China were not dissuaded from trying to develop comparable military space capabilities because the United States had such a commanding lead; they were instead motivated to offset or emulate U.S. capabilities. A 2022 RAND study of Russian- and Chinese-language government publications, military journals, academic reports, and domestic media found a consistent perception of U.S. military activities in space as hostile and threatening, intended to provide U.S. space forces "freedom from attack and freedom to attack."[175] These sources depicted the ultimate objective of U.S. space dominance as ensuring U.S. hegemony on earth. For example, a 2005 article published for the sixtieth anniversary of the nuclear attacks on Hiroshima and Nagasaki warned about motives driving the Bush administration's military buildup. "The US military department . . . announced its intention to start militarizing outer space with both defensive and offensive weapons. 'Who owns space, owns the world,' says the Pentagon. These statements aroused fear in the international community—the deployment of U.S. weapons in space will force other states to respond proportionally."[176] Chinese scholars and military officials said similar things, often incorrectly attributing to President John F. Kennedy the quotation "whoever controls space [the universe] can control the earth."[177]

Russian and Chinese sources were expressing concerns about post–Cold War U.S. space technology development projects that could be used for space weapons long before they ramped up their own similar efforts, in turn triggering U.S. apprehension. In 2003, the Experimental Satellite Systems program had a satellite (XSS-10) perform a range of orbital maneuvers around the Delta-2 second stage that had placed it into orbit.[178] The next year, XSS-11 was launched to test rendezvous operations.[179] Its mission was to demonstrate "controlled relative position and approach, close-in co-orbiting circumnavigation of other space objects, and automatic operations."[180] A follow-on project, the Autonomous Nanosatellite Guardian for Evaluating Local Space (ANGELS) program, included ways to inspect

noncooperative satellites. In 2014, it demonstrated a capability to orbit near and rendezvous with a Delta IV rocket upper stage in GEO.[181] In 2015, NASA tested its Demonstration of Autonomous Rendezvous Technology (DART) spacecraft, which was designed to do what its name suggests.[182]

These U.S. projects could have purely peaceful uses, such as the testing of crucial capabilities needed for cost-effective space exploration, but Russian and Chinese experts often make worst-case assumptions about the potential ASAT functions of American space activities, much the same way that American observers do about more recent co-orbital experiments by Russia and China. Russia has accused the United States and U.S. allies of being duplicitous and "naturally silent about their own efforts" at testing satellites with inspector and repair functions that also could have a dual role as ASAT weapons.[183] In 2021, Sergey Shoigu, the Russian defense minister, characterized American activities in space as attempts to attain "comprehensive military advantage" and insisted Russian efforts were defensive.[184]

Another ambiguous U.S. space program of great concern to China and Russia is the X-37B orbital test vehicle, a reusable robotic space plane about which little is publicly known, although the United States has been working on it much longer than the Chinese have been developing their space plane. After some initial work by NASA, the Defense Advanced Research Projects Agency (DARPA) took over the program in 2004, then transferred it to the Air Force. The X-37B has flown on six missions since 2010, often carrying classified payloads. The latest launch occurred in May 2020 and lasted for a record 908 days.[185] The vagueness of its official objectives—"space experimentation, risk reduction, and concept of operations development for reusable space vehicle technologies"—and the secrecy surrounding its budget and on-orbit activities have stoked concerns. Russian and Chinese analysts express fears about how the X-37B might interact with other satellites, whether it could carry weapons that could be used against terrestrial targets, where the satellites it launched were located (they were not included in the public satellite catalog maintained by the U.S. military until after they had decayed from orbit), and what functions these satellites might perform. Brian Weeden, a space expert at the Secure World Foundation, assesses that technical limitations make it highly unlikely that the X-37B would be used as a space weapon but that unwillingness to provide basic information about the program "raises questions about U.S. commitment to international norms and transparency and confidence building measures."[186]

Russian military scholars examining U.S. and NATO military campaigns have concluded that high-precision aerospace weaponry supported by satellite-enabled data has become indispensable to the American way

of war.[187] They note that the use of high-precision weaponry in American military operations has progressively increased from 10 percent of strikes during Desert Storm (1991) to 40 percent in Yugoslavia (1999) to 80 percent in Iraq (2003).[188] Igor Morozov, head of operations at the Russian Space Force, wrote, "during the Second World War, to destroy such a target as a large railway bridge, it was required to make 4,500 sorties and drop 9,000 bombs. In Vietnam, the destruction of a similar target was achieved with 190 bombs and 95 sorties. In the war against Yugoslavia, the same mission was solved by 1–3 cruise missiles fired from a submarine."[189] Russian analysts also point out that the ratio of standoff long-distance cruise missiles to aircraft-launched precision weapons has steadily increased "from 1:10 in Operation Desert Storm to 1:1.5 in Operation Desert Fox to 1:1 in Operation Allied Force to 1.8:1 in Operation Enduring Freedom."[190]

More broadly, Russian military leaders have long maintained that the American development of high-precision, high-speed strike weaponry enabled by satellite targeting and navigation poses an imminent danger to their national security.[191] In a 2013 conference attended by several cabinet ministers and members of Russia's Military-Industrial Commission, Deputy Prime Minister Dmitry Rogozin identified five conflict scenarios that Russia could face in the future.[192] The most prominent scenario involved a noncontact war with a technologically advanced adversary, that is, the United States and NATO. In this scenario, the United States would strike Russia's homeland using long-distance aerospace weapons and missiles. Rogozin warned that such a strike could destroy 80–90 percent of Russia's strategic arsenal, rendering its nuclear deterrent almost useless.[193]

Russian military analysts regularly write about a future war in which a massive air-missile strike campaign could be mounted against Russia. They believe that conventional hypersonic weapons developed under the Prompt Global Strike program would be used to start an aerospace assault against crucial Russian government command and control posts and mobile and stationary launchers of nuclear-armed missiles.[194] American missile defense would further degrade Russia's retaliatory potential.[195] Russians point out that, while the air-missile strikes would be launched from areas outside the range of Russia's air-defense radars, these aerospace weapons would be singularly dependent upon satellite-enabled targeting and navigation.[196] Consequently, Russians argue that ASAT and other counterspace weapons will "deter aggression" by the United States.[197] If deterrence fails, these weapons are postulated to offer Russian leaders "the ability to control escalation of a conflict through selective targeting of adversary space system."[198]

Chinese analysts make similar arguments. Interviews with Chinese experts indicate that the U.S. air strike against the Chinese embassy in Belgrade led China to accelerate what had been low-level research into hit-to-kill missile technologies, and that Bush administration security policies reinforced China's belief that it needed to match U.S. military space capabilities in order to deter their use against China.[199] In July 2022, Chinese Foreign Ministry spokesperson Zhao Lijian claimed the United States was turning outer space into a battlefield with its aggressive development and deployment of "a variety of offensive outer space weapons."[200] Chinese experts also worry about the possibility of a growing American first-strike capability buttressed by a multilayered American missile defense system.[201] In response, they seem to have decided to pursue a capacity "to weaken the U.S. space-based sensor system that serves as the eyes and brains of missile defense" to ensure that China retains the assured retaliation capability needed for a credible nuclear deterrent.[202] Lieutenant General Ge Dongsheng of the PLA, for instance, argues that "early warning, surveillance, tracking, communication, and guidance, which are all critical for nuclear war, are increasingly *dependent* on space systems . . . we therefore must accelerate the development of space capability to create new type of integrated space-nuclear strategic force . . . through anti-satellite weapons, we can clear a pathway for nuclear missiles so that our nuclear forces can survive, effectively penetrate, and accurately hit targets."[203]

Action-Reaction Patterns Reinforce Worst-Case Assumptions and Intensify the Security Dilemma

The 2022 RAND report examining Chinese and Russian reactions to U.S. military space activities focuses on ten events over three decades during and after the Cold War:[204]

- SDI (1983) and SPACECOM creation (1985)
- President Bill Clinton's National Space Policy (1996)
- Mid-Infrared Advanced Chemical Laser test (1997)
- Commission to Assess United States National Security Space Management and Organization (2001)
- U.S. withdrawal from the ABM Treaty (2002)
- U.S. Air Force Counterspace Operations doctrine (2004)
- President George W. Bush's National Space Policy (2006)
- Operation Burnt Frost (2008)

- President Barack Obama's National Space Policy (2010) and National Security Space Strategy (2011)
- Remarks of General William Shelton (Commander, Space Command) regarding the GSSAP (2014).

The authors found that the documents they analyzed provided modest evidence for action-reaction dynamics, with the clearest evidence coming from Russian reactions to the United States' withdrawal from the ABM Treaty. When that action was taken, Bush officials predicted that Russia would complain but would not or could not do anything in response that would negatively impact strategic stability. Instead, the study found a clear causal connection between withdrawal from the ABM Treaty, Russian decisions to put money back into their aging missile defense system, and military requirements for many new weapons, including ASATs and space mines.[205] Had the case selection included U.S. co-orbital efforts that began with the XSS-10 orbital maneuvers in 2003 and the work on a reusable space plane taken over from NASA by DARPA in 2004, developments often cited by Russian and Chinese sources, the RAND study would have likely found more extensive evidence of action-reaction dynamics.

The study's case selection also underestimates the importance of action-reaction dynamics by choosing only space-specific cases to study rather than including cases that would capture responses to the terrestrial military advantages that the United States gains from space assets. The authors justify this choice by noting that others have already examined how U.S. and allied use of space assets to support conventional military operations in Kosovo, Afghanistan, and Iraq influenced Russian and Chinese views on the future of warfare. Our review of Russian and Chinese explanations for developing ASAT-relevant space capabilities indicates that they are seeking to reduce the space-enabled advantages the U.S. military would have for crisis bargaining or conventional conflict, not aspiring to "win" a competition for military space dominance over the United States. Furthermore, if Russia's and China's most important security interest in space is preventing anyone from using space superiority to erode their nuclear deterrent or to project power around the world in ways that threaten their core interests, the main motivation driving their military space developments would be protective, not aggressive.[206]

The RAND authors did not analyze internal Russian and Chinese decision-making processes. Doing so would have provided clearer evidence of how much weight defensive reactions to each of these U.S. space developments carried compared with offensive motivations or internal factors such as organizational and bureaucratic politics. The RAND authors

provide two main reasons for assessing that these threat perceptions have a real impact on internal decisions rather than being made-up justifications for Russian and Chinese actions that are really driven by aggressive or internal motives. One is the consistency of concerns expressed across a breadth of sources consulted, particularly about the long-term military potential rather than the immediate effects on Russian and Chinese security. The other is that the sources sampled were intended primarily for internal expert and senior policy audiences, not for external audiences.

The RAND analysis produced several other noteworthy findings. One is that the political dimension of stability matters. When bilateral relationships are more confrontational, the same space events are described as more threatening; when tensions relax, interpretations soften somewhat, but suspicions remain. For example, the sources reviewed in the RAND study note that Clinton's and Obama's space policies, while more cooperative than George W. Bush's, were still focused on actions that the RAND scholars interpreted as evidence of an underlying continuity in the U.S. quest for space hegemony. "This suggests that existing negative perceptions held in Beijing and Moscow are relatively easily reinforced by those U.S. actions perceived as hostile, while U.S. actions perceived as less hostile do not appear to have a similarly robust effect, producing a seemingly minimal improvement in Chinese and Russian perceptions."[207]

This suggests that the Obama administration probably overestimated the extent to which the more cooperative tone of its National Space Strategy and its pursuit of space TCBMs convinced Russia and China that it had fundamentally reoriented U.S. space policy back toward reciprocal restraint. Those who have participated in or studied major security policy reviews undertaken by incoming presidential administrations know that to significantly change an inherited policy or end a legacy program is much more difficult than continuing what was done before. Political appointees who want a more cooperative approach have had to fight hard for small changes, such as abstaining rather than voting against a popular UN resolution or sharing a little more SSA information with Russia and China, so these moves may seem more significant to their American proponents than they do to foreign observers. Increased secrecy around U.S. space budgets and acquisition programs makes it even harder for outsiders to assess how much more restrained one administration's military space development efforts are compared to those before or after. The Obama administration also let the prospect of congressional opposition deter it from endorsing the EU Code of Conduct, sharing data that could have reduced some Russian concerns about existing missile defense systems, or discussing future limits on space-based missile defense, the basing mode that is most technically challenging and most worrisome for China and Russia. Since the Russian and

Chinese space development efforts of greatest concern to Obama officials were initiated or accelerated in response to Bush administration security policies and space programs, convincing those countries to cancel or slow those programs would have required much more reliable demonstrations of restraint in U.S. military space and missile defense development efforts than the Obama administration offered.

U.S. military space programs during the Trump administration reinforced worst-case assumptions about U.S. motives. Chinese and Russian officials interpreted the establishment of Space Force as a clear indication that the U.S. military had been reorganized to treat space more as a domain for deployment and use of weapons than as a source of information and communication used by terrestrial forces. After Trump announced this intention, a leading Russian Duma member made the far-fetched prediction that the United States might withdraw from the OST and deploy nuclear weapons in space.[208] A Chinese Foreign Ministry spokesperson called the move "a serious violation of the international consensus on the peaceful use of outer space."[209]

Other Trump administration moves also fueled foreign suspicions about U.S. motivations. Trump's 2019 missile defense review made explicit what Russia and China had always feared: that U.S. missile defense ambitions were not limited to countering proliferation but sought to neutralize Russian and Chinese nuclear deterrents, and that the technical difficulties of missile defense meant the United States would expand its "left of launch" (i.e., preemptive) options, thereby increasing its first-strike capabilities too.[210] The Trump administration's negative attitude toward arms control, particularly its withdrawal from the 1987 Intermediate-Range Nuclear Forces (INF) Treaty and its refusal to extend New START limits unless Russia agreed to include strategic systems not covered by the original accord and China joined the bilateral negotiations, was seen as further evidence that the United States saw no need for guardrails on great-power competition.[211]

Russian and Chinese sources maintain that the strategic rationales for their space technology development programs that are of greatest concern to U.S. officials and experts are largely if not solely driven by reactive rather than aggressive motives. At the same time, American officials routinely cite ASAT-related activities by China and Russia as necessitating urgent increases in U.S. spending on military space, transformative efforts to achieve comprehensive space control, and treatment of space as a war-fighting domain on par with land, sea, and air. Russian and Chinese sources are equally consistent about depicting their military space advances as necessary responses to things that the United States started doing decades ago. One need not take each such assertion at face value to ask how the implications

for strategic stability differ depending on whether one assumes that the motives for technological advancement are primarily offensive, defensive, or nonmilitary.

Evaluating Negative Effects on Strategic Stability, Broadly Defined

Much of the political rhetoric and military thinking that has framed recent policy debates about how the United States should respond to advances in Russian and Chinese space capabilities assumes that they pose a serious threat to the first dimension of strategic stability. The Space Priorities Framework issued in the first year of the Biden administration as a placeholder for a fuller revision of the National Space Strategy inherited from Trump declares, "the military doctrines of competitor nations identify space as critical to modern warfare and view the use of counterspace capabilities as a means both to reduce U.S. military effectiveness and to win future wars."[212] That assessment has one set of implications for strategic stability when juxtaposed with information revealed by the director of the Central Intelligence Agency (CIA); namely, that "Chinese President Xi Jinping has instructed his country's army 'to be ready by 2027 to conduct a successful invasion' of Taiwan."[213] It has different implications if it is understood in the context of what the intelligence community says in its Annual Threat Assessment for 2023: "Beijing is working to meet its goal of fielding a military by 2027 designed to deter U.S. intervention in a future cross-Strait crisis."[214] Even if one assumes that China and Russia have consistently aggressive motives, it is not clear logically or empirically that having more means of interfering with U.S. space assets would make China and Russia more likely to start a war of choice, because the United States would still have formidable conventional and nuclear capabilities.

Advances in ASAT-related technologies have more negative effects on the other three dimensions of strategic stability. These negative effects are intensified when the United States, Russia, and China all fear (rightly or wrongly) that the other side has offensive motives and is increasingly likely to initiate a war of choice as they come to believe (rightly or wrongly) that their own advancing space capabilities can be used to achieve victory at an acceptable cost. These action-reaction dynamics have already played out in ways that are dangerous and difficult to reverse. We have yet to see any postulated positive effects that suggest advances in counterspace capabilities might improve strategic stability by dissuading adversaries from developing threatening systems, persuading them to negotiate mutually beneficial limits, or obviating fears about how such capabilities might be used.

Incentives to Initiate a War of Choice

During the Cold War, the dominant problem for strategic stability was deterring the Soviet Union from initiating a nuclear or large-scale conventional attack on the United States or its allies. This dimension largely disappeared from post–Cold War assessments of strategic stability due to more benign assumptions about Russian motives and overwhelming U.S. military superiority gained through extensive use of space assets for the RMA. Over the past decade, as Chinese and Russian leaders have behaved more aggressively abroad and more repressively at home, concerns have grown that they might think that their ASAT capabilities could degrade U.S. military space assets enough for them to win a war of choice against a weaker neighbor. Russia's full-scale invasion of Ukraine in February 2022 vindicated those who had been warning that its military exercises in Belarus were clandestine preparations for a surprise attack. It also prompted more urgent warnings that Beijing was preparing to seize full control of Taiwan within the next few years. Yet, the course of the war in Ukraine to date provides several reasons for thinking that Russian and Chinese advances in military-relevant space technologies have not fundamentally changed their incentives to start another war of choice in the future in the expectation of easy victory at an acceptable cost.

Contrary to predictions, Russian counterspace capabilities have not provided a significant strategic advantage. Russian interference with space-enabled services occurred infrequently during the first ten months of war in Ukraine, with little lasting effect, and destructive attacks on satellites themselves have not happened at all. Shortly before the invasion, Russia went after ViaSat, an American company providing secure communications for the Ukrainian military. Instead of interfering with its KA-SAT in GEO over Europe, Russia used "wiper" malware to destroy ground terminals used by customers to send and receive high-speed internet data.[215] SpaceX helped the Ukrainian military overcome this problem by providing free terminals to access broadband internet from the Starlink constellation, which currently comprises several thousand small satellites in LEO. A software update quickly thwarted Russian efforts to jam signals transiting from the satellites to ground receivers.[216]

The Russian representative to a UN meeting on space security declared in September 2022 that his country would consider commercial and civilian satellites to be legitimate military targets if they were being used to support Ukrainian military operations, although disabling one satellite out of a thousand would provide little military benefit.[217] Russia has not acted on that threat so far, but it may help explain why Starlink's owner, Elon Musk, questioned whether his company should continue to subsidize internet access, and therefore disconnected some terminals after Ukraine's

president angrily rejected Musk's plan to end the war by ceding territory to its attacker.[218]

Classified and commercial satellite imagery has also proven extremely useful for Ukrainian military operations and for mobilizing a united Western response to Russian aggression. This raised concerns early in the war that Russia might use its counterspace capabilities against those satellites, but that has not happened yet, either.[219] Here again, Russia would gain little, if any, military benefit by destroying one of many imagery satellites operating over Ukraine, but would likely face strong political disapproval for crossing this Rubicon, not only from Western countries but also from space-faring nations like India and China.

Russian jamming of GPS navigation and timing signals has had no effect on U.S. military support operations and little effect on Ukraine's ability to use precision weapons provided by the West.[220] U.S. military equipment is hardened against jamming. Russia may also be reluctant to do as much GPS signal jamming as it could to avoid disruptions for Russian pilots, who sometimes use GPS rather than GLONAS, the less reliable Russian satellite navigation system, and to keep Ukraine from finding and destroying high-power jamming equipment.[221]

The fact that Russia has largely tolerated extensive use of space-based communication, navigation, and imagery services by Ukraine and its Western allies substantiates Ash Carter's caution against assuming that adversaries will use their counterspace capabilities regardless of whether the short-term benefits gained outweigh the broader costs. Russian officials seem to have figured out quickly that hacking SATCOM terminals and jamming GPS receivers did not paralyze Ukraine's defenders or frighten its leader into surrender, but that such actions did cause problems for its own forces and wasted scarce resources. Russia remains capable of upping the ante by destroying a commercial satellite or even one owned by the U.S. government. But while it has taken many other senselessly brutal actions during the first year of war, Russia has been relatively restrained in space. This contradicts U.S. intelligence predictions that Russia would neutralize or deny whatever perceived advantages an adversary might get from space.[222]

Russia and China have no realistic prospect of obtaining some new type of military space capability that could grant them such a major strategic advantage over the United States and its allies that Moscow and Beijing would be confident enough of victory at an acceptable cost to start another war of choice. Regardless of how the war in Ukraine ends, Russia is unlikely to have the money or technological talent needed to make major advances in military-relevant space capabilities anytime soon. China's ability to continue advancing its military-relevant space capabilities has not been diminished by the war in Ukraine. Instead, its incentives to do so

may have increased, but the same can be said for the United States. Russia's major miscalculations about how well its military would perform in Ukraine, how Ukrainians would react, and how the West would respond have presumably provided a cautionary lesson for China that advances in counterspace capabilities and other types of military modernization do not guarantee a low-cost victory even against a much less capable neighbor.[223] Assuming China and the United States both continue to improve their military space capabilities at least partially in response to what the other side is doing, Chinese leaders are highly unlikely to develop a high enough confidence in their ability to neutralize U.S. nuclear and conventional military superiority that they would start a war of choice when core national interests were not threatened.

Crisis Instability and Escalation Control

Recent advances in military-relevant space capabilities are more likely to have negative effects on the second dimension of strategic stability, especially when coupled with nuclear force structures and doctrines that include preparations to attack preemptively, launch on warning, or escalate to limited nuclear use to end a conventional conflict on favorable terms.

Space is a harsh environment, and satellites cannot be hardened against various hazards without adding weight that increases launch costs and shortens the satellite's lifetime. The likelihood of unintended interference and collisions is also growing as space becomes more congested. The number of active satellites in space rose from about one thousand in 2008, to two thousand in 2018, to nearly five thousand in 2021, with many more launched since then.[224] If an important satellite stopped functioning properly for any reason during a crisis, the United States could have difficulty quickly determining whether it had been attacked, hit by a small piece of space debris, had a technical malfunction, or suffered some other fate. Russia and China have less space situational awareness and thus less ability to accurately determine whether loss of service from a satellite signaled that war was about to start. If one country assumes the beginning of a coordinated ASAT operation is underway, it may decide to escalate quickly to avoid ceding significant advantages to the adversary.

These dangers are compounded by nuclear doctrines that posit strategic advantages to striking first or escalating rapidly if an adversary appears poised to do so. An extreme example of how advances in military space capabilities increase the risk of inadvertent nuclear war involves how those advances are sometimes cited as finally providing capabilities that the United States could use to conduct a disarming first strike if provoked. Some American analysts have argued enthusiastically that U.S. progress in remote

sensing, machine learning, targeting, and tracking capabilities, combined with highly accurate warheads, makes foreign nuclear forces in any type of basing mode vulnerable enough that launching a U.S. preemptive first strike, especially against North Korea's or China's relatively small strategic arsenal, might be less risky than waiting to see what happens after they put nuclear forces on alert.[225] China has been reorienting its own nuclear posture because its leaders believe that the "likelihood of a U.S. first strike has gone up."[226] Such claims exaggerate U.S. capabilities and downplay significant challenges. For example, in December 2021, the Air Force revealed that its experimental target recognition program had achieved a 25 percent success rate in classifying surface-to-surface missiles, but the program itself claimed to have achieved a 90 percent success rate.[227] Nevertheless, these experimental programs fuel efforts by other countries to counter worst-case scenarios that sound completely unrealistic to most Americans, such as Rogozin's assertion that a U.S. aerospace strike could destroy 80–90 percent of Russia's strategic arsenal. Relying on technologies with such vulnerabilities leaves the United States with the worst of both worlds. The postulated counterforce missions remain unattainable, and the pursuit of the necessary technology provokes strong responses from Russia and China.

A more realistic understanding of current U.S. nuclear deterrence policy still indicates ways in which great-power advances in military space capabilities could exacerbate crisis instability. Official U.S. nuclear doctrine does not include plans to execute a disarming first strike if nuclear war looks imminent; the United States is, and probably always will remain, a long way from being able to launch a disarming first strike and have a missile defense system that could limit residual damage to an acceptable level.[228] The 2022 Nuclear Posture Review (NPR) does, however, include language indicating that the United States should try to limit damage by attacking preemptively to destroy as much of the adversary's strategic forces as possible before they are launched, then using missile defense to intercept as many of the remaining weapons as it can. The Biden NPR is less explicit in this regard than the Trump administration's NPR, but it includes passages that point in this direction. For example, the 2022 NPR still specifies that the role of nuclear weapons is not only to deter strategic attacks and reassure allies but also to "achieve U.S. objectives if deterrence fails . . . and to end any conflict at the lowest level of damage possible on the best achievable terms."[229]

The 2022 NPR emphasizes the integration of nuclear and conventional forces more than previous versions did, indicating increased reliance on space-enabled precision conventional weapons for strategic missions. The NPR is coupled with a Missile Defense Review that seeks to reassure Russia and China that the U.S. homeland missile defense system is "neither

intended for, nor capable of defeating the large and sophisticated" strategic nuclear arsenals they possess.[230] At the same time, it underscores that integrated air and missile defense systems are being developed to address all regional missile threats (e.g., ballistic, hypersonic, and cruise missiles, plus lower-tier threats like rockets and unmanned aircraft systems) from any source.[231] The document also feeds Chinese and Russian concerns about how even limited U.S. missile defense capabilities support power projection and encourage greater risk-taking by noting that "damage limitation offered by missile defenses expands decision making space for senior leaders at all levels of conflict, and preserves capability and freedom of maneuver for U.S. forces."[232]

Russia and China may be making destabilizing changes to their nuclear doctrines to keep their strategic forces from being destroyed by a postulated U.S. first strike. After the Trump administration announced plans to withdraw from the 1987 INF Treaty in early 2019, Russian security expert Sergey Rogov warned that, if the United States deployed highly accurate, formerly banned missiles in the Baltic states or Poland, flight time to Russian nuclear facilities would be a matter of minutes, too short for Russia to determine whether an indicated launch had actually occurred, where the missile was aimed, and whether it had a nuclear warhead.[233] A 2020 document on Russian principles for nuclear deterrence suggests that they may be moving toward a launch-on-warning posture rather than the previous policy of waiting to retaliate until there is confirmation of a nuclear attack.[234] In 2020, the DOD also publicly noted the possibility that China was moving from its long-standing posture of keeping nuclear warheads separate from their delivery systems toward keeping at least a portion of its nuclear force prepared to launch upon warning of an attack.[235]

Some space-related sources of crisis instability come from conventional war-fighting doctrines that assume a strategic advantage can be gained at the outset of a war by disabling or destroying satellites used by the other side to collect and disseminate information utilized to coordinate joint military operations in high-intensity conflicts. Russian experts have pointed out that modern U.S. precise-strike weapons are highly dependent on satellite navigation and guidance, and they have argued for the need to deny U.S. forces access to these satellite services in a conflict. Chinese analysts have made similar arguments. For example, if the United States were in a conventional war with China or Russia, entanglement—that is, the use of the same space assets for both nuclear and conventional military purposes—could result in a nuclear war that nobody wanted.[236] Here, perhaps the most likely scenario involves a decision to disable U.S. missile defense systems by attacking the Defense Support Program (DSP) and Space-Based Infrared System satellites that detect missile launches and stall the missile

defense process. Around the time that China significantly increased its ASAT-related work, four PLA officers published a detailed analysis of various ways to destroy DSP satellites. They argued that developing this capability was important for maintaining China's ability to deter the United States, without considering how the United States would respond to the loss of sensors that it also uses for early warning of a nuclear attack.[237] Among Chinese experts, an understanding of how provocative this would be and how it could be misinterpreted as the prelude to a nuclear attack has grown, but the option still might prove tempting.[238] If such an attack on early warning satellites were to occur during a conventional conflict, American decision-makers might conclude that China was preparing to initiate nuclear use, perhaps as a desperate escalate-to-de-escalate move, regardless of its official "no first use" policy. That worst-case interpretation would itself be destabilizing regardless of how unrealistic it actually was.[239]

Here, Ash Carter's 1985 prediction that ASAT development could have a silver lining if it dissuaded countries from using vulnerable satellites for missions that other space powers find intensely threatening has not been borne out. Instead, China and Russia have invested heavily in the development of ASAT weapons to disable key components of missile defense systems ever since Bush withdrew from the ABM Treaty. They may have hoped that developing this capability would dissuade the United States from continuing to spend hundreds of billions of dollars on developing defenses against long-range ballistic missiles that could be rendered inoperable by a small number of ASAT weapons. However, instead of giving up on missile defense and accepting mutual nuclear vulnerability as inescapable so long as nuclear weapons exist, the United States has embraced the idea of distributing early warning and missile-tracking sensors across many satellites linked together in the nascent National Defense Space Architecture. Such U.S. efforts to increase resilience are intended to enhance strategic stability by reducing the military significance of disabling a single satellite. But Russia and China view missile defense as destabilizing, so the more the United States does to reduce concerns about one type of vulnerability, the more Russia and China will invest in other types of countermeasures.

Arms Racing and Arms Control

These assessments of the extent to which major-power advances in military-relevant space technologies erode the first two dimensions of strategic stability amount to informed speculation. The feared outcome has not happened yet, and no reliable method allows us to measure how much the risks of deliberate attack or inadvertent war have grown, and how much of

that change can be attributed to (perceived) changes in military space capabilities. The negative effects on the third dimension of strategic stability are more tangible.

These effects can be seen in the action-reaction dynamics discussed above. The Russian and Chinese ASAT-related programs of greatest concern to the United States were stimulated by their discomfort with how the Clinton administration used its "reconnaissance strike" capabilities without UN Security Council approval, how the Bush administration's quest for comprehensive military space dominance fit into its unilateral security plans on earth, and how the United States has sometimes used its military, political, economic, and information power to intervene in the internal affairs of other countries in ways that threaten Russian and Chinese regime security. Instead of acknowledging that Chinese and Russian development of ASAT-relevant capabilities was at least in part a defensive effort to deny the United States the uncontested ability to use space for a range of military purposes that Moscow and Beijing found threatening, DOD officials associated with Third Offset thinking, Trump administration officials, hawkish members of Congress, and many other Americans attributed aggressive motives to the other major powers and pushed for major increases in U.S. spending on military space programs. The rhetoric used to discuss space security was more confrontational during the Bush and Trump administrations and somewhat more cooperative vis-à-vis Russia and China during the Obama and Biden years. But increased secrecy around U.S. military space spending and expanded classification of military space development activities leave all three countries pursuing space acquisition plans based on worst case assumptions about the other sides' capabilities and intentions.

Over the past decade, commentators in all three countries have been recycling Johnson's admonition that "control of space means control of the world" for the same political purpose that he had: to urge their leaders to build up their country's space capabilities enough to prevent their rivals from using space to dominate them. They seem unaware that, when Johnson accused Eisenhower of letting the Soviets get a dangerous lead in space, the president's advisers had already convinced him to try using diplomacy to protect military uses of space that were stabilizing and to keep the space race from going in directions that would be particularly destabilizing and wasteful. When Johnson was president, he used arms control to obviate the prospect of either superpower gaining strategic advantage by asserting sovereign claims in space: Articles I and II of the 1967 OST established that space was free for all to use for mutually beneficial purposes and that it could not be subject to national appropriation by any means. This time, though, rapid increases in military spending spurred by

dire warnings about the stakes in a purported U.S.-China competition for space superiority have not been accompanied by a sustained U.S. effort to get agreement on new legally binding restrictions on the types of military space activities that each country finds most threatening. Instead, some Americans have evinced a "bring it on" mentality regarding a military space race.[240] Such bravado implies that the United States could outspend and outcompete peer rivals, causing their collapse, a misreading of Cold War history that is inapplicable to the U.S.-China case.

U.S. officials accuse Russia and China of being hypocritical and duplicitous for advancing their own ASAT-relevant capabilities while mobilizing international support for PAROS negotiations intended to constrain U.S. military space programs.[241] Yet, the United States has often adopted a "dual track" response to a particular military capability that an adversary has but it does not, such as Soviet intermediate-range missiles deployed in Europe in the 1970s.[242] Proponents claim that such U.S. arms buildups are necessary both to incentivize the other side to negotiate mutual limitations and to strengthen deterrence if diplomacy fails.[243] Some American critics of the Bush administration's unilateralist approach to space security hypothesized that China's 2007 ASAT test could have been intended to kick-start negotiations on an ASAT ban, while others doubted that China would end a twenty-year effort to acquire hit-to-kill capabilities, started in response to Reagan's SDI, unless the United States addressed China's more basic concerns about the United States seeking "absolute security" at China's expense.[244] Whether Chinese leaders hoped that testing an ASAT weapon would convince the United States that legally binding arms control was needed to prevent an arms race in outer space, that action had the opposite effect: it substantiated claims that the United States needed more counterspace capabilities to protect vulnerable satellites from Chinese threats.

Effects on Political Relations

Action-reaction patterns in space that have accelerated ASAT-relevant technology development, increased funding for military space acquisition, and spurred cynicism about arms control have also contributed to a downward spiral in great-power relations. One cannot say to what extent advances in military space capabilities are a cause or an effect of deterioration in political relations, but the two are clearly mutually reinforcing. What started as questions about how the United States intended to use the military space capabilities that it continued to improve after the Cold War ended, or what China might do with the dual-use space technologies that it was rapidly developing by the late 2000s, have now hardened into assumptions that

two implacable adversaries are fighting for military space superiority as an essential element of competition between great powers with radically different visions for "what comes next."[245]

The Biden administration's National Security Strategy does not depict U.S. relations with China, Russia, and other authoritarian countries in purely zero-sum terms. It acknowledges that major powers have a responsibility to work together on shared challenges like climate change, pandemics, and proliferation. It also commits the United States to manage its competition with authoritarian countries responsibly and to "seek greater strategic stability through measures that reduce the risk of unintended military escalation, enhance crisis communication, build mutual transparency, and eventually engage Beijing on more formal arms control efforts."[246] The National Defense Strategy released at the same time notes that the risk of inadvertent escalation is particularly high in the space and cyber domains "due to unclear norms of behavior and escalation thresholds, complex domain interactions, and new capabilities."[247]

Negative effects on the political dimension of strategic stability exacerbate problems in the other three dimensions. This is apparent in the Biden administration's current efforts to promote responsible actions in space and reduce the risk of inadvertent escalation by gaining agreement among space-faring countries on norms of behavior, such as how satellites should interact with other satellites during close-proximity operations in GEO.[248] Its first high-profile norm-building initiative began with Vice President Kamala Harris's announcement that the United States would no longer conduct destructive direct-ascent ASAT missile tests. She encouraged other countries to make similar pledges and join the United States in establishing this as a norm for responsible behavior in space.[249] Making a unilateral declaration was a bold move that went beyond what Obama did on this issue. It sparked a series of similar declarations by U.S. allies and spawned a UN resolution on the topic that 155 countries endorsed.[250] China, Russia, Iran, and several other countries voted against that resolution, reinforcing the Western perception that they are irresponsible space users who think the benefits of demonstrating that they can destroy any of the over three thousand satellites currently in LEO outweigh the environmental, economic, and political costs of generating more space debris.

The Biden administration considered reviving the Obama administration's effort to make a joint presidential commitment with China rather than a unilateral announcement, then cosponsoring a UNGA resolution against debris-generating ASAT tests, but political relations had deteriorated in the wake of Pelosi's visit to Taiwan to the extent that this seemed unfeasible. Chinese unwillingness to engage on the topic at that time was a missed opportunity to better understand what the United States had in

mind and, perhaps, suggest ways to modify the resolution introduced by the United States so that many if not all of the countries that ended up opposing or abstaining would instead have voted for it as a worthwhile first step. Instead, the Russians and Chinese went on record calling U.S. motives for promoting a political commitment not to carry out further testing of direct-ascent ASATs "dubious" and "one-sided and hypocritical." They also belittled the arms control significance of not testing one type of ASAT while developing other means of interfering with satellites; not renouncing ASAT production, possession, or combat use; and not supporting Russian and Chinese proposals regarding PAROS and a "no-first-placement of weapons in outer space" pledge.[251] This type of polarization does not bode well either for agreement on small cooperative steps to enhance space security or for the major powers' ability to work together constructively to address other shared global challenges.

Concluding Observations

The destabilizing effects of advances in military-relevant space technologies that have occurred over many decades are clearly driven by politics and perceptions at least as much as they are by technical characteristics and relative capabilities. During the Cold War, U.S. decisions about how to react to Sputnik, co-orbital ASAT tests, and other Soviet space activities were influenced by the state of superpower relations, U.S. domestic politics, and judgments about whether the Soviets shared U.S. desires for stable nuclear deterrence and reciprocal restraint in space. After the Cold War, Russia and China became more concerned about how the United States would use its military space capabilities when NATO engaged in precision airstrikes against Serbia over Kosovo without UN Security Council approval and especially after the Bush administration sought comprehensive U.S. military space dominance to enable layered missile defense, support its Prompt Global Strike program, and wage its preventive war against Iraq. In response, Russia and China accelerated work on a range of military-relevant space capabilities that initially attracted relatively little attention from U.S. policy-makers and security experts, then generated increasing alarm as more Americans viewed the developments through the frame of renewed great-power competition. The Obama and Biden administrations have tried to soften the most adversarial aspects of their predecessors' national security space policies, promoting voluntary transparency and confidence-building steps and norms of responsible behavior in space, but Russian and Chinese perceptions of these overtures have been colored by the simultaneous continuation of U.S. military space development efforts from earlier administrations that are viewed as evidence of hegemonic

intent. They have questioned U.S. motives, countered with space arms control proposals that have long been unacceptable to the United States, and sometimes refused even to talk about cooperative ways to enhance strategic stability in space.

These developments have several implications for space and global security. First, Americans need to have a fuller understanding of how developments in U.S. space policy and capabilities are perceived by other major space powers, and vice versa. The historical narrative in the first section of this paper is consistent with the dominant view in the U.S. national security space community that, after the Cold War ended, the United States shifted the focus of its military space activities to address emerging threats from proliferation, terrorism, civil conflict, and wars in the Middle East. While the United States was concentrating on these global security challenges, the argument goes, China and Russia developed an array of ASAT capabilities that they could use to offset U.S. conventional military superiority and erode its economic power. Russian and Chinese experts tell a very different story, depicting their advances in military-relevant space capabilities as partly defensive and partly a by-product of technological advances motivated by commercial and civilian space ambitions. The point is not to argue about which narrative is more accurate or to justify any particular action taken in the space domain as a necessary and appropriate reaction to something another major power did first. Instead, it is to suggest that one characteristic of a responsible space power might be to show more self-awareness of how its actions affect and are perceived by others.

Second, while secrecy exacerbates the worst-case thinking that drives the security dilemma in space, increasing transparency can also be destabilizing if it is done for competitive rather than cooperative reasons. The United States has historically provided more information about its military space spending, acquisition plans, policies, and activities in space than Russia or China has done. Public documents and statements, however, are often vague, inviting multiple interpretations, and much of what the United States does in the space domain has always been classified. Changes to military space budget accounting methods made during the Obama administration further complicated efforts by nongovernmental experts and foreign governments to assess change and continuity across the many years needed to go from basic research with transformative potential to operational capabilities deployed in space.

Greater transparency would enhance congressional oversight and inform public debates about how much the United States should currently be spending to make its space architecture more resilient. If done for cooperative reasons, it could enhance space security in other ways too. Being

more transparent can build confidence among space users that one is behaving responsibly in that shared environment and not acting aggressively, regardless of whether other countries are equally transparent. For example, a previously classified capability can be publicly unveiled to provide reassurance that it is not as sinister as suspected.

That same action, though, could be taken, or perceived to be taken, for more adversarial reasons, such as putting others on notice that one actually has better national security space capabilities than they might have thought. Debate was heated early in the Biden administration about whether to go through with a plan approved by Trump officials to declassify and demonstrate a secret space weapon, possibly at the 2021 National Space Symposium.[252] Biden space policy officials decided against this proposal from Space Force. Not knowing what the classified program is or how the big reveal was going to be framed makes it hard to judge whether this would have been a cooperative or competitive use of transparency.

Our assessment indicates that the Biden administration is correct to see emerging space technologies as raising the risks of inadvertent deterrence failure more than the incentives for Russia or China to initiate another war of choice anytime soon. This suggests that overreaction might be more dangerous than underreaction right now. Chyba, Acton, and some others who study the effects of emerging technologies on strategic stability have also recommended more realistic threat assessments, more attention to unintended consequences, and more self-restraint regarding the development and use of technologies that shorten decision time and expand potential destruction. But such recommendations go against military inclinations.

Given the current state of U.S. relations with Russia and China and the strength of competitive nationalist sentiment inside all three major powers, self-restraint might seem an easier way than formal arms control to dampen action-reaction dynamics and make space-related security dilemmas seem a little less intense. Unfortunately, the mix of suspicions, misperceptions, and genuine conflicts of interest responsible for each country justifying its own space programs as necessary defensive measures given what other major powers are doing makes it difficult to exercise self-restraint without being attacked by domestic political rivals for ceding some advantage to an adversary, as Eisenhower was after Sputnik. Ambiguous efforts to encourage reciprocal strategic restraint can also backfire, as occurred during the Obama administration when the United States, Russia, and China each paid far more attention to space-related developments that seemed threatening than they did to indicators of restraint, such as China not testing debris-generating ASATs again and Obama opting to prioritize space resilience over increasing U.S. offensive capabilities.

The United States, China, and Russia should make a sustained investment in developing the concepts, capabilities, and personnel needed for real progress on space diplomacy to match advances in space technology. The superpowers made various bilateral and multilateral arms control agreements to enhance strategic stability during the Cold War. These ranged from the reciprocal restraint regarding ASAT use that continues despite decades of assertions about the inevitability of space warfare, to nonbinding agreements establishing shared expectations that differentiate between normal military activities and those that are unacceptably aggressive or irresponsible, to legally binding treaties like the OST.

History shows that the United States should be careful about using tacit bargaining strategies to incentivize reciprocal restraint. Vague cooperative proposals have been rejected because the terms were unclear or were assumed to be something other than what the United States actually had in mind. The superpowers had trouble determining whether the other side's ASAT-related tests and capabilities were restrained relative to what they were technologically and financially capable of doing at that point. When the United States tried to get the Soviets to stop co-orbital ASAT tests in the 1970s by threatening to deploy the direct-ascent ASAT system that had previously been a low-level technology demonstration project, the Soviets paid more attention to advancing U.S. ASAT capabilities than they did to the cooperative side of this dual-track strategy.

Geopolitics, global economic interdependence, and cutting-edge technologies are much different today than they were during the Cold War, so the kinds of formal and informal arms control arrangements that would be mutually beneficial, verifiable, and equitable must change accordingly. Some creative thinking about this problem is already underway.[253] For such thinking to gain traction and yield results over time, though, the United States, China, and Russia each need to acknowledge that trying to enhance its own security by building up its military space capabilities without regard for other countries' interests and concerns will be increasingly expensive, unnecessarily dangerous, and ultimately counterproductive.

Authors' Note

We would like to thank Chris Chyba, Laura Grego, David Koplow, Clay Moltz, Victoria Samson, Brian Weeden, Tong Zhao, and the participants at the American Academy and Hoover Group Joint Discussion Seminar on Space and Strategic Stability in October 2022 for helpful comments on earlier drafts of this manuscript. We also thank Carnegie Corporation of New York for financial support.

Endnotes

1. Nathan Hodge, "Russian Generals Want Their Space Weapons, Too," *Wired*, May 13, 2010, https://www.wired.com/2010/05/russian-generals-want-their-space-weapons-too.

2. *National Defense Authorization Act for Fiscal Year 2016: Hearing on Fiscal Year 2016 Budget Request for National Security Space before the Committee on Armed Services, Subcommittee on Strategic Forces*, 114th Cong. (2015) (testimony of Gen. John Hyten, Commander, U.S. Air Force Space Command; testimony of Douglas Loverro, Deputy Assistant Secretary of Defense for Space Policy), https://www.govinfo.gov/content/pkg/CHRG-114hhrg94232/html/CHRG-114hhrg94232.htm.

3. Elbridge A. Colby and Michael S. Gerson, eds., *Strategic Stability: Contending Interpretations* (Carlisle, PA: Strategic Studies Institute, 2013), https://ssi.armywarcollege.edu/2013/pubs/strategic-stability-contending-interpretations.

4. Lawrence Freedman, *The Evolution of Nuclear Strategy* (London: MacMillan, 1983).

5. Everett Carl Dolman, "New Frontiers, Old Realities," *Strategic Studies Quarterly* 6 (1) (Spring 2012): 93, https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-06_Issue-1/dolman.pdf.

6. Thomas Schelling and Morton Halperin, *Strategy and Arms Control* (New York: Twentieth Century Fund, 1961), 2.

7. Lora Saalman, "Placing a Renminbi Sign on Strategic Stability and Nuclear Reductions," in *Strategic Stability*, ed. Colby and Gerson, 343–381.

8. Lora Saalman, "China and the U.S. Nuclear Posture Review," Carnegie-Tsinghua Center for Global Policy, February 2011, https://carnegieendowment.org/2011/02/28/china-and-u.s.-nuclear-posture-review-pub-42705.

9. For a more detailed version of this historical background, see Nancy Gallagher and John Steinbruner, *Reconsidering the Rules for Space Security* (Cambridge, MA: American Academy of Arts and Sciences, 2008), https://www.amacad.org/publication/reconsidering-rules-space-security.

10. Walter A. McDougall, *The Heavens and the Earth* (Baltimore: Johns Hopkins University Press, 1997), 122–123.

11. Clay Moltz, *The Politics of Space Security*, 3rd ed. (Palo Alto, CA: Stanford University Press, 2019), 90–94.

12. "Text of Johnson's Statement on Status of Nation's Defenses and Race for Space," *The New York Times*, January 8, 1958, 10, https://www.nytimes.com/1958/01/08/archives/text-of-johnsons-statement-on-status-of-nations-defenses-and-race.html.

13. Clayton K. S. Chun, *Shooting Down a "Star": Program 437, the U.S. Nuclear ASAT System, and Present-Day Copycat Killers*, Cadre Paper no. 6 (Maxwell Air Force Base, AL: Maxwell Air University Press, 2000), https://media.defense.gov/2017/Nov/21/2001847039/-1/-1/0/CP_0006_CHUN_SHOOTING_DOWN_STAR.PDF.

14. Laura Grego, "A History of Anti-Satellite Weapons Programs," Union of Concerned Scientists, 2012, https://allthingsnuclear.org/lgrego/an-updated-history-of-anti-satellite-weapons.

15. Paul Stares, *The Militarization of Outer Space: U.S. Policy, 1945–48* (Ithaca, NY: Cornell University Press, 1985).

16. Schelling and Halperin, *Strategy and Arms Control*.

17. See Steven Weber, *Cooperation and Discord in U.S.-Soviet Arms Control* (Princeton, NJ: Princeton University Press, 1991), 204–272; and Steven Weber and Sidney Drell, "Attempts to Regulate Military Activities in Space," in *U.S.-Soviet Security Cooperation*, ed. Alexander George et al. (New York: Oxford University Press, 1988), 373–431.

18. "Introduction to Outer Space," in James Killian, *Sputnik, Scientists, and Eisenhower* (Cambridge: MIT Press, 1977), 288–299. The primer was originally released by the White House on March 26, 1958.

19. Raymond Garthoff, "Banning the Bomb in Outer Space," *International Security* 5 (3) (Winter 1980/1981): 27, https://doi.org/10.2307/2538418.

20. "Research and Development as a Factor in Defense Procurement," address by Deputy Secretary of Defense Roswell L. Gilpatric, South Bend, Indiana, September 5, 1962, reprinted in *Congressional Record*, September 21, 1962, Appendix, A7007–7009.

21. Garthoff, "Banning the Bomb," 30–34.

22. For domestic political reasons, this agreement took the form of parallel U.S. and Soviet statements of intent that were formally endorsed on October 17, 1963, by UN General Assembly Resolution 1884, "Stationing Weapons of Mass Destruction in Space." See ibid., 25–40.

23. "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies" (1966), United Nations Office for Outer Space Affairs, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html.

24. Weber, *Cooperation and Discord*, 238; and Weber and Drell, "Attempts to Regulate Military Activities in Space," 391.

25. Stares, *The Militarization of Outer Space*, 164.

26. Weber and Drell, "Attempts to Regulate Military Activities in Space."

27. Raymond Garthoff, *Détente and Confrontation*, rev. ed. (Washington, D.C.: Brookings, 1994), 214.

28. Ibid., 214–215.

29. Jeffrey T. Richelson, *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea* (New York: Norton, 2006), 279.

30. Phillip J. Klass, "Anti-Satellite Laser Use Suspected," *Aviation Week and Space Technology*, December 8, 1975, 12, https://archive.aviationweek.com/issue/19751208; "DOD Continues Satellite Blinding Investigation," *Aviation Week and Space Technology*, January 5, 1976, 18, https://archive.aviationweek.com/issue/19760105; and "A Visit to Sary Shagan and Kyshtym," *Science and Global Security* 1 (1–2) (1989): 12.

31. Paul Stares assessed that countering U.S. military capabilities was the most likely motive for the resumption of Soviet ASAT testing. He found that press reports indicating that the United States was going to embark on a new ASAT program also played a role. Other experts placed more weight on internal technological motivations than action-reaction dynamics. See Paul Stares, *Space Weapons and U.S. Strategy: Origins and Development* (London: Croom Helm, 1985), 146–155; and Herbert York, *Making Weapons: Talking Peace* (New York: Basic Books, 1987), 275.

32. The Carter administration's two-track ASAT decision is laid out in "Arms Control for Anti-Satellite (ASAT) Systems," PD/NSC-33, March 10, 1978, in *Presidential Decisions: NSC Documents*, ed. Stephanie Feyock (Washington, D.C.: George C. Marshall Institute, 2006), 153; and "National Space Policy," PD/NSC 37, May 11, 1978, in *Presidential Decisions: NSC Documents Supplement: Newly Declassified Excerpts*, ed. R. Cargill Hall (Washington, D.C.: George C. Marshall Institute, 2006), sec. 2.D, 6.

33. David Hafner, "Averting a Brobdingnagian Skeet Shoot: Arms Control Measures for Anti-Satellite Weapons," *International Security* 5 (3) (Winter 1980/1981): 44, https://doi.org/10.2307/2538419.

34. Ibid., 49.

35. Garthoff, *Détente and Confrontation*, 836–837.

36. Richard Pipes, "Why the Soviet Union Thinks It Could Fight and Win a Nuclear War," *Commentary* 64 (1) (July 1977): 21–34.

37. "National Space Policy," National Security Decision Directive 42, July 4, 1982, https://irp.fas.org/offdocs/nsdd/nsdd-042.htm.

38. Pavel Podvig, "Did Stars Wars Help End the Cold War? Soviet Response to the SDI Program," *Science and Global Security* 25 (1) (2017): 3–27, http://doi.org/10.1080/08929882.2017.1273665.

39. Ashton Carter, "Satellites and Anti-Satellites: The Limits of the Possible," *International Security* 10 (4) (Spring 1985): 46–98, https://doi.org/10.2307/2538950.

40. Ibid., 68.

41. John David Steinbruner, *The Significance of Joint Missile Surveillance* (Cambridge, MA: American Academy of Arts and Sciences, 2001), https://www.amacad.org/publication/significance-joint-missile-surveillance.

42. Victoria Samson, "Prospects for Russian-American Missile Defence Cooperation: Lessons from RAMOS and JDEC," *Contemporary Security Policy* 28 (3) (2007): 494–512, https://doi.org/10.1080/13523260701737778.

43. William J. Perry, "Military Action: When to Use It and How to Ensure Its Effectiveness," in *Global Engagement*, ed. Janne Nolan (Washington, D.C.: Brookings, 1994), 235–242.

44. Joseph S. Nye Jr. and William A. Owens, "America's Information Edge," *Foreign Affairs* (March/April 1996), https://www.foreignaffairs.com/articles/united-states/1996-03-01/americas-information-edge.

45. U.S. Space Command, *Vision for 2020* (Peterson Space Force Base, CO: United States Space Command, 1997), https://thecommunity.com/wp-content/uploads/2018/08/Vision2020.pdf.

46. Theresa Foley, "Space: 20 Years Out," *Air Force Magazine Online* 83 (2) (February 2000): 2. Foley quotes SPACECOM Commander General Richard B. Meyers.

47. U.S. Space Command, *Vision for 2020*.

48. Ibid., n.p.

49. "U.S. Interests and Priorities at the CD: Interview with Robert T. Grey, Jr.," *Arms Control Today*, November 1998, https://www.armscontrol.org/act/1998-11/features/us-interests-priorities-cd-interview-robert-t-grey-jr.

50. Robert Grey, "Weaponization of Outer Space," Bipartisan Security Group Policy Brief, May 9, 2007, http://gsinstitute.org/bsg/docs/05_09_07_Grey_space.pdf.

51. Ibid., 2.

52. *Report of the Commission to Assess United States National Security Space Management and Organization* (Washington, D.C.: The Commission, January 11, 2001), https://aerospace.csis.org/wp-content/uploads/2018/09/RumsfeldCommission.pdf.

53. "Rumsfeld, Mueller Warn of New Attacks," *ABC News*, January 31, 2002, https://abcnews.go.com/US/story?id=91953&page=1.

54. Office of Science and Technology Policy, "U.S. National Space Policy," 2006, https://aerospace.csis.org/bush-us-national-space-policy.

55. Ibid., 4.

56. "White House Press Release Concerning the New National Space Policy," September 19, 1996, in Clinton Digital Library, https://clinton.presidentiallibraries.us/items/show/101693.

57. Office of Science and Technology Policy, "U.S. National Space Policy," 2.

58. For an analysis of the more or less technologically sophisticated ways countries could have interfered with U.S. military space operations in the 2000s, see David Wright, Laura Grego, and Lisbeth Gronlund, *The Physics of Space Security* (Cambridge, MA: American Academy of Arts and Sciences, 2005), https://www.amacad.org/publication/physics-space-security-reference-manual.

59. This move followed the Rumsfeld space commission's recommendations to elevate attention to national security space assets as strategic capabilities. It also paved the way for the creation of NORTHCOM after the 9/11 terrorist attacks without exceeding the congressionally mandated cap of ten combatant commands. See Marcia Smith, "U.S. Space Command Re-established after 17-Year Hiatus," SpacePolicyOnline.com, August 29, 2019, https://spacepolicyonline.com/news/u-s-space-command-reestablished-after-17-year-hiatus.

60. Ivan Vlasic, "The Legal Aspects of the Peaceful and Non-Peaceful Uses of Outer Space," in *The Peaceful and Non-Peaceful Uses of Space*, ed. Bhupendra Jasani (New York: Taylor and Francis, 1991), 37–55; and Elizabeth Waldrop, "Weaponization of Outer Space: U.S. National Policy," *High Frontier*, Winter 2005, 36–37.

61. "Appendix D-1A: Space Activities of the U.S. Government: Historical Table of Budget Authority in Real-Year," in *Aeronautics and Space Report of the President to Congress, Fiscal Year 2019 Activities* (Washington, D.C.: NASA, 2020), 225, https://history.nasa.gov/presrep2019.pdf.

62. Walter Pincus, "Space Bomber Program Gets Extra Funding," *The Washington Post*, November 12, 2007.

63. Theresa Hitchens, Michael Katz-Hyman, and Jeffrey Lewis, "U.S. Space Weapons: Big Intentions, Little Focus," *Nonproliferation Review* 13 (1) (March 2006): 48, http://doi.org/10.1080/10736700600861350.

64. For a detailed technical analysis of the military implications of the 2007 Chinese ASAT test, see Jaganath Sankaran, "Limits of the Chinese Threat to the United States," *Strategic Studies Quarterly* 8 (4) (Winter 2014), https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-08_Issue-4/Sankaran.pdf.

65. On the human safety motivation, see Nicholas L. Johnson, "Operation Burnt Frost: A View from the Inside," *Space Policy* 56 (May 2021): 1–5, https://doi.org/10.1016/j.spacepol.2021.101411.

66. Gallagher and Steinbruner, *Reconsidering the Rules for Space Security*, 72.

67. Sebastian Springer, "Obama White House Signals New Tack on Space Militarization," *InsideDefense.com*, January 21, 2009, https://insidedefense.com/daily-news/obama-white-house-signals-new-tack-space-militarization.

68. "Remarks by President Obama as Delivered in Prague," The White House, April 5, 2009, https://obamawhitehouse.archives.gov/the-press-office/remarks-president-barack-obama-prague-delivered.

69. Victoria Samson, "Making a Mark in Space: An Analysis of Obama's Options for a New U.S. Space Policy," *Arms Control Today* (October 2009), https://www.armscontrol.org/act/2009-10/making-mark-space-analysis-obama's-options-new-us-space-policy.

70. *National Space Policy of the United States of America* (Washington, D.C.: The White House, June 2010), https://obamawhitehouse.archives.gov/sites/default/files/national_space_policy_6-28-10.pdf; and Jeff Foust, "A Change in Tone in National Space Policy," *The Space Review*, July 6, 2010, https://www.thespacereview.com/article/1660/1.

71. *National Space Policy*, 3.

72. Deputy Secretary of Defense William J. Lynn, "Remarks," presented at the 26th National Space Symposium, Colorado Springs, CO, April 14, 2010. U.S. Department of Defense, Space Posture Review, 2001, https://dod.defense.gov/News/Special-Reports/SPR; and Office of the Director of National Intelligence, National Security Space Strategy, 2011, https://www.dni.gov/index.php/newsroom/reports-publications/reports-publications-2011/item/620-national-security-space-strategy.

73. Jeff Foust, "The National Space Policy, One Year Later," *The Space Review*, June 27, 2011, https://www.thespacereview.com/article/1873/1.

74. *National Space Policy*, 14.

75. "Appendix D-1A: Space Activities of the U.S. Government," 225.

76. *National Space Policy,* 7.

77. See "Ambassador Laura Kennedy's CD Statement on Space Policy," U.S. Mission to International Organizations in Geneva, February 8, 2011, https://geneva.usmission.gov/2011/02/08/ambassador-kennedy-space-policy. Ambassador Kennedy, the U.S. permanent representative to the Conference on Disarmament, underscored that "Our position on the PPWT, outlined in CD 1847, has not changed—it is fundamentally flawed and provides no basis for a negotiating mandate in the CD for a binding arms control agreement" (ibid.). She was referencing the "Letter Dated 19 August 2008 from the Permanent Representative of the United States of America Addressed to the

Secretary-General of the Conference Transmitting Comments on the Draft Treaty on Prevention of the Placement of Weapons in Outer Space and the Threat or Use of Force against Outer Space Objects (PPWT)," Conference on Disarmament, CD/1847, August 26, 2008, 4, https://digitallibrary.un.org/record/637449.

78. *National Space Policy,* 7.

79. Gregory Kulacki, "Chinese Intentions in Space: A Historical Perspective for Future Cooperation," *Space and Defense* 4 (1) (Winter 2010): 101–113.

80. Moltz, *The Politics of Space Security*, 321–322.

81. Department of Defense and Full-Year Continuing Appropriations Act, Pub. L. no. 112-10, 125 Stat. 38 (2011), https://www.congress.gov/112/plaws/publ10/PLAW-112publ10.htm.

82. Makena Young, "Bad Idea: The Wolf Amendment Limiting Collaboration with China in Space," Defense360°, Center for International and Strategic Studies, December 4, 2019, https://defense360.csis.org/bad-idea-the-wolf-amendment-limiting-collaboration-with-china-in-space; Dingli Shen, "A Chinese Perspective on China-United States Cooperation in Space," *Space and Defense* 2 (3) (December 2009): 64–75, https://www.usafa.edu/app/uploads/Space_and_Defense_2_3.pdf; and Keith Bradsher, "As Last Module Docks, China Completes Its Space Station," *The New York Times*, October 31, 2022, https://www.nytimes.com/2022/10/31/world/asia/china-launch-space-station.html.

83. Turner Brinton, "U.S. Air Force Declined to Help Intelsat with Satellite Maneuver," *Space News*, December 8, 2008, 1.

84. Brian Weeden, "2009 Iridium-Cosmos Collision Fact Sheet," Secure World Foundation, https://swfound.org/media/6575/swf_iridium_cosmos_collision_fact_sheet_updated_2012.pdf (updated November 10, 2010).

85. U.S. Strategic Command, "GSSAP and ANGELS Contribute to Space Neighborhood Watch," July 23, 2014, https://www.stratcom.mil/Media/News/News-Article-View/Article/983725/gssap-and-angels-contribute-to-space-neighborhood-watch.

86. Space Data Association, "The Space Data Association Celebrates 10 Years of SSA/STM Operations with the Space Data Center," press release, July 15, 2020, https://www.space-data.org/sda/press/the-space-data-association-celebrates-10-years-of-ssa-stm-operations-with-the-space-data-center.

87. General John Hyten, head of Air Force Space Command, quoted in Moltz, *The Politics of Space Security*, 328.

88. Members of the Five Eyes alliance—the United States, Canada, the United Kingdom, Australia, and New Zealand—share a broad range of intelligence. *National Defense Authorization Act for Fiscal Year 2016: Hearing on Fiscal Year 2016 Budget Request for National Security Space before the Committee on Armed Services, Subcommittee on*

Strategic Forces, 114th Cong. (2015) (testimony of Lt. Gen. John W. Raymond, Commander, Joint Functional Component Command for Space), https://www.govinfo.gov/content/pkg/CHRG-114hhrg94232/html/CHRG-114hhrg94232.htm.

89. Gregory Schulte and Audrey Schaffer, "Enhancing Security by Promoting Responsible Behavior in Space," *Strategic Studies Quarterly* 6 (1) (Spring 2012): 9, https://www.jstor.org/stable/26270787.

90. Roundtable on Future Space Issues, organized by the Eisenhower Center for Space and Defense Studies, Arlington, VA, September 22–23, 2011.

91. Jordana Mishory, "Tauscher: U.S. Rejects European Space Code, Is Working on Arms Deal with Russia," *InsideDefense.com*, January 12, 2012, https://insidedefense.com/daily-news/tauscher-us-rejects-european-space-code-working-arms-control-deal-russia.

92. Letter to Secretary of State Hillary Clinton, February 2, 2011, in author's personal files. After the Obama administration decided not to agree to the EU code, leading Republican House and Senate members sent the president a letter on January 18, 2012, indicating that they expected the administration to address their concerns prior to any future negotiations with any foreign states on any type of international arms control regime for space like the EU code.

93. "Clinton: U.S. Will Help Draft a Code of Conduct for Space," *SpaceNews*, January 23, 2012, https://spacenews.com/clinton-us-will-help-draft-code-conduct-space.

94. Anatoly Diakov, Eugene Miasnikov, and Timur Kadyshev, "Nuclear Reductions after New START: Obstacles and Opportunities," *Arms Control Today*, May 2011, https://www.armscontrol.org/act/2011-05/nuclear-reductions-after-new-start-obstacles-opportunities.

95. Jaganath Sankaran, *The United States' European Phased Adaptive Approach Missile Defense Systems* (Santa Monica, CA: RAND Corporation), 5, https://www.rand.org/pubs/research_reports/RR957.html.

96. Nancy W. Gallagher, "International Security on the Road to Zero," *Nonproliferation Review* 18 (2) (June 2011): 431–444, https://doi.org/10.1080/10736700.2011.583121.

97. Nancy W. Gallagher, "China on Arms Control, Nonproliferation, and Strategic Stability," in *China's Strategic Arsenal*, ed. James M. Smith and Paul L. Bolt (Washington, D.C.: Georgetown University Press, 2022), 195.

98. Moltz, *The Politics of Space Security*, 322.

99. David C. Gompert and Phillip C. Saunders, *The Paradox of Power: Sino-American Strategic Restraint in an Age of Vulnerability* (Washington, D.C.: Center for the Study of Chinese Military Affairs at the National Defense University, 2011), https://ndupress.ndu.edu/Portals/68/Documents/Books/paradox-of-power.pdf.

100. James B. Steinberg, "Administration's Vision of the U.S.-China Relationship," keynote address at the Center for a New American Security, Washington, D.C., September 24, 2009, https://china.usc.edu/james-steinberg-obama-administrations-vision-us-china-relationship-september-24-2009.

101. Andrea Shalal-Esa, "Space Plays a Growing Role in U.S.-China Security Talks—Official," Reuters, April 11, 2013, https://www.reuters.com/article/us-usa-china-space/space-plays-a-growing-role-in-u-s-china-security-talks-official-idUSBRE93B01W20130412.

102. U.S. Mission to International Organizations in Geneva, "U.S. Statement on Conventional Weapons—Thematic Debate of UNGA First Committee," October 19, 2009, https://geneva.usmission.gov/2009/10/19/conventionalweapons.

103. The White House, "FACTSHEET: President Xi Jinping's State Visit to the United States," Office of the Press Secretary, September 25, 2015, https://obamawhitehouse.archives.gov/the-press-office/2015/09/25/fact-sheet-president-xi-jinpings-State-visit-united-States.

104. Frank A. Rose, *Safeguarding the Heavens: The United States and the Future of Norms of Behavior in Outer Space*, Foreign Policy at Brookings (Washington, D.C.: Brookings, June 2018), https://www.brookings.edu/research/safeguarding-the-heavens-the-united-states-and-the-future-of-norms-of-behavior-in-outer-space.

105. Gian Gentile, Michael Shurkin, Alexandra T. Evans, Michelle Grisé, Mark Hvizda, and Rebecca Jensen, *A History of the Third Offset, 2014–2018* (Santa Monica, CA: RAND Corporation, 2021), ix, 23, https://doi.org/10.7249/RRA454-1.

106. Robert O. Work and Shawn Brimley, *20YY: Preparing for War in the Robotic Age* (Washington, D.C.: Center for New American Security, 2014), 7, https://www.cnas.org/publications/reports/20yy-preparing-for-war-in-the-robotic-age.

107. Ibid., 23.

108. Theresa Hitchens and Joan Johnson-Freese, *Toward a New National Security Space Strategy: Time for a Strategic Rebalancing*, Atlantic Council Strategy Paper No. 5 (Washington, D.C.: Atlantic Council, June 2016), 3, https://www.atlanticcouncil.org/in-depth-research-reports/report/toward-a-new-national-security-space-strategy-time-for-a-strategic-rebalancing-2.

109. Office of the Assistant Secretary of Defense for Homeland Defense and Global Security, *Space Domain Mission Assurance: A Resilience Taxonomy* (Washington, D.C.: Department of Defense, September 2015), https://man.fas.org/eprint/resilience.pdf.

110. Christopher Chyba, "New Technologies and Strategic Stability," *Dædalus* 149 (2) (Spring 2020): 160, https://www.amacad.org/publication/new-technologies-strategic-stability.

111. Matthew Daniels and M. Elizabeth Paté-Cornell, "Quantitative Analysis of Satellite Architecture Choices: A Geosynchronous Imaging Satellite Example," presented at 30th Space Symposium, Colorado Springs, CO, May 19–22, 2014, https://www.spacesymposium.org/wp-content/uploads/2017/10/M.Daniels_30th_Space_Symposium_Tech_Track.pdf; and Andrew Hunter and Kaitlyn Johnson, eds., *Small Satellites, Big Missions: The Implications of the Growing Small Satellite Market for Launch and Key Applications* (Washington, D.C.: Center for Strategic and International Studies, September 2017), 5.

112. Kevin L. Pollpeter, Michael S. Chase, and Eric Heginbotham, *The Creation of the PLA Strategic Support Force and Its Implications for Chinese Military Space Operations* (Santa Monica, CA: RAND, 2017), https://doi.org/10.7249/RR2058; and Pavel Podvig, "Russian Space Systems and the Risks of Weaponizing Space," in *Advanced Military Technology in Russia: Capabilities and Implications*, Chatham House Research Paper (London: Chatham House, September 2021), 34–46, https://www.chathamhouse.org/2021/09/advanced-military-technology-russia.

113. Air Force Space Command Public Affairs, "Hyten Announces Space Enterprise Vision," Air Force, April 13, 2016, https://www.af.mil/News/Article-Display/Article/719941/hyten-announces-space-enterprise-vision; and Sandra Erwin, "Q&A: Air Force General Hyten Says U.S. Space Strategy, Budget Moving 'Down the Right Path,'" *SpaceNews*, March 26, 2018, https://spacenews.com/qa-air-force-gen-john-hyten-says-u-s-space-strategy-budget-moving-down-the-right-path.

114. Simons Center for Ethical Leadership and Interagency Cooperation, "JICSpOC Creates More Seamless Coordination across Government," September 30, 2016, https://thesimonscenter.org/ia-news/jicspoc-creates-more-seamless-coordination-across-government.

115. The White House, "President Donald J. Trump Is Unveiling an America First Space Strategy," March 23, 2018, https://trumpwhitehouse.archives.gov/briefings-statements/president-donald-j-trump-unveiling-america-first-national-space-strategy.

116. The DOD had viewed space as a war-fighting domain for decades but had been prohibited from saying so publicly before Trump took office. See ibid.

117. U.S. Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge* (Washington, D.C.: U.S. Department of Defense, 2018), 6, https://www.hsdl.org/c/2018-national-defense-strategy.

118. Phillip Swarts, "The JICSpOC Is Dead; Long Live the National Space Defense Center," *SpaceNews*, April 4, 2017, https://spacenews.com/the-jicspoc-is-dead-long-live-the-national-space-defense-center.

119. Just as the Marine Corp is part of the Navy, the Space Force remained part of the Air Force but gained more control over funds in the space acquisition budget. See Sandra Erwin, "Space Force Proponents in Congress Warn Air Force: 'We Will

Watch You like a Hawk,'" *SpaceNews*, December 11, 2019, https://spacenews.com/space-force-proponents-in-congress-warn-air-force-we-will-watch-you-like-a-hawk.

120. Space Development Agency, "About Us," https://www.sda.mil/home/about-us.

121. Sandra Erwin, "Pentagon Space Procurement and R&D Budget on an Upward Trend: How Long Can This Last?" *SpaceNews*, January 31, 2019, https://spacenews.com/pentagon-space-budget-is-on-an-upward-trend-how-long-can-this-last.

122. Todd Harrison, *Battle Networks and the Future Force: Part 1: A Framework for Debate*, CSIS Briefs (Washington, D.C.: Center for Strategic and International Studies, August 2021), https://www.csis.org/analysis/battle-networks-and-future-force.

123. Nathan Strout, "What Will the Space Development Agency Really Do?" C4ISRNET, July 24, 2019, https://www.c4isrnet.com/battlefield-tech/space/2019/07/24/what-will-the-space-development-agency-really-do.

124. Douglas Loverro, "Why the US Must Lead Again," *The Space Review*, August 14, 2017, https://www.thespacereview.com/article/3307/1.

125. Cynthia Plath quoting Vice President Pence, in Paul Meyer, "Washington Sparks a Space Spat at the United Nations," *The Bulletin*, December 11, 2018, https://thebulletin.org/2018/12/washington-sparks-a-space-spat-at-the-united-nations.

126. Office of the Director of National Intelligence, *Annual Threat Assessment of the U.S. Intelligence Community* (Washington, D.C.: Office of the Director of National Intelligence, February 2022), https://www.dni.gov/index.php/newsroom/reports-publications/reports-publications-2022/item/2279-2022-annual-threat-assessment-of-the-u-s-intelligence-community.

127. Shannon Bugos, "Russian ASAT Test Creates Massive Debris," Arms Control Association, December 2021, https://www.armscontrol.org/act/2021-12/news/russian-asat-test-creates-massive-debris.

128. Julian E. Barnes and Eric Schmitt, "U.S. Warns Allies of Possible Russian Incursion as Troops Amass Near Ukraine," *The New York Times*, November 19, 2021, https://www.nytimes.com/2021/11/19/us/politics/russia-ukraine-biden-administration.html; and Tom Rogan, "Why Russia Just Created an Orbital Debris Field," *The Washington Examiner*, November 15, 2021, https://www.washingtonexaminer.com/opinion/why-russia-just-created-an-orbital-debris-field.

129. Todd Harrison, Katilyn Johnson, Makena Young, Nicholas Wood, and Alyssa Goessler, *Space Threat Assessment 2022*, CSIS Aerospace Security Project (Washington, D.C.: Center for Strategic and International Studies, April 2022), 25, https://www.csis.org/analysis/space-threat-assessment-2022.

130. Cort Thompson, "Russia's Recent Space Activity Is a Return to Old Form," *Lawfare* (blog), April 20, 2020, https://www.lawfareblog.com/russias-recent-space-activity-return-old-form.

131. Angelique Chrisafis, "'Act of Espionage': France Accuses Russia of Trying to Spy on Satellite Data," *The Guardian*, September 7, 2018, https://www.theguardian.com/world/2018/sep/07/france-accuses-russia-spying-satellite-communications-espionage. Reacting to the incident, French Defense Minister Florence Parly speculated that the Russian satellite "was trying to intercept our communications" and called the incident an "act of espionage." Ibid.

132. Thompson, "Russia's Recent Space Activity Is a Return to Old Form."

133. "Russian Space Object 2014-28E Sparks Worries about 'Satellite Killer,'" NBC News, November 18, 2014, https://www.nbcnews.com/science/space/russian-space-object-2014-28e-sparks-worries-about-satellite-killer-n251111; and Sam Jones, "Object 2014-28E—Space Junk or Russian Satellite Killer?" *Financial Times*, November 17, 2014, https://www.ft.com/content/cdd0bdb6-6c27-11e4-990f-00144feabdc0.

134. W. J. Hennigan, "Strange Russian Spacecraft Shadowing U.S. Spy Satellite, General Says," *Time*, February 10, 2020, https://time.com/5779315/russian-spacecraft-spy-satellite-space-force/.

135. Joseph Trevithick, "A Russian 'Inspector' Spacecraft Now Appears to Be Shadowing an American Spy Satellite," *The Drive*, January 30, 2020, https://www.thedrive.com/the-war-zone/32031/a-russian-inspector-spacecraft-now-appears-to-be-shadowing-an-american-spy-satellite.

136. Julian Borger, "Britain and US Accuse Russia of Launching 'Weapon' in Space," *The Guardian*, July 23, 2020, https://www.theguardian.com/world/2020/jul/23/britain-us-accuse-russia-launching-weapon-space-satellite-threat.

137. "While the US Experiments, Russian Laser Weapon 'Peresvet' Active since 2018," *EurAsian Times*, February 10, 2021, https://eurasiantimes.com/while-the-us-experiments-russian-laser-weapons-active-since-last-year; and "Peresvet Combat Lasers Enter Duty with Russia's Armed Forces," TASS: Russian News Agency, December 4, 2018, https://tass.com/defense/1034344.

138. Bart Hendrickx, "Russia Gears up for Electronic Warfare in Space (Part 1)," *The Space Review*, October 26, 2020, https://www.thespacereview.com/article/4056/1; Jonas Kjellén, *Russian Electronic Warfare: The Role of Electronic Warfare in the Russian Armed Forces* (Stockholm: Swedish Defence Research Agency, September 2018), https://www.foi.se/rest-api/report/FOI-R--4625--SE; and Roger N. McDermott, *Russia's Electronic Warfare Capabilities to 2025: Challenging NATO in the Electromagnetic Spectrum* (Tallinn: International Centre for Defence and Security, September 2017), https://icds.ee/wp-content/uploads/2018/ICDS_Report_Russias_Electronic_Warfare_to_2025.pdf.

139. One source suggests that the Murmansk-BN is supported with 400 kW of power and can suppress signals "over an area of 640,000 sq. km." See also Kjellén, *Russian Electronic Warfare*, 50; and McDermott, *Russia's Electronic Warfare Capabilities*, 15.

140. Robert K. Ackerman, "Russian Electronic Warfare Targets NATO Assets," *SIGNAL Magazine*, November 1, 2017, https://www.afcea.org/signal-media/international/russian-electronic-warfare-targets-nato-assets.

141. Dmitry Kornev, "Космос как поле боя [Space as a battlefield]," *Известия* [Izvestia], December 14, 2017, https://iz.ru/680335/dmitrii-kornev/kosmos-kak-pole-boia; and Kjellén, *Russian Electronic Warfare*, 51–54.

142. "Россия начала работу над оружием для поражения спутников" [Russia begins work on weapons to destroy satellites], *Интерфакс* [Interfax], November 30, 2017, https://www.interfax.ru/russia/589740.

143. Lt. Gen. David A. Deptula, William A. LaPlante, and Robert Haddick, *Modernizing U.S. Nuclear Command, Control, and Communications* (Arlington, VA: The Mitchell Institute for Aerospace Studies, Air Force Association, February 2019), 26, https://mitchellaerospacepower.org/modernizing-u-s-nuclear-command-control-and-communications. See also Craig Murray, "China Missile Launch May Have Tested Part of a New Anti-Satellite Capability," U.S.-China Economic and Security Review Commission, Staff Research Backgrounder, May 22, 2013, https://www.uscc.gov/research/china-missile-launch-may-have-tested-part-new-anti-satellite-capability.

144. U.S.-China Economic and Security Review Commission, *2015 Report to Congress of the U.S.-China Economic and Security Review Commission* (Washington, D.C.: The Commission, 2015), 293–294, https://www.uscc.gov/annual-report/2015-annual-report-congress. Some of China's ballistic missile defense tests may also have validated ASAT capabilities. See Roderick Lee, "China's Recent Ballistic Missile Defense Test May Have Actually Been an Anti-Satellite Test," China Aerospace Studies Institute, Air University, February 9, 2021, https://www.airuniversity.af.edu/CASI/Display/Article/2497584/chinas-recent-ballistic-missile-defense-test-may-have-actually-been-an-anti-sat.

145. Brian Weeden and Victoria Samson, *Global Counterspace Capabilities: An Open Source Assessment* (Washington, D.C.: Secure World Foundation, April 2022), https://swfound.org/counterspace.

146. Brett Tingley, "A Chinese Satellite Just Grappled Another and Pulled It Out of Orbit," *The Drive*, January 27, 2022, https://www.thedrive.com/the-war-zone/44054/a-chinese-satellite-just-grappled-another-and-pulled-it-out-of-orbit.

147. Ibid.

148. Andrew Jones, "An Object Is Now Orbiting alongside China's Shijian-21 Debris Mitigation Satellite," *SpaceNews*, November 5, 2021, https://spacenews.com/an-object-is-now-orbiting-alongside-chinas-shijian-21-debris-mitigation-satellite. The object might have been an apogee kick motor. However, in the case of SJ-21, the object did not exhibit behavior typical of an apogee kick motor, which, Jones writes, "usually perform[s] a final maneuver after satellite separation so as not to pose a threat to active satellites through risk of collision. However, both Shijian-21 and the SJ-21 AKM are side by side in geostationary orbit." Ibid.

149. Andrew Jones, "China's Shijian-21 Towed Dead Satellite to High Graveyard Orbit," *SpaceNews*, January 27, 2022, https://spacenews.com/chinas-shijian-21-spacecraft-docked-with-and-towed-a-dead-satellite.

150. Brian Weeden, *Current and Future Trends in Chinese Counterspace Capabilities*, Proliferation Papers No. 62 (Paris: French Institute of International Relations, November 2020), 19, https://www.ifri.org/en/publications/etudes-de-lifri/proliferation-papers/current-and-future-trends-chinese-counterspace.

151. Katie Drummond, "China's Secret Satellite Rendezvous 'Suggestive of a Military Program,'" *Wired*, August 31, 2010, https://www.wired.com/2010/08/chinas-secret-satellite-rendezvous-suggestive-of-a-military-program. The author notes, "depending on who you believe, it's either a sign of China's increasingly sophisticated space program—or a sign of its increasingly sophisticated space warfare program." See also Brian Weeden, "Dancing in the Dark: The Orbital Rendezvous of SJ-12 and SJ-06F," *Space Review*, August 30, 2010, https://www.thespacereview.com/article/1689/1.

152. Rui C. Barbosa, "China 'Secretly' Launch Three Satellites via Long March 4C," Spaceflight, July 19, 2013, https://www.nasaspaceflight.com/2013/07/china-secretly-long-march-4c-three-sats.

153. Thomas G. Roberts, "Unusual Behavior in GEO: SJ-17," Aerospace Security: A Project of the Center for Strategic and International Studies, March 31, 2021, https://aerospace.csis.org/data/unusual-behavior-in-geo-sj-17. See also Weeden, *Current and Future Trends*, 20.

154. Gen. James H. Dickinson, "Fiscal Year 2022 Priorities and Posture of the United States Space Command," presentation to the Senate Armed Services Committee, April 21, 2021, https://www.armed-services.senate.gov/download/dickinson-testimony-042021. See also Ken Moriyasu, "China Can 'Grapple' U.S. Satellites with Robotic Arm, Commander Says," Nikkei Asia, April 21, 2021, https://asia.nikkei.com/Politics/International-relations/US-China-tensions/China-can-grapple-US-satellites-with-robotic-arm-commander-says. A review of China's counterspace doctrinal debates can be found in Mark Stokes, Gabriel Alvarado, Emily Weinstein, and Ian Easton, *China's Space and Counterspace Activities* (Washington, D.C.: U.S.-China Economic and Security Review Commission, March 2020), https://www.uscc.gov/research/chinas-space-and-counterspace-activities.

155. Andrew Jones, "China's Mysterious Spaceplane Releases Object into Orbit," *SpaceNews*, November 2, 2022, https://spacenews.com/chinas-mystery-spaceplane-releases-object-into-orbit.

156. Andrew Jones, "China's Spaceplane Conducted Proximity and Capture Maneuvers with Subsatellite, Data Suggests," *SpaceNews,* May 11, 2023, https://spacenews.com/chinas-spaceplane-conducted-proximity-and-capture-maneuvers-with-subsatellite-data-suggests.

157. Andrew Jones, "China Launches Space Mining Test Spacecraft on Commercial Rideshare Mission," *SpaceNews*, April 27, 2021, https://spacenews.com/china-launches-space-mining-test-spacecraft-on-commercial-rideshare-mission.

158. U.S. Space Command Public Affairs Office, "Russian Direct-Ascent Anti-Satellite Missile Test Creates Significant, Long-Lasting Space Debris," U.S. Space Command, November 15, 2021, https://www.spacecom.mil/Newsroom/News/Article-Display/Article/2842957/russian-direct-ascent-anti-satellite-missile-test-creates-significant-long-last.

159. Defense Intelligence Agency, *2022 Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion* (Washington, D.C.: Defense Intelligence Agency, 2022), https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Challenges_Security_Space_2022.pdf. See also Jaganath Sankaran, "Russia's Anti-Satellite Weapons: A Hedging and Offsetting Strategy to Deter Western Aerospace Forces," *Contemporary Security Policy* 43 (3) (2022): 436–463, https://doi.org/10.1080/13523260.2022.2090070.

160. Defense Intelligence Agency, *2022 Challenges to Security in Space*, 9.

161. Jen Judson, "Chinese Hypersonic Missile Test Unlikely to Trigger Arms Race, Experts Say," *Defense News*, October 20, 2021, https://www.defensenews.com/land/2021/10/20/chinese-hypersonic-missile-test-unlikely-to-trigger-arms-race-experts-say.

162. Representative Mike Gallagher (R-WI), "Statement on Reports of Chinese Hypersonic Missile Test," press release, October 17, 2021, https://gallagher.house.gov/media/press-releases/gallagher-statement-reports-chinese-hypersonic-missile-test.

163. Charles Pope, "FY22 Budget Gives Air and Space Forces the Strength to Meet Threats, Roth, Brown, Raymond Tell Senate," *Air Force News Service*, June 8, 2021, https://www.af.mil/News/Article-Display/Article/2650871/fy22-budget-gives-air-space-forces-the-strength-to-meet-threats-roth-brown-raym.

164. Sandra Erwin, "Congress Gives DOD More Money for Space, with Caveats," *SpaceNews*, March 13, 2022, https://spacenews.com/congress-gives-dod-more-money-for-space-with-caveats.

165. Sandra Erwin, "Biden's 2023 Defense Budget Adds Billions for U.S. Space Force," *SpaceNews*, March 28, 2022, https://spacenews.com/bidens-2023-defense-budget-adds-billions-for-u-s-space-force.

166. Theresa Hitchens, "'Compromise' NDAA Boosts Space Force Budget, but Keeps Tight Reins on Policy Decisions," *Breaking Defense*, December 7, 2022, https://breakingdefense.com/2022/12/compromise-ndaa-boosts-space-force-budget-but-keeps-tight-reins-on-policy-decisions.

167. For a well-written short primer on China's space program see Mark Hilborne, *China's Space Programme: A Rising Star, a Rising Challenge* (London: Lau China Institute, King's College, 2021), https://www.kcl.ac.uk/lci/assets/kssppolicyno.2-final.pdf.

168. Andrew Jones, "On China's New Space Station, a Robotic Arm Test Paves Way for Future Construction," *Space*, January 9, 2022, https://www.space.com/china-space-station-robotic-arm-construction-test.

169. Ibid.

170. Leonard Davis, "U.S.-China Cooperation in Space: Is It Possible, and What's in Store?" *Space*, June 16, 2015, https://www.space.com/29671-china-nasa-space-station-cooperation.html.

171. Eytan Tepper and Scott Shackelford, "China's New Space Station Is Open for Business in an Increasingly Competitive Era of Space Activity," *The Conversation*, December 9, 2022, https://theconversation.com/chinas-new-space-station-opens-for-business-in-an-increasingly-competitive-era-of-space-activity-195882.

172. For example, see Christopher A. Bidwell and Bruce W. MacDonald, *Emerging Disruptive Technologies and their Potential Threat to Strategic Stability and National Security* (Washington, D.C.: Federation of American Scientists, September 2018), https://uploads.fas.org/media/FAS-Emerging-Technologies-Report.pdf.

173. For a more detailed treatment on the hedging and offsetting framework, see Sankaran, "Russia's Anti-Satellite Weapons."

174. Richard A. Best, Jr., "Kosovo: Implications for Military Intelligence," CRS Report for Congress, RL30366, November 5, 1999, https://www.everycrsreport.com/reports/RL30366.html.

175. Alexis A. Blanc, Nathan Beauchamp-Mustafaga, Khrystyna Holynska, M. Scott Bond, and Stephen J. Flanagan, *Chinese and Russian Perceptions of and Responses to U.S. Military Activities in the Space Domain* (Santa Monica, CA: RAND, 2022), https://doi.org/10.7249/RRA1835-1.

176. Aleksey Lyashchenko, "Военно-политическое обозрение: Реанимация гонки ядерных вооружений" [Military-political review: Reanimation of the nuclear arms race], *Красная звезда* [Red star] (147) (2005).

177. Larry M. Wortzel, *The Chinese People's Liberation Army and Space Warfare* (Washington, D.C.: American Enterprise Institute, 2007), 1, https://www.aei.org/wp-content/uploads/2011/10/20071017_SpaceWarfare.pdf.

178. Leonard Davis, "Military Micro-Sat Explores Space Inspection, Servicing Technologies," *Space*, July 22, 2005, https://www.space.com/1336-military-micro-sat-explores-space-inspection-servicing-technologies.html.

179. Ibid.

180. Elaine M. Grossman and Keith J. Costa, "Is XSS-11 a Robotic Handyman or Anti-Satellite Hatchet Man? Small, Experimental Satellite May Offer More than Meets the Eye," *Inside the Air Force* 14 (49) (December 5, 2003): 12–13, https://www.jstor.org/stable/24792055.

181. Stew Magnuson, "New Satellites to Keep Watch over Space-Based Systems," *National Defense*, June 1, 2009, https://www.nationaldefensemagazine.org/articles/2009/6/1/2009june-new-satellites-to-keep-watch-over-spacebased-systems; and "ANGELS Satellite Overview," Spaceflight101.com, n.d., https://spaceflight101.com/spacecraft/angels.

182. "Overview of the DART Mishap Investigation Results," ca. April 15, 2005, https://www.nasa.gov/pdf/148072main_DART_mishap_overview.pdf. Unfortunately, the mission was a failure.

183. AFP, "Russia Rejects Space Weapon Claim as 'Propaganda,'" *The Moscow Times*, July 24, 2020, https://www.themoscowtimes.com/2020/07/24/russia-rejects-space-weapon-claim-as-propaganda-a70964.

184. Sankaran, "Russia's Anti-Satellite Weapons," 437.

185. Mike Wall, "X-37B: The Air Force's Mysterious Space Plane," *Space*, May 15, 2020, https://www.space.com/25275-x37b-space-plane.html; and Mike Wall, "US Military's X-37B Space Plane Lands, Ending Record-Breaking Mystery Mission," *Space*, November 12, 2022, https://www.space.com/space-force-x-37b-space-plane-otv-6-mission-ends. Other experimental programs such as the X-43A, X-51A, X-41 CAV, FALCON HCV-2, AHW, and ArcLight may also have space weapons capabilities.

186. Brian Weeden, "X-37B Orbital Test Vehicle Fact Sheet," Secure World Foundation, updated May 2022, https://swfound.org/media/207377/swf-x-37b-otv-fact-sheet-may-2022.pdf.

187. Jaganath Sankaran, "Russia's Anti-Satellite Weapons: A Hedging and Offsetting Strategy to Deter Western Aerospace Forces," *Contemporary Security Policy* 43 (3) (2022): 436–463, https://doi.org/10.1080/13523260.2022.2090070.

188. B.F. Cheltsov, "Approaches to the Creation of the National Aerospace Defense System in the Conditions of Future Network-Centric Wars," *Military Thought* 17 (4) (2008): 6.

189. Igor Morozov, Baushev Sergey, and Kaminsky Oleg, "Космос и характер современных военных действий" [Space and the nature of modern military operations], Воздушно-Космическая Оборона [Aerospace defense], August 11, 2009, http://www.vko.ru/koncepcii/kosmos-i-harakter-sovremennyh-voennyh-deystviy.

190. S.V. Kuralenko, "Changing Trends in Armed Struggle in the Early 21st-Century," *Military Thought* 21 (4) (2012): 31.

191. Interfax, "Воздушно-Космические силы РФ приступили к службе" [Aerospace forces of the Russian Federation began service], Интерфакс [Interfax], August 3, 2015, https://www.interfax.ru/russia/457604.

192. Dmitry Rogozin, "Рогозин: Россия должна быть самостоятельной, либо ее не будет вовсе" [Rogozin: Russia must be independent, or it will not exist at all], Российская Газета [Rossiyskaya gazeta], July 3, 2013, https://rg.ru/2013/07/03/rogozin.html; and Dmitry Rogozin, "Дмитрий Рогозин рассказал о пяти сценариях возможных войн будущего" [Dmitry Rogozin spoke about five scenarios of possible future wars], Российская газета [Rossiyskaya gazeta], July 4, 2013, https://rg.ru/2013/07/04/voyna.html.

193. Ibid.

194. Several new U.S. aerospace weapon systems that are under development may exacerbate perceived Russian vulnerabilities. The U.S. Air Force, for example, is investing a lot of resources in the development of Long-Range Stand Off nuclear-capable air-launched cruise missiles intended to penetrate sophisticated air defense systems. See Kingston Reif, "Raytheon to Build New Nuclear Cruise Missile," Arms Control Association, May 2020, https://www.armscontrol.org/act/2020-05/news/raytheon-build-new-nuclear-cruise-missile; and Steve Trimble, "Cruise Missiles Rise to Top of U.S. Weapons Agenda," *Aviation Week*, February 9, 2021, https://aviationweek.com/defense-space/missile-defense-weapons/cruise-missiles-rise-top-us-weapons-agenda. The AGM-183A Air-launched Rapid Response Weapon, another highly capable long-range hypersonic missile, is under development. Next-generation unmanned combat aerial vehicles that are predicted to possess deep penetration capabilities against advanced air defenses are now in the R&D phase. The United States is also testing a new unmanned aircraft system, Speed Racer, that can operate in dense air defense environments. See Steve Trimble, "Secretive New Skunk Works UAS Set for Ground Testing Soon," *Aviation Week*, February 11, 2021, https://aviationweek.com/defense-space/aircraft-propulsion/secretive-new-skunk-works-uas-set-ground-testing-soon. DARPA is exploring a new program called LongShot, envisioned as a drone that carries air-to-air weapons and can be deployed from a manned platform from a standoff distance, thereby "extending the range from which the military can defeat adversary defenses while protecting piloted vehicles at a safe distance." See Sara Sirota, "DARPA Aims for LongShot Air-Launched Drone Flight Test in FY-24," *Inside Defense*, February 23, 2021, https://insidedefense.com/daily-news/darpa-aims-longshot-air-launched-drone-flight-test-fy-24. However, Russia is also developing a variety of high-precision weapons, including hypersonic systems. They include the Kinzhal air-launched hypersonic ballistic missile, Tsirkon hypersonic cruise missile, Poseidon nuclear-powered nuclear-tipped torpedo, and Burevestnik nuclear-powered nuclear-tipped cruise missile. See Jill Hruby, *Russia's New Nuclear Weapon Delivery Systems: An Open-Source Technical Review* (Washington, D.C.: Nuclear Threat Initiative, November 2019), https://media.nti.org/documents/NTI-Hruby_FINAL.PDF. Russia is also developing a hypersonic aircraft-launched missile named Gremlin to defeat modern air defense systems. See Anton Lavrov and Alexey Ramm, "Враг и 'Гремлин': Новую гиперзвуковую ракету испытают в 2023 году" [Enemy and "Gremlin": A new hypersonic missile will be tested in 2023], Известия [Izvestia], February 20, 2021, https://iz.ru/1127234/anton-lavrov-aleksei-ramm/vrag-i-gremlin-novuiu-giperzvukovuiu

-raketu-ispytaiut-v-2023-godu; and RIA Novosti, "На Су-57 испытали макеты гиперзвуковых ракет, сообщил источник" [The Su-57 tested mock-ups of hypersonic missiles, a source said], РИА Новости [RIA Novosti], February 17, 2021, https://ria.ru/20210217/su-57-1597772758.html.

195. For a detailed treatment of Russian and Chinese fears of how U.S. national missile defenses will impact on their nuclear deterrence, see Jaganath Sankaran and Steve Fetter, "Defending the United States: Revisiting National Missile Defense against North Korea," *International Security* 46 (3) (Winter 2021/2022): 51–86, https://doi.org/10.1162/isec_a_00426.

196. Lt. Gen. G.P. Kupriyanov (Res.), "Principal Trends in the Evolution of Spare Warfare," *Military Thought* 14 (1) (2005): 85; and Lt. Col. Thomas R. McCabe, "The Russian Perception of the NATO Aerospace Threat: Could It Lead to Preemption?" *Air and Space Power Journal* 30 (3) (Fall 2016): 66, https://www.airuniversity.af.edu/Portals/10/ASPJ_Spanish/Journals/Volume-29_Issue-2/2017_2_09_mccabe_s_eng.pdf.

197. Defense Intelligence Agency, *Challenges to Security in Space* (Washington, D.C.: Defense Intelligence Agency, January 2019), https://www.dia.mil/Portals/110/Images/News/Military_Powers_Publications/Space_Threat_V14_020119_sm.pdf; and "Генштаб: Особенностью конфликтов будущего станет применение роботов и космических средств" [General Staff: A feature of future conflicts will be the use of robots and space assets], TASS: Russian News Agency, March 24, 2018, https://tass.ru/armiya-i-opk/5062463.

198. Defense Intelligence Agency, *Challenges to Security in Space*, 24.

199. Gregory Kulacki and Jeffrey Lewis, "Understanding China's Antisatellite Test," *The Nonproliferation Review* 15 (2) (2008): 335–347, https://doi.org/10.1080/10736700802117346.

200. Ed Browne, "China Accuses U.S. of Turning Outer Space into 'a Weapon and a Battlefield,'" *Newsweek*, July 20, 2022, https://www.newsweek.com/china-us-space-military-zhao-lijian-1726231.

201. Jaganath Sankaran, "Missile Defenses and Strategic Stability in Asia: Evidence from Simulations," *Journal of East Asian Studies* 20 (3) (November 2020): 485–486, https://doi.org/10.1017/jea.2020.10.

202. Baohui Zhang, "The Security Dilemma in the U.S-China Military Space Relationship: The Prospects for Arms Control," *Asian Survey* 51 (2) (March/April 2011): 313, https://doi.org/10.1525/AS.2011.51.2.311.

203. Ibid., 321; emphasis added.

204. Blanc et al., *Chinese and Russian Perceptions of and Responses to U.S. Military Activities in the Space Domain*.

205. Ibid., 22–25.

206. Dimitry Stefanovich and Daniel Porras, "Space as a Competition Domain: Threats and Opportunities" [in English], *Международная аналитика* [Journal of international analytics] 13 (2) (2022), http://dx.doi.org/10.46272/2587-8476-2022-13-2-95-106; and Zhang, "The Security Dilemma in the U.S.-China Military Relationship."

207. Blanc et al., *Chinese and Russian Perceptions*, 44.

208. "Russia Warns of 'Tough Response' to New U.S. Military Space Force," *The Moscow Times*, June 20, 2018, https://www.themoscowtimes.com/2018/06/20/russia-warns-of-tough-response-to-new-us-military-space-force-a61928.

209. John Bowden, "China Calls New U.S. Space Force a 'Threat to Space Peace and Security,'" *The Hill*, December 23, 2019, https://thehill.com/policy/international/475714-china-calls-new-space-force-a-threat-to-space-peace-and-security.

210. Office of the Secretary of Defense, *Missile Defense Review* (Washington, D.C.: U.S. Department of Defense, 2019), https://www.defense.gov/Portals/1/Interactive/2018/11-2019-Missile-Defense-Review/The%202019%20MDR_Executive%20Summary.pdf.

211. Tong Zhao, "Practical Ways to Promote U.S.-China Arms Control Cooperation," Carnegie Endowment for International Peace, October 7, 2020, https://carnegieendowment.org/2020/10/07/practical-ways-to-promote-u.s.-china-arms-control-cooperation-pub-82818.

212. The White House, *United States Space Priorities Framework* (Washington, D.C.: The White House, December 2021), 6, https://www.whitehouse.gov/wp-content/uploads/2021/12/united-states-space-priorities-framework-_-december-1-2021.pdf.

213. Greg Norman, "China's Xi Has Ordered Military to Be Ready for Taiwan Invasion by 2027, CIA Director Says," *Fox News*, February 3, 2023, https://www.foxnews.com/world/china-xi-ordered-military-ready-taiwan-invasion-2027-cia-director-burns-says.

214. Office of the Director of National Intelligence, *Annual Threat Assessment of the U.S. Intelligence Community* (Washington, D.C.: Office of the Director of National Intelligence, February 2023), 7, https://www.dni.gov/files/ODNI/documents/assessments/ATA-2023-Unclassified-Report.pdf.

215. "A Mysterious Satellite Hack Has Victims Far beyond Ukraine," *Wired*, March 23, 2022, https://www.wired.com/story/viasat-internet-hack-ukraine-russia.

216. Valerie Insinna, "SpaceX Beating Russian Jamming Attack Was 'Eyewatering': DOD Official," *Breaking Defense*, April 20, 2022, https://breakingdefense.com/2022/04/spacex-beating-russian-jamming-attack-was-eyewatering-dod-official.

217. Brett Tingley, "Russia Says Private Satellites Could Become 'Legitimate Target' during Wartime," *Space*, September 16, 2022, https://www.space.com/russia-private-satellites-legitimate-target-wartime-united-nations.

218. Alex Marquardt and Sean Lyngaas, "Ukraine Suffered a Comms Outage When 1300 SpaceX Satellite Units Went Offline over Funding Dispute," *CNN Politics*, November 7, 2022, https://www.cnn.com/2022/11/04/politics/spacex-ukraine-elon-musk-starlink-internet-outage/index.html.

219. Patrick Tucker, "As Satellite Images Reshape Conflict, Worries Mount about Keeping Them Safe," *Defense One*, April 28, 2022, https://www.defenseone.com/technology/2022/04/satellite-images-reshape-conflict-worries-mount-about-keeping-them-safe/366265.

220. Theresa Hitchens, "'Local' Russian GPS Jamming in Ukraine Hasn't Affected US Support Ops, So Far," *Breaking Defense*, March 1, 2022, https://breakingdefense.com/2022/03/local-russian-gps-jamming-in-ukraine-hasnt-affected-us-support-ops-so-far.

221. "Why Isn't Russia Blocking GPS in Ukraine," *The Economist*, August 8, 2022, https://www.economist.com/the-economist-explains/2022/08/08/why-isnt-russia-blocking-gps-in-ukraine.

222. Defense Intelligence Agency, *2022 Challenges to Space Security*, 21. This online publication has an information cut-off date of March 2022 but does not mention the war in Ukraine.

223. Josh Boak, "CIA Director: Putin Too Confident He Can Grind Down Ukraine," AP News, February 26, 2023, https://apnews.com/article/russia-ukraine-politics-jake-sullivan-michael-mccaul-china-dcc45ebf4bfc273d9a4dc0ad01984806.

224. Stephen Young, "The Meteoric Rise in Satellite Numbers," *The Equation* (blog), Union of Concerned Scientists, March 17, 2022, https://blog.ucsusa.org/syoung/the-meteoric-rise-in-satellite-numbers.

225. Keir A. Lieber and Daryl G. Press, "The New Era of Counterforce," *International Security* 41 (4) (Spring 2017): 9–49, https://doi.org/10.1162/ISEC_a_00273.

226. Office of the Director of National Intelligence, *2022 Annual Threat Assessment*, 7.

227. Patrick Tucker, "This Air Force Targeting AI Thought It Had a 90% Success Rate; It Was More Like 25%," *Defense One*, December 9, 2021, https://www.defenseone.com/technology/2021/12/air-force-targeting-ai-thought-it-had-90-success-rate-it-was-more-25/187437.

228. A perpetual challenge for missiles defense is its vulnerability to much cheaper countermeasures, including decoys. See Sankaran and Fetter, "Defending the United States: Revisiting National Missile Defense against North Korea," 68–70.

229. U.S. Department of Defense, *2022 Nuclear Posture Review* (Washington, D.C.: Department of Defense, 2022), 8, https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF.

230. U.S. Department of Defense, *2022 Missile Defense Review*, in U.S. Department of Defense, *2022 National Defense Strategy of the United States of America, Including the 2022 Nuclear Posture Review and the 2022 Missile Defense Review* (Washington, D.C.: Department of Defense, October 2022), 6, https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF#page=33.

231. Ibid., 7–8.

232. Ibid., 5.

233. "Russian Nuclear Expert Rogov on the Suspension of the INF Treaty: We Can Inflict an Intolerable Blow on the Americans," MEMRI, February 4, 2019, https://www.memri.org/reports/russian-expert-rogov-suspension-inf-treaty-we-can-inflict-intolerable-blow-americans.

234. Cynthia Roberts, "Revelations about Russia's Nuclear Deterrence Policy," June 19, 2020, https://warontherocks.com/2020/06/revelations-about-russias-nuclear-deterrence-policy.

235. Office of the Secretary of Defense, *Military and Security Developments Involving the People's Republic of China, 2020: Annual Report to Congress* (Washington, D.C.: Department of Defense, 2020), https://media.defense.gov/2020/Sep/01/2002488689/-1/-1/1/2020-DOD-CHINA-MILITARY-POWER-REPORT-FINAL.PDF.

236. James Acton, ed., *Entanglement: Chinese and Russian Perspectives on Non-Nuclear Weapons and Nuclear Risks* (Washington, D.C.: Carnegie Endowment for International Peace, 2017), https://carnegieendowment.org/2017/11/08/entanglement-chinese-and-russian-perspectives-on-non-nuclear-weapons-and-nuclear-risks-pub-73162.

237. Wortzel, *The Chinese People's Liberation Army and Space Warfare*, 8–9.

238. Tong Zhao and Li Bin, "The Underappreciated Risks of Entanglement: A Chinese Perspective," in *Entanglement: Chinese and Russian Perspectives on Non-Nuclear Weapons and Nuclear Risks*, ed. Acton.

239. Fiona Cunningham and M. Taylor Fravel, "Dangerous Confidence? Chinese Views on Nuclear Escalation," *International Security* 44 (2) (Fall 2019): 61–109, https://doi.org/10.1162/isec_a_00359.

240. Joan Johnson-Freese, "U.S. Plans for Space Security," in *Collective Security in Space: Asian Perspectives*, ed. John M. Logsdon and James Clay Moltz (Washington, D.C.: George Washington University Space Policy Institute, January 2008), 116; and Mark R. Whittington, "Russian ASAT Test Endangers the International Space Station," *The Hill*, November 21, 2021, https://thehill.com/opinion/international/582528-russian-weapons-test-endangers-the-international-space-station.

241. Christopher A. Ford, "Arms Control in Outer Space: History and Prospects," *Arms Control and International Security Papers* 1 (12) (2020), https://2017-2021.state.gov/wp-content/uploads/2020/07/T-Paper-Series-Space-Norms-Formatted-T-w-Raymond-quote-2543.pdf.

242. Paul Meyer, *Arms Control in Outer Space: Mission Impossible or Unrealized Potential?* (Calgary: Canadian Global Affairs Institute, October 2020), https://www.cgai.ca/arms_control_in_outer_space_mission_impossible_or_unrealized_potential.

243. David Cooper, *Arms Control for the Third Nuclear Age: Between Disarmament and Armageddon* (Washington, D.C.: Georgetown University Press, 2021).

244. Kulacki and Lewis, "Understanding China's ASAT Test," 341–342.

245. The White House, *National Security Strategy* (Washington, D.C.: The White House, October 2022), https://www.whitehouse.gov/wp-content/uploads/2022/10/Biden-Harris-Administrations-National-Security-Strategy-10.2022.pdf.

246. Ibid., 25.

247. U.S. Department of Defense, *2022 National Defense Strategy*.

248. Sandra Erwin, "White House Official: Norms Needed for 'Satellite to Satellite Interaction,'" *SpaceNews*, January 26, 2022, https://spacenews.com/white-house-official-norms-needed-for-satellite-to-satellite-interaction.

249. "Fact Sheet: Vice President Harris Advances National Security Norms in Space," The White House, April 18, 2022, https://www.whitehouse.gov/briefing-room/statements-releases/2022/04/18/fact-sheet-vice-president-harris-advances-national-security-norms-in-space.

250. Jeff Foust, "United Nations General Assembly Approves ASAT Test Ban Resolution," *SpaceNews*, December 13, 2022, https://spacenews.com/united-nations-general-assembly-approves-asat-test-ban-resolution.

251. "Approving 21 Drafts, First Committee Asks General Assembly to Halt Destructive Direct-Ascent Anti-Satellite Tests in Outer Space," United Nations, November 1, 2022, https://press.un.org/en/2022/gadis3703.doc.htm.

252. Theresa Hitchens, "Exclusive: Pentagon Poised to Unveil, Demonstrate Classified Space Weapon," *Breaking Defense.com*, August 20, 2021, https://breakingdefense.com/2021/08/pentagon-posed-to-unveil-classified-space-weapon.

253. Victoria Samson and Brian Weeden, "Enhancing Space Security: Time for Legally Binding Measures," *Arms Control Today* (December 2020): 6–13, https://www.armscontrol.org/act/2020-12/features/enhancing-space-security-time-legally-binding-measures.

Contributors

Nancy W. Gallagher is a research professor at the University of Maryland's School of Public Policy, the director of the Center for International and Security Studies at Maryland (CISSM), and the former director of the Clinton administration's Comprehensive Test Ban Treaty Ratification Task Force. Her current research includes a book project on *Strategic Logics for Arms Control*; initiatives to improve cybersecurity decision-making; and strategies to reduce risks from nuclear, cyber, space, and other dual-use technologies. Dr. Gallagher is the author of *The Politics of Verification* (Johns Hopkins University Press, 1999) and co-author of four monographs: *The Desirability and Feasibility of Strategic Trade Controls on Emerging Technologies* (2023), *Comprehensive Nuclear Material Accounting* (2014); *Reconsidering the Rules for Space Security* (2008); and *Controlling Dangerous Pathogens* (2007). Starting in 2014, Dr. Gallagher and colleagues have also published reports based on in-depth surveys they field several times a year on Iranian public opinion on nuclear policy, domestic politics, and regional security.

Jaganath Sankaran is an assistant professor in the Lyndon B. Johnson School of Public Affairs at The University of Texas at Austin and a nonresident fellow in the Foreign Policy program at the Brookings Institution. He studies the impact of emerging technological advances on weapons systems and strategic stability. His current research focuses on missile defenses, space weapons, and military net assessments. He has held fellowships at the Los Alamos National Laboratory, the Belfer Center for Science and International Affairs at Harvard University, and the RAND Corporation, and has served on study groups of the National Academy of Sciences and the American Physical Society. Dr. Sankaran's research has been published in *International Security*, *Contemporary Security Policy*, *Journal of Strategic Studies*, and several other leading academic and policy publications.

About the American Academy of Arts & Sciences

Since its founding in 1780, the American Academy has served the nation as a champion of scholarship, civil dialogue, and useful knowledge.

As one of the nation's oldest learned societies and independent policy research centers, the Academy convenes leaders from the academic, business, and government sectors to address critical challenges facing our global society.

Through studies, publications, and programs on Science, Engineering, and Technology; Global Security and International Affairs; the Humanities, Arts, and Culture; Education; and American Institutions, Society, and the Public Good, the Academy provides authoritative and nonpartisan policy advice to decision-makers in government, academia, and the private sector.

American Academy of Arts & Sciences

Board of Directors

Goodwin H. Liu, *Chair*
David W. Oxtoby, *President*
Paula J. Giddings, *Vice Chair*
Stephen B. Heintz, *Vice Chair*
Kenneth L. Wallach, *Treasurer*
Earl Lewis, *Secretary*
Kwame Anthony Appiah
Philip N. Bredesen
Margaret A. Hamburg
John Mark Hansen
Cherry A. Murray
David M. Rubenstein
Deborah F. Rutter
Larry Jay Shapiro
Shirley M. Tilghman
Natasha D. Trethewey
Jeannette M. Wing
Pauline Ruth Yu

Selected Publications of the American Academy

Missile Defense and the Strategic Relationship among the United States, Russia, and China, by Tong Zhao and Dmitry Stefanovich (2023)

The Fragile Balance of Terror: Deterrence in the New Nuclear Age, edited by Vipin Narang and Scott D. Sagan (2023)

Nuclear Perils in a New Era: Bringing Perspective to the Nuclear Choices Facing Russia and the United States, by Steven E. Miller and Alexey Arbatov (2021)

Please contact the Academy's Publications Office at publications@amacad.org to order print copies of Academy publications.

AMERICAN ACADEMY
OF ARTS & SCIENCES

@americanacad
www.amacad.org