

NUCLEAR WEAPONS IN SPACE

Orbital Bombardment and Strategic Stability

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Executive Summary

In 2015, a new space race began. Blue Origin, a privately owned company, landed a booster on a launch pad back on earth, after lifting an object 100 kilometers into the atmosphere. SpaceX quickly followed suit, landing its own Falcon booster back on a pad for use again for later space flight. The dramatic drop in the cost of space launch has revolutionized how humans now use space. SpaceX now operates thousands of satellites in large constellations and a bevy of private companies have hundreds of privately owned satellites now circling the globe taking images of every surface of the planet. Ukrainian soldiers, fighting against the Russian army, use satellite internet to coordinate fires and fly small drones over the front lines. In response to this revolution in space, American adversaries have invested in the tools to hold these satellites at risk. Russia is reportedly experimenting with a nuclear-armed co-orbital satellite, a program that has links back to the early days of the Cold War. China has invested in anti-satellite weapons and, in yet another throwback to Soviet Cold War behavior, invested in an orbital bombardment system to overcome any future deployment of space-based missile defenses.

The United States is in an advantageous position. Its space private sector has no true competitor. The dramatic decrease in the cost of space launch has made space-based missile defense more feasible than ever before. However, the moves by U.S. adversaries to hold at risk U.S. assets in space require new thinking about how to protect those same assets, deter the use of nuclear weapons to target large constellations, and to defend against the novel ways adversaries are now experimenting with to defeat space-based missile defense. The U.S. should consider how to repurpose current missile defense interceptors to hold any Russian co-orbital satellites at risk, make explicit that any nuclear attack on U.S. origin satellites would invite retaliation, continue to invest in sensors to detect missile launch from adversary nations (including those fired south to travel over the South Pole), and to be the insurer of last resort for private satellites that could be destroyed by a hostile act.

Introduction

The American scientific community was in “awe” on October 4, 1957. The Soviet Union had defied expectations and launched the satellite Sputnik 900 kilometers above the earth’s surface. The launch had ominous overtones: The Soviet Union used an intercontinental range ballistic missile to launch a satellite into orbit and the foreign body circled the earth 1800 times before falling back to earth and burning up in the atmosphere.

In 1957, the Soviet Union was the world’s space pioneer. Moscow recognized the value of space and invested considerable resources in beating the United States into orbit. The launch of Sputnik kicked off the space race, which culminated in America’s dash to the moon, and continues with the rapid – and unprecedented – breakthroughs now being witnessed in the private sector.

Humanity’s exploration of space has pushed the boundaries of science since the start of the rocket age. It has also blurred the lines of peace and war. Sputnik was a civilian satellite, designed for prestige and to carry out scientific experiments. It was also a technology demonstrator for intercontinental nuclear war. The Eisenhower administration understood its political vulnerabilities and sought to downplay the Russian achievement. Soviet Premier Nikita

Khrushchev did not and continued to boast that his country had a technological lead over the United States in rocketry and ballistic missiles.

The tensions between offense and defense have dominated how the United States has sought to manage access to space.

Space technology is inherently dual-use: The platforms used to launch satellites can also be used to deliver atomic weapons. The same is true of defenses: The things built to shoot down incoming missiles can also be repurposed to shoot down satellites. The tensions between offense and defense have dominated how the United States has sought to manage access to space. On the one hand, space is a global common, and nations that make appropriate investments in rocketry and flight can one day take advantage of it. Yet, on the other hand, access to space is required to launch nuclear weapons trans-continental distances, supported by imaging and reconnaissance satellites that the entirety of the modern kill chain is now dependent on.

The Soviet Union pioneered novel and unique ways to hold U.S. space-based assets at risk. China is now following suit. The United States did dabble in the development of anti-satellite weapons, launching the world's first direct ascent anti-satellite missile in October 1959. Moscow's response, in retrospect, set in motion the drivers of the space race that is now threatening to return. In 1961, purportedly in response to U.S. actions in space, Khrushchev directed his government to expand work on the militarization of space.¹

In the early days of the Cold War, the superpowers' conquering of the cosmos helped enhance deterrence.

In the early days of the Cold War, the superpowers' conquering of the cosmos helped enhance deterrence. Both the United States and the Soviet Union focused, first, on developing reconnaissance satellites, followed by early warning satellites designed to monitor missile launches, and then integrated both into their monitoring of each other's nuclear forces.

The basic idea of deterrence is mutual vulnerability, specifically that no side has an incentive to use nuclear weapons. Instead, a first strike would invite guaranteed retaliation, which in the aggregate would lead to a sub-optimal outcome for the first attacking state, thereby disincentivizing any nuclear power from launching first. To ensure that this balance remained in place, a defending state would need to ensure a second-strike capability. To enhance stability, it made sense for each side to watch the other and increase predictability.

The development of reconnaissance satellites allowed for each side to monitor the other, which added transparency to the type and number of nuclear forces each side was deploying. In the 1970s, the ability to monitor one another from space allowed for each side to agree to forego the deployment of military technology or limit the type and number of deployed systems.²

The pursuit of arms control, as John Maurer notes, was not solely some altruistic attempt to make the world safer. Instead, it was part of a series of offset strategies, designed to account for how the United States could retain military superiority over the Soviet Union, even at a time when Moscow had pulled even with the United States in terms of total numbers of nuclear warheads deployed. The Anti-Ballistic Missile (ABM) Treaty



President Ronald Reagan delivered a speech from the Oval Office in March 1983 announcing what became the Strategic Defense Initiative.

was a lynchpin of this strategy. It was designed to cap the number of deployed anti-ballistic missile interceptors around Moscow. For Russia, it capped U.S. deployments, locking in a sense of mutual vulnerability that helped to enhance deterrence.

The Soviet Union, however, continued to test the limits and spirit of the arms control treaties it signed. The period of détente did not hinder Moscow's interest in the militarization of space and the continued development of orbital platforms to evade U.S. early warning and nascent missile defense architecture.³ Instead, Soviet designers continued to develop new and innovative ways to attack U.S. satellites and to deliver nuclear weapons to the U.S. homeland.

Moscow also views international agreements as tools to add to national power. The Soviet leadership was not constrained by either the Outer Space Treaty or the Strategic Arms Limitation Treaty (SALT I) when testing space-based weapons and new classes of medium-range missile.

This study will examine the new dynamics in space. For decades, government was the main driver of space innovation. Over the past two decades, the traditional way in which space technology is developed and launched has changed. The rise of companies like Blue Origin and SpaceX has completely altered the economics of space and has revolutionized how goods and humans are sent to the heavens.

The rapid decrease in the cost of launch and satellite construction has increased global connectivity, improved the global economy, and has changed the world profoundly. The growing use of space has also heightened efforts to further militarize the cosmos and creates an obvious incentive for American adversaries to explore ways to hold at risk orbiting constellations with nuclear weapons.

The U.S. military has long depended on space-based capabilities, with that dependence set to grow. The war in Ukraine has demonstrated the value of the commercial Starlink constellation, led to the development of the national security Starshield version, and probably also spurred Russia's development of orbiting nuclear weapons to mass-kill smallsat constellations in the event of a wider war with NATO. The promise of decrease launch costs from SpaceX's planned Starship also makes space-based missile defense more economically viable than ever, raising again the promise of novel ways to evade missile defense. China demonstrated one such technique in August 2021, when it tested an orbital bombardment system.

The United States has considerable opportunities to take advantage of this new space age. Its industry is far ahead of any competitor. The rapid decrease in launch costs will undercut Russia's launch services industry, depriving its

competitor of potential funds. However, U.S. adversaries will not simply sit back and let Washington retain such advantages unchallenged. The incentives for an adversary to develop anti-satellite weapon and orbital bombardment systems are considerable. There are also ample incentives for Russia to push ahead with a nuclear-armed, co-orbital anti-satellite weapon. However, with each such deployment, U.S. adversaries may also face weaknesses that, if exploited by proper investments, could ensure the United States retains its enviable lead in space launch capabilities and burgeoning space-based missile defense.

Circumvention and Hedging: Soviet Practice in Space

The Soviet space program provides a useful guide about how Moscow has historically sought to circumvent treaty agreements to gain military advantages vis-à-vis the United States. For much of the Cold War, the Soviet Union had fewer nuclear weapons than the United States. However, both sides have used mutual restraint to their advantage. The Soviet Union sought and received limits on American missile defense with the signing of the ABM Treaty, as part of the SALT I agreements.

Almost immediately, however, Russia violated the spirit of the agreement with the development of a Fractional Orbital Bombardment System, or FOBS. Moscow officially pledged not to place nuclear weapons in orbit when it agreed to the Outer Space Treaty in 1966. Article IV of the agreement clearly states that state parties “undertake not to place in orbit around the earth any object carrying nuclear weapons.”⁴ The Soviet Union then promptly violated the spirit of the treaty. At the dawn of the missile age, Soviet planners viewed orbital weapons as potentially superior to missile-launched warheads. Military planners correctly argued that an orbital weapon would have an unlimited flight range, be able to strike targets simultaneously from two different directions, have unpredictable trajectories and faster flight times to targets. These advantages would obviate any advantage a defender could gain from missile defense, thereby ensuring the credibility of a retaliatory nuclear strike.⁵

At the dawn of the Cold War, both the United States and the Soviet Union explored orbital bombardment concepts. The idea is that you can place something in orbit and, after a fraction of an orbit or a total orbit around the earth, it can then be de-orbited to strike targets on the ground. Orbit is a state of being. An object placed in orbit is moving fast enough that it continues to fall over the horizon faster than it does back to earth.

At the dawn of the Cold War, both the United States and the Soviet Union explored orbital bombardment concepts.

To come back to earth, an object in space must slow down. This is how a FOBS would work: An object is inserted into orbit and then fires a small rocket to slow down and fall to its target. One advantage of such a system is that you do not have to fire a missile on a ballistic arc, therefore decreasing early warning time for the defending state. The other advantage is that an attacking state could insert an object into orbit over Antarctica (flying south) and have the object “take the long way around” the earth. This object then would avoid U.S. early warning radar and missile defense tracking, which remain pointed at the North Pole (the shortest distance between the United States and Russia and China).

In retrospect, Moscow’s interest in the ABM Treaty makes more sense. The Soviet Union agreed to place reciprocal limits on missile defense deployment. It did so knowing that it had other tools to hedge against any qualitative advancement in U.S. missile defense interceptors and that it could still hold at risk U.S. targets with nuclear weapons deployed in exotic ways.

The Soviet Union tested and deployed this FOBS in 1967, just months after the leadership in Moscow signed the Outer Space Treaty. The United States chose to accept the Soviet legalese explaining away the violation: The weapon did a fractional orbit but the treaty ostensibly only covered a full orbit, thereby giving some wiggle room to President Lyndon Johnson to ignore the violation.⁶ The Soviet FOBS system remained operational for close to two decades, before being dismantled in 1983.

As we look back at the early days of the space race, the paranoia about Sputnik is often how Americans frame the U.S. government's subsequent effort to conquer the cosmos. However, in Moscow, a similar paranoia had taken hold and drove its own ambitions in space. In a forgotten part of the early Cold War, the Soviet Union shot down numerous American surveillance aircraft over the Baltic Sea and over Hokkaido in the Pacific between 1950 and 1952.⁷ Moscow's belligerence prompted American innovation, sparking the development of the U-2 aircraft in 1954. The use of the U-2 to overfly the Soviet Union prompted Moscow's push for more capable air defense, ending in the shooting down and capture of Francis Gary Powers in 1960.

The U.S. response, as is now well known, was to push forward with the development of reconnaissance satellites.

Moscow noticed. In 1959, according to Dr. Asif A. Siddiqi, "Khrushchev was reportedly personally upset over the possibility of 'spy' flights over the Soviet Union" and directed scientific and military personnel to develop the means to identify hostile satellites and to shoot them down. Shortly thereafter, in early 1960, Moscow settled on co-orbital maneuvering satellite that could hard kill satellites in orbit.⁸ The Soviets envisioned, at first, this satellite carrying a nuclear warhead, but after studying the effects of nuclear explosions in space, scientists concluded that the blast was indiscriminate. Put simply: It would kill both American and Soviet satellites by frying their electronics.

The United States had reached the same conclusion as their Soviet counterparts. Following the Starfish Prime high-atmospheric nuclear test in 1962, the radiation level in the Van Allen Radiation belt increased. As Robert Vincent wrote in *War on the Rocks*:

The Van Allen radiation belts perform a crucial task of sweeping charged particles from the sun away from Earth to create a shield against charged particle radiation from low Earth orbit to the surface (below 1,000 kilometers in altitude). ... commercial satellites in low Earth orbit take full advantage of the reduced particle radiation and may incorporate standard

*commercial electronics into their payloads. The use of these components sharply reduces costs.*⁹

As a result, the world's first commercial communications satellite, Telstar, lasted only 8 months in orbit before the residual radiation from the Starfish Prime test destroyed its electronic components.¹⁰

The Soviet Union settled on a conventional payload for its co-orbital satellite in response because of its own desire to protect its satellites in orbit. In the mid-1970s, it ramped up experiments of exo-atmospheric interception, which culminated in the first single orbit interception in 1976 – a milestone for the project. This period in Soviet space history is often overlooked. A half-decade before President Ronald Reagan announced the Strategic Defense Initiative (SDI), the Soviet leadership issued a decree to establish *Fon*, a program to develop orbiting lasers and missiles. The ambitious program was designed to attack orbiting satellites, rather than missiles, and was pursued with some ambition for close to a decade.¹¹ This program was beset by funding challenges, but a prototype was launched into orbit at the tail end of the Cold War.

SDI codified U.S. policy in space. After decades of seeking to carve out a passive role for satellites, and therefore

pushing the Soviets to agree to peaceful use of space, the Reagan administration pushed forward with an ambitious plan to overtly defend U.S. territorial interests with space-based assets. The Reagan administration's pursuit of space-based missile defense was controversial – and continues to be to this day. However, the investments made in rocket technology has contributed to the development of the technology that has revolutionized space flight over the past decade. The basic idea of SDI was to build missile interceptors in space, capable of tracking and then striking missiles while they are being boosted into space. The program would require a radical leap forward in technology and major advances in rocketry to bring the cost of launch down considerably. The basic challenge with SDI is that the number of satellites required to protect the United States is considerable and the cost to launch each satellite also very high.¹² This made the project infeasible from an economic standpoint and the technology required was simply not mature enough during the program's lifetime to deploy the entirety of the system.

The Soviet Union did seek to compete with SDI, matching the program's ambitions with design-bureau led efforts of its own. However, in retrospect, the program's launch coincided with the Soviet Union's rapid decline. Moscow was simply unable to compete with the United States on a spending level during



Concept art for Project Excalibur (USAF)

this period. Thus, while the Soviets clearly had the ambitions to match the United States in space, and had invested heavily in the militarization of space, the program atrophied alongside the decay of the Russian state. The final days of the Soviet Union coincided with Operation Desert Storm, the first true test of American-led doctrine pitted against a Soviet armed state, Iraq, outfitted with the latest air defense Moscow had to offer.

The rapid defeat of Saddam Hussein, primarily with air power, appeared to validate the Soviet concerns, first articulated in the 1970s, about the lethality of U.S.-made precision-guided weapons. These weapons, according to Marshal Nikolai Ogarkov, could upend Soviet assumptions about ground combat and required rapid change within the Soviet

armed forces to plan for future conflicts.¹³ The so-called revolution in military affairs codified the success of the second offset. It also depended considerably on the connectivity of communications for almost all aspects of joint warfighting.

In the decades since the war, the United States has iterated on the lessons learned from the conflict, further deepened its reliance on precision weapons, and created a surveillance architecture to monitor combat zones around the world.¹⁴ The development of uncrewed platforms has contributed to this evolution – and those platforms are dependent on satellite communications to connect war planners in Washington with operators in theater.¹⁵ U.S. adversaries also studied closely the lessons of the Gulf War and the follow-on air campaigns in the former

Yugoslavia, Afghanistan, and Iraq. The Russian and Chinese governments have, ever since, invested in weapons to offset U.S. advantages. They have also developed doctrines to challenge the American way of war. China, as Peter Mattis writes, is a good example of how observations informed the party's thinking about conflict and coalesced around a "three warfare" concept. According to Mattis:

*From the Gulf War onward, analysts in the PLA [People's Liberation Army] saw a trend they described as "peacetime-wartime integration." Victory in war, or at least achieving one's political objectives, increasingly depended on the preparations made in peacetime. Success required shaping how other governments and their people as well as one's own population viewed the conflict. Information operations needed external and internal dimensions ... The importance of this trend was amplified by the 'conventionalization of deterrence.'*¹⁶

The focus on both influence operations and conventional weapons is instructive. It suggests a synergy between both the Russian Federation and Chinese Communist Party about basic concepts for war with the United States. These

broad synergies do not necessarily lead to the same preferred tactics, but they do suggest a lesson incorporated from U.S. action in Iraq: the disruption of command and control with conventional attack.

This approach was the centerpiece of the American war effort against the Iraqi government. It was an attack on the Iraqi command-and-control infrastructure, following a months-long psychological warfare effort to convince individual Iraqis to capitulate and turn on Hussein. The air campaign worked well. The psychological campaign, perhaps not so much.¹⁷ However, in both the Russian and Chinese cases, the appeal of such an approach is easy to understand: A conflict could be kept below the nuclear threshold, with the threat of nuclear escalation used as a mechanism to limit potential U.S. involvement in a localized territorial conflict. In extremis, both countries have sought to limit the potency of American aerospace attack.

Russia has fallen back on its traditional approach to such a contingency: investing in air and missile defense, coupled with the development of a range of nuclear delivery systems to hold U.S. and Western targets at risk. In times of war, Russia has brandished its nuclear sword to deter U.S. involvement, albeit to varying degrees of success.¹⁸ China has sought to physically change the space around it. It has built artificial islands. It has invested in longer range weapons to hold U.S. air and sea-

based targets at risk at greater ranges. It has also recently invested in upgrading its nuclear forces, a signal that Beijing may consider using a larger arsenal to protect itself from future U.S. missile defense deployments and to sue for war termination on favorable terms.

These trends in Chinese and Russian military adaptation have had a direct impact on their approach to space warfare. The other part of these operations – hindering U.S. command and control – is also central to future contingencies. And it helps explain both countries' aggressive return to the development and deployment of ground-based anti-satellite weapons.

Challenging U.S. Supremacy in the Heavens

In 2007, a Chinese ballistic missile fired from earth smashed into a satellite orbiting at the upper boundary of low earth orbit. The anti-satellite test destroyed its target and created nearly a thousand pieces of debris.¹⁹ The test was not a shock for U.S. intelligence, which had warned consistently since 2003 that Beijing was working towards this type of capability. A Chinese analyst, writing

at the time suggested that the test to enhance Chinese nuclear deterrence. A PLA colonel, writing months before the test, suggested that China needed an anti-satellite capability to challenge the United States in space.²⁰ The test was a watershed moment for U.S. security planning and thinking about operations in space. In response, the United States sought to demonstrate to China that it too could target satellites in space, ostensibly to prevent the uncontrolled reentry of a defunct satellite back to earth. However, the 2008 shootdown of a U.S. satellite with a modified SM-3 missile undoubtedly signaled that U.S. capabilities were on par, or greater than, those of its adversaries.

The SM-3 is the backbone of the U.S. missile defense architecture in Europe. It also underscores the undeniable linkages between hit-to-kill missile defense interceptors and direct-ascent anti-satellite weapons. In the 2004, the Bush administration set aside funds for the construction of a limited missile defense system. This decision came after the United States chose to withdraw from the ABM Treaty in 2002. The administration argued that the United States should develop ground and sea-based mid-course missile defense interceptors, along with updated terminal defenses, and a slew of new tracking satellites to defend the homeland from attack.²¹ The inclusion of this language in the nuclear posture review, I believe, is why Chinese



China's new hypersonic glide vehicle was launched with a 'Long March' rocket, seen here carrying China's Chang'e-5 lunar probe for its space program. (AFP)

experts explicitly linked the 2007 ASAT test to its own nuclear deterrent. It also explains why adversaries would seek to blind U.S. sensors. The shooting down of a satellite would, of course, both hinder operational command and control for the U.S. military and blind early warning sensors, upending elements of U.S. missile defense, and enhancing the survivability of nuclear forces.

Russia pursued a slightly different strategy, albeit in cooperation with China. The Russian Federation faced economic calamity after the collapse of the Soviet Union. However, by 1999, the early signs of the breakdown of the post-Cold War order were evident. In response to Serbian ethnic cleansing, NATO began airstrikes in Kosovo. Russia vehemently protested the intervention, arguing that

the United States' power to intervene needed to be constrained, and litigated through the U.N. Security Council. The relationship was temporarily reset after the September 11, 2001 attacks, but quickly soured over the issue of missile defense in Europe.

The real turning point for Russia came in 2007, when President Vladimir Putin articulated the same concerns about the international community that his predecessors first began to raise in 1999. Putin suggested that the only international arbiter for the use of force should be the United Nations – and not solely NATO or the European Union. He also created the groundwork for his future military invasions of his neighbors. He warned against inviting Ukraine and Georgia to join NATO and,

critically, outlined his objections to the Bush administration's pursuit of missile defense:

*it is impossible to sanction the appearance of new, destabilizing high-tech weapons. Needless to say it refers to measures to prevent a new area of confrontation, especially in outer space. Star Wars is no longer a fantasy – it is a reality.*²²

Months later, Putin sanctioned the invasion of Georgia. Russia won the war, but the Russian performance on the battlefield was lacking.²³ In response, the country's armed forces were reorganized and, importantly, a major rearmament plan was created to modernize the armed forces by 2020.²⁴ In retrospect, this was the start of a Russian military build-up that culminated in the second invasion of Ukraine in 2022.

Thus, by 2009, the United States was staring down two adversaries that had made the strategic decision to build up their armed forces. China had started this process far earlier than the Russian Federation. The United States, in contrast, was still operating under assumptions from the post-Cold War era. Washington was distracted by two wars in Iraq and Afghanistan and its efforts to counteract the build-up of these two powers only just began in or around 2022.

Novel Weapons, Nuclear Taunts, and the New Space Race

In 2015, a private company achieved a longstanding goal. A rocket built by Blue Origin landed gently back on the pad after launching 100 kilometers into space.²⁵ A month later, SpaceX's Falcon 9 rocket did the same. The technologies that may make this renewed effort more financially feasible all began as offshoots of the Reagan-era missile defense program. One such program, was the DC-X Clipper, which was part of the decades-long effort to build a single-stage to orbit launch platform to decrease the cost of vertical launch. This technology remains elusive, but the next best outcome is to reuse the booster. The results have made the concepts underpinning space-based missile defense more economically feasible than at any other point in human history.

The company has been able to perfect its Falcon launch system, reusing boosters and dramatically lowering the cost of launch. In the near future, the planned development of Starship – the world's largest rocket – promises to further decrease costs. This rapid cost decrease enables human progress, particularly



Starlink satellites before deployment. (Image credit: SpaceX)

around communication and the launch of large numbers of satellites. SpaceX's cost per kilogram launched is estimated at approximately \$200. The Space Shuttle's cost per kilogram launched was approximately \$30,000.²⁶ The decrease in cost has enabled the launch of large constellations, now devoted to internet services, communications, and imagery. The same technology could be used to launch thousands of space-based interceptors, a concept that Reagan kicked off with SDI and President Donald Trump is now pursuing again as "Golden Dome." The economics of space-based missile defense is now more favorable than ever before. It is no longer "economic fiction" to conceptualized large satellite constellations, orbiting

the earth constantly and launched on demand via an efficient and proven booster.

In late 2019, Russia shifted its own operations in space. The United States accused Moscow of launching a single satellite that settled into the same orbit as a U.S. imaging satellite. The Russian satellite then released a second satellite, which could maneuver in orbit and get even closer to U.S. surveillance satellites.²⁷ A maneuvering co-orbital satellite is exactly what the Soviet Union built and tested in the 1960s, 1970s, and 1980s. Russia's return to this technology, therefore, signaled an intention to revive dormant programs, presumably with the same intent: to integrate anti-satellite

operations into nuclear war planning.

It is worth examining how the Soviets thought about the linkage between ground based anti-satellite weapons, missile defense, offensive nuclear strikes, and co-orbiting anti-satellite weapons. The Soviets conducted exercises as late as 1982 with simulated strategic and medium-range missile strikes against U.S. and NATO targets, paired with co-orbital satellites tasked with maneuvering towards a then defunct Soviet satellite to pass close by the target satellite. The Soviets, according to Siddiqi, intended to destroy the target satellite with the co-orbiting chase satellite, but the fusing mechanism failed as it passed by. Moscow also used its space-based assets to test an anti-ballistic missile interceptor.²⁸ It was only after this large-scale test, where Moscow validated a proof of concept, that the Soviet leadership then chose to embark on an international campaign to limit the weaponization of space. In keeping with historical precedent, in 2022, Russia followed through and tested an updated anti-satellite missile, the Nudol, and destroyed a satellite in orbit.²⁹

China also has reportedly developed similar capabilities to maneuver in orbit to get close to U.S. satellites. Beijing has also sanctioned a considerable increase in deployed nuclear weapons. In 2024, the Department of Defense estimated that China had plans to deploy 1,000

nuclear weapons in 2030.³⁰ The rapid increase would bring Beijing's deployed arsenal approximately in line with the currently deployed warheads in the United States and Russia.

In October 2021, *The Financial Times* reported that China had tested in August a hypersonic weapons system that circled the globe and dropped off a munition as the space plane glided back to earth and crashed.³¹ This test is the latest iteration of the Soviet orbital bombardment system. Just as was the case previously, the advantage of this system is that China can quickly launch a nuclear weapon into orbit and have it travel in a way that limits warning time and gives planners options about novel routes to attack targets. The advantage of an orbital bombardment system is that the attacker can map current missile defenses and design a way to evade them. This is what China appears to be doing. It is using an older Soviet-era idea, most probably updated with a space plane of some sort, and testing ways to evade missile defense.

It also suggests a change in how Beijing views nuclear-era fighting. The increase in nuclear forces indicates that Chinese planners are re-considering contingency planning for how China would fight a nuclear-armed conflict with the United States, or at least deter such a conflict from ever taking place. This would seem to fit with the investments in space, deployment of ground based anti-satellite

missiles, and expansion of nuclear strike options.

The increase in nuclear forces indicates that Chinese planners are re-considering contingency planning for how China would fight a nuclear-armed conflict with the United States.

American dependence on space for all facets of warfighting, combined with the explosion in the number of satellites in orbit, has once again changed how adversaries think about conflict with the United States. In the past, it was feasible to assign small numbers of anti-satellite missiles that, with the evolution of precision, could be conventionally armed. Thus, an adversary could cost-effectively build up its interceptor magazines to hold at risk space-based assets. This is now no longer feasible.

Hitting 7,000+ objects in a Starlink constellation requires building thousands of ground-based interceptors, which is not cost-efficient for the attacker. However, rather than simply accept defeat, adversaries have returned to an efficient way to think about destroying a large number of targets with a correspondingly small number of missiles:

the brute force of nuclear weapons.

The Soviet Union understood at the outset of their co-orbital anti-satellite program that a nuclear weapon's blast would be indiscriminate and kill every satellite in range. However, given the new asymmetry in the numbers of satellites in orbit (there is simply no realistic competitor to U.S. privately owned space companies), the cost-exchange ratio shifts for a potential attacker.

The loss of U.S. capabilities with a strike would be so disproportionately large when compared to the loss of other nations that the debate about holding these satellites at risk with nuclear weapons becomes more salient. It also raises interesting questions about how best to defend against this new dynamic. In the past, the United States was at a disadvantage because its satellites would be risked should it target other nation's satellites – it had much more to lose in a conflict in space than an adversary because it had more satellites and relied more heavily on them.

Detering War, Building Resilience, and Preparing for Conflict

If Russia pushes forward again with a nuclear armed co-orbital system, the cost of deploying such a satellite is higher than the cost of launching a Starlink-like satellite. Thus, does it now make more sense for U.S. planners to dedicate forces to striking what is certain to be a small constellation of nuclear-armed satellites? The cost exchange may, in fact, come to favor the United States, the defense justified because of the need to protect U.S. orbiting platforms, and the resilience of any future satellite architecture may be considerable given the evolution of SpaceX's launchers. Such a change will have an impact on nuclear stability and is worthy of further examination.

It is also important for the United States to consider assigning an anti-satellite role to the SM-3 and SM-6 missiles and to increase future purchases to allow for a portion of all future weapon buys to have a dual-deployment role. The United States should assume that any deployment of a Russian or Chinese nuclear-armed, co-orbital satellite will be small. Thus, dedicating a small amount of the total SM-3/6 buy to holding these weapons at risk would be beneficial to

the United States. It would also be cost effective and allow for already fielded capabilities to be used to hold adversary assets at risk in space.

The cost of a large satellite constellation is no longer the barrier to missile defense deployment – instead, it is the cost of the kill vehicle.

The economics of vertical launch should spur considerable work on how to decrease the cost of any proposed kill vehicle for a space-based missile defense. The cost of a large satellite constellation is no longer the barrier to missile defense deployment – instead, it is the cost of the kill vehicle. Working hard towards driving the purchase cost of any such system to a reasonable number would unlock the promise of SDI and Golden Dome and add yet more complexity to Russian and Chinese efforts to “out build” potential missile defense deployments. As part of this approach, the United States may need to consider how to more rapidly design, build, and launch early warning sensors. The idea would be to be able to get off the ground capabilities to augment the current U.S. sensor infrastructure. Such an approach could also give more capabilities for monitoring novel attack profiles,

specifically the longer way around the earth to attack U.S. targets from the south.

It is important to think through how Russia and China would respond to any deployment of more capable U.S. missile defenses in space. The first and most obvious way to respond is to build up more nuclear forces. This is why continued engagement on arms control, per the thinking that guided the second offset, is worth undertaking. It would be wise to try and negotiate a trilateral cap on deployed strategic forces, perhaps at the 1,000-warhead mark. This would complicate Russian and Chinese targeting challenges, at a time when U.S. advantages in access to space remain considerable.

It is important to think through how Russia and China would respond to any deployment of more capable U.S. missile defenses in space.

China and Russia may also consider developing short burn-time missiles to decrease the amount of time that their forces are in boost phase. This would negate some advantages to a space-based missile defense system and allow

for attacking forces to get into mid-course flight more quickly, which is when they can launch countermeasures and decoys. This is yet another reason to consider further improvements to U.S. sensor architecture to increase warning time from launch to detection.

The United States could also update its nuclear doctrine. A nuclear blast in space, targeting U.S.-built products used for U.S. military purposes and in support of U.S. military operations, should be considered a nuclear attack on U.S. forces. This would allow for the United States to hold a reciprocal target at risk to a retaliatory strike, which could help deter an attacking leader from using a nuclear weapon in space.

Finally, the U.S. government should consider becoming the “insurer of last resort” for these companies. The new space industry is worth about \$600 billion today, with projections for it to grow to more than \$1 trillion in the 2030s. The increasing military contestation described in this paper puts commercial and civil constellations at great risk. This risk is only poorly appreciated by the new space industry, which for the most part is not insured against acts of war.

The issue of orbital debris created from military tests is more ambiguous. Insurance companies are beginning to review their coverage and consider what sorts of products are appropriate for an

increasingly contested environment. These changes will have a major impact on new space companies. It is in the government's interest to ensure that innovation does not slow down. One way to do so is to provide further incentives through the provision of insurance, if indeed it does become a hindrance to future space flight.

The rapid changes in space have spurred American adversaries to return to concepts and ideas first tested and deployed during the Cold War. The United States should consider carefully how it plans to compete in space. The economics of space launch has placed the United States in an advantageous position to win this new space race.



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