

EMERGING SPACE SECURITY DILEMMA: IMPLICATIONS FOR GLOBAL SECURITY

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Abstract

Outer space, once considered a frontier of peaceful scientific exploration and international cooperation, has undergone a dramatic transformation. Space-based military technologies are re-emerging as central elements of contemporary strategic competition. The weaponisation of outer space is no longer a hypothetical concern but an increasingly evident reality shaping the global security environment. States are developing and testing systems that can strike from orbit, jam or blind enemy satellites, and defeat traditional missile defence systems. These include anti-satellite (ASAT) weapons, Fractional Orbital Bombardment Systems (FOBS), space-based missile defence architectures, and directed-energy weapons. The continuous militarisation leading to weaponisation of outer space—driven primarily by the United States’ quest for space superiority — is generating serious risks of escalation, accidental conflict, and space debris. The article argues that while the US frames these developments as defensive, its actions have pushed China and Russia to develop orbital countermeasures to bolster their own defensive and deterrent capabilities. The article concludes that without an updated space governance mechanism and new verification regimes, the integration of orbital strike capabilities into military doctrines risks accelerating arms competition in space and increasing the likelihood of miscalculation due to less decision-making time and inadvertent escalation in future crises.

Keywords: Space Weapon, Arms Control, Strategic Stability, Deterrence.

Introduction

Outer space was historically conceptualised as a peaceful domain, reserved only for scientific exploration and civilian use, and states abstained from turning it into a battlefield. It was mainly used for communication, navigation,

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weather forecasting, and scientific exploration. The Outer Space Treaty (OST) of 1967 reflected this – prohibiting the placement of nuclear weapons and Weapons of Mass Destruction (WMDs) in orbit and declaring the Moon and other celestial bodies to be used for the benefit and interest of all countries.¹ However, intensifying geopolitical competition among the major powers has transformed space into a contested strategic domain, which has created a security dilemma for other States.

Moreover, the advent of air power, followed by nuclear weapons and now space technologies, has fundamentally transformed the nature of warfare.² Today, space-based assets have become indispensable to modern military operations, providing secure communications, navigation, intelligence, surveillance, reconnaissance (ISR), missile early warning, and precision targeting. These capabilities enable armed forces to coordinate operations across the land, sea, air, cyber, and space domains with greater speed, accuracy, and resilience. As military dependence on satellites continues to grow, ensuring the security and survivability of these assets has become a strategic priority. Consequently, the prospect of conflict extending beyond Earth is no longer theoretical; outer space is increasingly emerging as a contested domain and a new frontier of military competition.

The growing prominence of outer space for military use has contributed to a gradual shift from the militarisation of space towards its weaponisation. While space weaponisation and militarisation are often conflated, they denote separate and distinct aspects of military activity in outer space.³ Militarisation is the use of outer space to conduct military operations more efficiently. It can include providing timely information/ intelligence gained through space assets, or communication or navigation⁴, whereas weaponisation of space is a different concept, which involves damaging space assets or ground assets from or in space. It also includes systems designed from orbit, disabling satellites, or intercepting missiles during their flight through space.⁵

The legal gaps in the OST, particularly its prohibition of only nuclear weapons and other WMDs in outer space while remaining silent on conventional weapons, Anti-satellite (ASAT) systems, and other counter-space capabilities, have enabled major powers to expand their military activities in space.⁶ Efforts have been made at international forums such as the UN Conference on Disarmament (CD) to negotiate a treaty preventing an arms race in outer space

(PAROS). However, the US and allies have blocked these efforts systematically. They are of the view that there are no weapons in outer space; thus, there is no arms race in space.⁷ Although no state admits that it is using space for military purposes and continues to maintain that outer space is for peaceful purposes only, reality is different. Through increasing tests, policies, and military planning, outer space is becoming more complex, contested and congested. Technological advancements in ASAT weapons, Fractional Orbital Bombardment Systems (FOBS), space-based missile defence architectures, directed-energy weapons, and autonomous orbital systems make this trend more apparent.

The recent debate on space-related issues is more focused on Chinese and Russian activities in outer space. Their developments of ASAT capabilities and other counter-space systems are projected as a challenge to the existing international order. However, such assessment often overlooks the impetus behind these developments. The US has been a primary driver of space militarisation. Since the 1980s, when President Ronald Reagan announced the Strategic Defence Initiative—commonly known as ‘Star Wars’—to the recent missile defence program and space dominance doctrines, all have been aimed at ensuring the US’s ability to operate freely in space.

Russia and China have been keenly observing and responding to the US space policy shifting from a defensive posture towards an openly offensive one. Accordingly, both are investing in counter-space and orbital strike capabilities designed to ensure the survivability of their deterrent forces. The security dilemma, which was once limited to conventional and non-conventional domains, is now heading to outer space. As the US, France, China and Russia formed their own special forces for space, NATO declared space a warfighting domain in 2019 and established the NATO Space Centre at Ramstein Air Base.⁸

Evolution of Space Militarisation leading to Weaponisation

The launch of the Sputnik demonstrated the potential of space technologies, leading both Washington and Moscow to recognise the significant military and intelligence advantages offered by satellites. As a result, outer space became militarised from the very beginning of the space age, with both powers integrating space capabilities into their military and strategic planning.⁹ Concerns over the vulnerability of high-altitude spy aircraft, reinforced by the U-2 incident, strengthened interest in space-based intelligence platforms as a safer and more reliable means of monitoring adversaries.¹⁰ Both superpowers moved towards

developing an ASAT programme. Throughout the 1960s and 1970s, the Soviet Union focused on producing co-orbital ASAT systems. The US developed and tested its own ASAT systems in 1985.¹¹ This system was a kinetic energy weapon intended to strike satellites moving at a very fast speed and destroy them. It caused a significant amount of space debris, endangering other satellites.¹² Likewise, in 1962, the US carried out a high-altitude nuclear test conducted above the Pacific Ocean.¹³ The test highlighted the potentially widespread consequences of nuclear detonations in space. The resulting electromagnetic pulses damaged many satellites and showed that nuclear explosions in space could have effects across entire continents.¹⁴

During the Cold War era, the US SDI planned a missile defence system incorporating space-based sensors, interceptors, and directed-energy weapons. This initiative fundamentally changed perceptions regarding the military role of space. It introduced the idea that space could become an active theatre for warfare in the near future. Military activities in space didn't end with the end of the Cold War. Instead, the Gulf War I demonstrated the decisive military advantages of space-based capabilities. During the conflict, the US used GPS for navigation, communication satellites for coordination, and surveillance satellites to collect imagery and intelligence, significantly enhancing the effectiveness of military operations. As a result, the US invested heavily in space capabilities through the 1990s and the 2000s. US policy papers focused on concepts such as space control, space superiority and space dominance. The 2001 "Rumsfeld Commission" report warned that the US could face a "Space Pearl Harbor"¹⁵ if enemies attacked its satellites, and this idea forced Washington towards building stronger offensive and defensive space capabilities.

The US Space Command was created in 1985, closed in 2002, and reactivated in 2019 when the US Space Force was established. The creation of the Space Force showed that the US views space as an important military domain.¹⁶ The creation of the US Space Force makes US space ambitions more explicit. The creation of a dedicated military branch focused entirely on space operations signalled the recognition of space as an independent warfighting domain alongside land, sea, air, and cyberspace. The growing interest of major powers in outer space military applications is now more obvious than ever. Both Russia and China are closely monitoring US activities in outer space, taking necessary reactionary measures.

Fractional Orbital Bombardment System (FOBS)

One of the most significant trends in recent military affairs is the development of orbital strike capabilities. Although some remain conceptual and debated, rapid technological advancement suggests that many could become operational realities sooner or later. Among the most widely discussed orbital strike concepts is the FOBS. The defining feature of FOBS lies in the term “fractional”; it refers to the idea that the weapon does not execute a complete circle around the Earth. Instead, it is there in orbit for only a portion of a revolution before de-orbiting and dropping onto its target.¹⁷

As per definition, FOBS is a system that sends a payload into a fractional orbit around the Earth. It only travels part of the way and then comes back down towards its target instead of rotating around the planet like a satellite.¹⁸ According to the US Defense Intelligence Agency (DIA), FOBS can be described as an ICBM that is designed to enter a Low Earth Orbit (LEO) before coming back to Earth along a non-traditional trajectory. In 1963, John McCone, who headed the CIA assessment, indicated that the future militarisation of space might include the widespread presence of satellites equipped with nuclear weapons. Moreover, FOBS was identified as a standby deterrent capability.¹⁹ It can carry multiple payload types, including nuclear warheads, hypersonic glide vehicles (HGVs), manoeuvrable reentry vehicles (MaRVs), as well as non-kinetic systems such as Electromagnetic Pulse (EMP) devices or potentially ASAT. This multi-payload capability introduces significant ambiguity, as an adversary may be unable to determine whether an incoming system is nuclear or conventional, thereby increasing escalation risks.

FOBS is not a new concept; however, its modern integration with recent hypersonic and space-based technologies introduces new destabilising dynamics that are different from its Cold War predecessor. In the 1960s, the Soviets developed FOBS. It was designed to deliver a nuclear weapon by launching it into LEO, and then de-orbiting it after flying only a fraction of one orbit to destroy an Earth-based target.²⁰ The FOBS changed the Cold War nuclear balance by giving the Soviets a way to strike that was harder for the US to detect. FOBS warheads could travel along low, sub-orbital paths that avoided US radar pointing North, cutting warning time from 20–30 minutes for regular ICBMs to as little as five minutes. This made the Soviets more confident in their ability to respond to an attack, because it was harder for the US to launch a preemptive strike.

To address this threat, the US deployed space-based infrared satellites that could monitor missile launches from any direction. Concerns were raised that FOBS might make leaders act too quickly in a crisis, since its fast and unpredictable path left little time to decide. Regular ICBMs are easier to track and give more time to think. During the Cold War period, such systems were deployed by the Soviet Union to bypass early warning radars and ballistic missile tracking architectures. The Ballistic Missile Early Warning Systems deployed by the US were oriented towards the North Pole, anticipating missile trajectories from the USSR over the Arctic. Considering the vulnerability, the Soviet strategic planners conceptualised a system capable of approaching the US from the South. This innovation potentially reduced US warning time.

Between 1956 and 1972, the Soviet Union is believed to have carried out roughly twenty-four test launches as part of the development of its FOBS program, with around seventeen of those missions achieving their intended objectives.²¹ Although on 27 January 1967 Russia signed the OST and ratified it in August of the same year, it nevertheless continued the development and testing of the FOBS shortly thereafter. A U.S. official stated that Soviet tests had sent nuclear-capable warheads into low Earth orbit about 100 miles high before bringing them back down.²² The purpose was to simulate attacks approaching from directions that could avoid US polar warning radars. It was argued that as “the system didn’t complete a full orbit, it did not violate OST”.²³

In 1968, the R-36O system was deployed by the Soviet Union.²⁴ It was the first operational FOBS. However, as submarine-launched ballistic missiles and survivable second-strike capabilities matured, the utility of FOBS diminished.²⁵ During the 1970s and 80s, developments in US missile warning and tracking capabilities had significantly diminished the strategic value of FOBS. The operational viability of FOBS was further undermined by the SALT II (1979), which prohibited the deployment of nuclear weapons in orbit and effectively rendered such systems obsolete.²⁶ Though the US Senate never ratified SALT II, both sides adhered to its provisions for years. The system was decommissioned in 1983. These rules extended the limits of the Anti-Ballistic Missile (ABM) Treaty of 1972 to cover FOBS, which could travel in partial orbits and avoid detection by early-warning radars.²⁷ Article IX of the treaty specifically banned any system designed to put nuclear weapons into Earth orbit, directly including FOBS.

Each Party undertakes not to develop, test, or deploy:

(C) Systems for placing into Earth orbit nuclear weapons or any other kind of weapons of mass destruction, including fractional orbital missiles.²⁸

In addition, the treaty's protocol set short-term restrictions on the development and testing of technologies needed to build such systems. This meant that FOBS and similar weapons were explicitly constrained, limiting their deployment and further testing. However, the US withdrawal from the ABM treaty increased concerns of other states regarding US intentions and capabilities. Even the New START did not address specifically fractional orbital systems, emerging hypersonic technologies, or other space-based systems.

FOBS is different from traditional strategic delivery systems. It differs from the conventional ICBM in its flight profile. Traditional ICBMs follow ballistic trajectories which are predictable once midcourse flight begins, and early warning systems use this predictability. FOBS introduces directional flexibility and reduces the ability of ground-based radars to anticipate targets. Submarine-Launched Ballistic Missiles (SLBMs) are considered the most likely part of a country's nuclear weapons to survive an attack. Submarines operate covertly and are difficult to detect. However, while highly effective, they do not alter trajectory predictability in the same way as FOBS does.

Likewise, Hypersonic Glide Vehicles (HGVs) and FOBS have a few common specifications as both aim to defeat missile defence through manoeuvrability and unpredictable trajectories. However, both operate at unpredictable stages of flight. FOBS relies on partial orbital insertion to alter approach direction before reentry, while the HGVs rely on a ballistic booster to reach high altitude before gliding toward the target. Both, when combined, result in layered complexity, intensifying pressure on existing missile defence architectures. With a speed above Mach 5 and manoeuvring within the atmosphere, this capability makes it harder for HGVs to be intercepted.

In 2021, it was reported that China carried out a test involving a FOBS combined with an HGV. The test highlighted progress in advanced long-range delivery systems designed to reduce the effectiveness of existing missile warning and defence capabilities.²⁹ This development sparked renewed global discussion about the strategic risks posed by orbital strike systems. At the time, US officials

referred to the test as a “near Sputnik moment,” highlighting its significance in terms of technological competition and strategic balance.³⁰ China, however, rejected this assertion and stated the test as a routine test of a space vehicle.³¹ Moreover, Beijing reiterated its policy of peaceful use space.³²

Anti-Satellite (ASAT) Developments

While FOBS represents one category of orbital strike capability designed to evade missile defences, the weaponisation of outer space has also accelerated through the development of ASAT weapons. Unlike FOBS, which targets terrestrial objectives through orbital trajectories, ASAT systems are intended to destroy, disable, or degrade satellites that support military and civilian operations. The evolution of ASAT capabilities in China and Russia is also closely linked to their perceptions of the US's growing military presence and strategic ambitions in outer space. In 1985, the US was the first to conduct an ASAT test.³³ Since the end of the Cold War, the US has pursued advanced space-based military architectures. Beijing and Moscow have repeatedly argued that these developments undermine strategic stability by increasing the vulnerability of their deterrent forces and creating incentives for weaponisation of outer space. In response, both countries have invested in a range of counter-space capabilities, including direct-ascent ASAT designed to hold adversary space assets at risk during a conflict.

Russia's concerns became more evident in November 2021 when it conducted a direct-ascent ASAT test against its defunct Cosmos 1408 satellite.³⁴ Moscow viewed the test within the broader context of the US expanding its military space capabilities, including missile defence, space-based surveillance, and the establishment of the US Space Force. From the Russian perspective, developing and demonstrating counter-space capabilities was necessary to preserve strategic balance and deter potential threats to its space assets. Russian Defence Minister Sergei Shoigu characterised the test as a routine operation of a “cutting-edge future weapon system” to strengthen Russia's deterrent and defence against US attempts to attain “comprehensive military advantage” in space.³⁵ China's 2007 ASAT test reflected its perception that the US was pursuing military dominance in space. By demonstrating its ASAT capability, China fears a space-based U.S. missile defence system could neutralise its nuclear arsenal, which has encouraged Beijing to develop counter-space capabilities while advocating restrictions on the deployment of space weapons.³⁶

In 2008, Moscow and Beijing proposed a “Treaty on the Prevention of the Placement of Weapons in Outer Space (PPWT)”, focusing on preventing the deployment of weapons in outer space.³⁷ Though revised in 2014, the proposal has not been accepted by the US and its allies, who argue that it leaves out ground-launched ASAT capabilities, lacks enforcement and verification measures, and may create strategic imbalances by constraining US missile defence systems while permitting continued development of ground-based counter-space weapons. This deadlock, the PPWT versus Western objections, is the central reason why no binding global treaty on space weapons has ever been agreed.

Furthermore, India's 2019 ASAT test, conducted under Mission Shakti, reflected the diffusion of counter-space technologies among emerging space powers. While officially presented as an indigenous achievement, decades of strategic cooperation with the US—including collaboration in missile defence, space situational awareness, satellite technologies, and broader defence partnerships—contributed to the technological ecosystem that facilitated India's advancement in this domain. The US has expanded strategic cooperation with India across multiple domains—including defence, space, advanced technologies, intelligence, and missile defence—to strengthen India's capabilities in support of its broader objective of balancing China's growing influence in the Indo-Pacific. However, the potential implications of this cooperation for regional strategic stability, particularly in South Asia, have received comparatively less attention.

Another category, co-orbital kinetic threats, commonly known as “killer satellites,” are satellites designed to approach and physically damage or destroy another satellite in orbit. These systems can manoeuvre close to a target and disable it through collision or other kinetic means. Because they operate in the same orbital environment as their targets, they can be difficult to detect and monitor. The destruction of satellites can generate large amounts of space debris, posing risks to other spacecraft and satellites. As states become increasingly dependent on space assets, co-orbital weapons are emerging as a significant challenge to space security and strategic stability.

Golden Dome Initiative

The re-emergence of FOBS and other advanced missile technologies has increased interest in stronger missile defence systems. In 2025, US President Donald Trump announced the Golden Dome initiative to protect the US from existing and emerging threats. The system is intended to defend against ballistic

missiles, cruise missiles, hypersonic missiles, drones, and orbital threats such as FOBS, whether they carry conventional or nuclear warheads.³⁸ It would use a large network of space-based sensors to detect, track, and identify missile launches from land, sea, air, and space. These sensors would work together with ground-based systems and advanced command-and-control networks to improve the detection and interception of incoming missiles.³⁹

A key feature of the Golden Dome is the proposed deployment of interceptor satellites in space to destroy missiles during their boost phase using kinetic interceptors or directed-energy weapons. This marks an important shift in US space policy, moving beyond the traditional use of satellites for communication, navigation, surveillance, and early warning toward the deployment of active defensive systems in space. Russia and China have criticised the initiative, arguing that space-based interceptor systems have dual-use potential and can serve both defensive and offensive purposes. They believe the project could accelerate the weaponisation of outer space and increase strategic competition among major powers.⁴⁰ They argue that weapons in space can be both defensive and offensive, since the same system can be used differently depending on how it is deployed.⁴¹

Non-Kinetic Counter-Space Capabilities

Beyond kinetic systems, states are also developing non-kinetic counter-space capabilities that can disrupt or disable satellites without physically destroying them. Non-kinetic threats are weapons and techniques that disrupt or disable space systems without physically destroying them. A major challenge is that many counter-space capabilities are inherently dual-use, making it difficult to distinguish between defensive and offensive intentions. For example, electronic jamming may be used either to protect friendly operations or to disrupt an adversary's satellite communications. Likewise, rendezvous and proximity operations (RPO), which are often conducted for satellite inspection, servicing, or debris removal, can also be used to interfere with or damage another state's satellite. Similarly, debris-producing actions, including kinetic ASAT tests, may be justified as technical demonstrations or defensive measures but can also degrade the space environment and threaten the assets of all space users. Because states cannot easily determine the intended purpose of these activities, they are more likely to interpret them as hostile preparations, increasing mistrust, strategic uncertainty, and the risk of escalation.

Implications

Technological progress is acting as a catalyst for the return of orbital strike capabilities. The new weapons and equipment have become much smaller than the previous ones, which makes it easier to place them in space. Second, modern guidance and navigation systems, including AI, help these weapons find and hit targets more accurately. Likewise, the reusable launch vehicles have made such systems more affordable. Because of all these reasons, systems which were once considered difficult to use are now becoming practical in today's strategic environment. Moreover, dual-use application of space launch and missile technologies makes it harder to respond to these emerging threats. All these developments together will have several implications for strategic stability.

First, technologies such as FOBS, hypersonic glide vehicles, anti-satellite weapons, and space-based missile defence architectures introduce new variables into strategic calculations. These systems reduce predictability, shorten warning times, increase uncertainty regarding intentions, and complicate deterrence relationships among major powers. The reduction in early warning time compresses decision-making windows, thus increasing the likelihood of miscalculation.

Second, space debris from ASAT tests threatens satellites of all; it is not just limited to rival states. The space debris can stay in orbit for years and decades and can hit commercial, scientific, and military satellites from all nations, including the country that conducted the test.

Third, FOBS can carry both types of payloads, i.e., conventional as well as nuclear. This is very alarming because the adversary states may fail to identify the nature of the incoming weapon. Due to this ambiguity and uncertainty, there is a significant risk that an opponent state may respond with nuclear retaliation, considering the "use it or lose it" dilemma, even if the attack is conventional. Thus, it increases the likelihood of inadvertent nuclear escalation and undermines crisis stability.

Fourth, the development of such systems is likely to trigger a prolonged and costly arms race at both the regional and global levels. States that perceive these capabilities as a threat will be compelled to invest in disruptive technologies to counterbalance their adversaries' military advantages. This may include the development of advanced missile defence systems, next-generation interceptors,

and space-based military capabilities designed to mitigate emerging threats. Nuclear-armed states may also seek to modernise their Nuclear Command, Control, and Communication (NC³) systems to ensure operational effectiveness under increasingly compressed decision-making timelines. Collectively, these developments are likely to intensify strategic competition, fuel quantitative and qualitative arms buildups, and accelerate the global arms race, particularly through the proliferation of destabilising weapon systems.

Lastly, the absence of clear and updated legal norms governing advanced orbital weapon systems risks undermining the existing global arms control architecture. Major Powers often exploit ambiguities and loopholes in international law to advance their strategic interests. The OST, which entered into force on 10 October 1967, prohibits under Article IV the placement of nuclear weapons and WMDs in Earth orbit or their stationing in outer space in any other manner. However, the treaty was negotiated in a vastly different technological environment and does not adequately address many contemporary space-based military capabilities.

The inherently dual-use nature of space technologies further complicates matters, as the same launch vehicles and satellite systems can serve both civilian and military purposes. Another challenge is the absence of a clear legal definition of what constitutes an "armed attack" in outer space. Existing international space law does not clearly specify whether activities such as electronic jamming, laser dazzling, cyber-attacks on satellites, or close-proximity operations should be treated as hostile acts or legitimate peacetime activities. This legal ambiguity makes it difficult for states to distinguish between routine operations and preparations for an attack. As a result, states may interpret ambiguous actions through a worst-case lens, increasing mistrust, encouraging pre-emptive responses, and heightening the risk of unintended escalation during crises. As space technologies continue to evolve, existing legal frameworks require substantial modernisation to ensure effective verification, transparency, and enforcement mechanisms. Without such reforms, the growing militarisation of outer space is likely to heighten strategic uncertainty, weaken arms control efforts, and increase the risks of misunderstanding and escalation during crises.

Conclusion

Outer space is undergoing a profound strategic transformation. Advances in orbital strike capabilities, anti-satellite weapons, hypersonic delivery systems,

missile defence architectures, directed-energy technologies, and artificial intelligence are reshaping the security environment in ways that were unimaginable only a few decades ago. Although Russia and China are frequently portrayed as the principal drivers of space weaponisation, a broader examination of strategic developments suggests a more complex reality. The long-standing pursuit of space superiority by the US, combined with expanding missile defence initiatives, advanced surveillance networks, and emerging orbital warfare concepts, has significantly influenced the security perceptions of both Moscow and Beijing.

The international community should update existing laws and create arms control measures for 21st-century technology. If precautionary steps are not taken, then the spread of this and related technology could harm global security and international peace. It can also increase the risk of accidental escalation. The future of arms control depends upon how countries respond to the prevailing situation, choosing unlimited, unnecessary, expensive competition or acting responsibly. There is an urgent need for a legally binding arms control framework to regulate military activities in outer space.

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