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The Consequences of Space Militarization: Deterrence, Escalation, and Damage

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What are the consequences of space militarization? This review article analyzes and synthesizes the literature surrounding the issue of space militarization. This project identifies three broad impacts that academics and researchers have identified: alterations in deterrence calculations, possibilities of escalation and arms races, as well as widespread physical damage through Kessler Syndrome. It finishes by indicating future avenues for research.

Introduction

The Soviet Union launched the first satellite into space, Sputnik 1, in 1957. Since then, there have been many satellites put into space, with many having military roles. There are currently roughly 600 dedicated military satellites in orbit as of 2025, and while this is far from the roughly 12,000 total satellites in orbit today, this number is still considerable (Union of Concerned Scientists, 2023). The domain has been militarized since the dawn of the space age and is characterized by the increasing number of assets that assist military action, like reconnaissance satellites that relay movement of militaries (Harrison, 2017). It is clear that modern satellites greatly enhance the fighting capabilities of militaries, primarily through their utility as intelligence-gathering and communications platforms, as well as other roles like weapons guidance, navigation, and more. In light of their increasing importance to militaries, technologies meant to counter them, denoted as Anti-Satellite (ASAT) weapons have also increased in use. Such weapons have been tested several times by a variety of different countries, including the US in 2008, Russia in 2021, and China in 2007 (Cooper, 2024). With both military satellites and technologies meant to bring them down becoming more widespread, the issue of space militarization is highly pressing and constantly evolving. This paper explores the far-reaching consequences of space militarization. The literature argues that the consequences of space militarization can be seen in changes to deterrence calculations due to the unique characteristics of space, an increased risk of arms races due to uncertainty and suspicion of military capabilities in space, and wide

scale physical damage caused during space war.

Discussion

Preventing a Space War - Deterrence Theory

A consequence of space militarization is that space changes the calculus of deterrence due to its unique attributes as a domain (Harrison, 2017). Deterrence is the act of discouraging and stopping a certain action due to fear of its potential consequences. Deterrence theories are integral to understanding the nuclear domain, which is seen through Mutually Assured Destruction. However, despite seeming similar to deterrence in this domain, some authors argue that space carries with it certain differences and unique characteristics that change these calculations of deterrence. They include differences in the type of damage caused by nuclear and space warfare, context of use, lack of legal regulation, as well as the secrecy and distance in space that hinders the capacity, credibility, and communication that is critical to successful deterrence.

A fundamental difference between the Nuclear and Space domain mentioned is the type of destruction a war in each domain can bring. Nuclear warfare is an active threat to life on Earth, while Space warfare, though it destroys the use of space, brings little direct harm to life on Earth (Mueller, 2013). For example, a war in space in which many satellites are kinetically destroyed may make space difficult to use in the future but will have little impact on terrestrial life, as most of the damage will be in space. As such, there is a clear difference between a space war and a nuclear war, which can wipe out much of the life on this planet.

Another key difference mentioned by many is the context in which weapons of both domains could be used. Nuclear weapons, despite seeming like offensive weapons, are more often used for defensive purposes in deterring other nuclear states. On the other hand, proposals for weapons in space tend to be almost exclusively offensive, due to perceptions of space militarization favoring the aggressor rather than defender (Mueller, 2013). Though, a caveat to this point brought up by some is that the nature of these offense-defense relationships is hinged on doctrines and technology, which can change over time. An example of this is the mainly offensive role played by nuclear weapons during the cold war, compared to their primarily defensive role as a deterrent in the current day (Mueller, 2013).

Finally, another crucial difference brought up by some is the lack of legal regimes surrounding the use of the space domain when compared to the nuclear domain (Rajagopalan, 2021). The significant potential impact of the nuclear domain has created many legal and diplomatic agreements surrounding its creation and use, which is something completely absent in the space domain. These critical differences between the nuclear and space domains indicate that

understandings of deterrence in the nuclear field cannot be applied to space. Such differences in deterrence need to be kept in mind due to the ever-expanding scope of space militarization, as improper application of deterrence theories in a highly militarized space environment can have severe consequences. Aside from these factors, though, there are also additional challenges presented due to space's characteristics as a domain that call into question theories pertaining to deterrence.

Authors also connect concepts of rational choice theory to understand the challenges presented in space deterrence. Specifically, they argue that rational choice approaches to deterrence are based on three factors: capability, credibility, and communication (Harrison, 2017). First, the capacity to deter means that the deterrer can respond to an attack, and for that response to be damaging enough for the opponent to not try, exemplified by the extensive nuclear strike capabilities on both sides of the iron curtain during the cold war, indicating to each other their capacities to respond to attacks. Second, the credibility of deterrence in space relies on assurances that the deterrer would respond to an attack. Finally, communication of deterrence in space is a demonstrator of the previous two factors: that the deterrer has the capability and credibility to retaliate if attacked.

Some state that, in the space domain, the capacity and credibility to deter aggressors in space can be unclear, due to secrecy on all sides regarding ASAT technologies as well as the unclear consequences of interference with satellites (Harrison, 2017). They also argue that communication is especially difficult due to the nature of space as a domain. This is due to the potential of misunderstanding goals and fears, misreading of signals, unclear commitments, overestimation of threats, and the difficulty of balancing threats and communication (Schreiber, 2023). Constraints unique to space include its remoteness and highly classified nature, which further undermines efforts to communicate capability and credibility (Harrison, 2017; Schreiber, 2023). These unique challenges of space as a domain in applying rational choice concepts makes it clear that preconceived understandings of deterrence are unfit to be applied to space.

It is clear that the differences in damage and legal restrictions between the nuclear and space domains, as well as the uniquely long distances and secrecy of space that undermines application of capacity, credibility, and communication makes deterrence in space difficult. As such, due to the increasing militarization of the unique domain of space, many indicate that preexisting conceptions of deterrence cannot and should not be applied to space (Mueller, 2013). Some also argue that these issues in applying theories of deterrence in space creates an environment of suspicion and instability that may lead to arms races.

Dangerous Escalations - Arms Races

Another consequence of space militarization brought up by many is its role in increasing tensions that sets the stage for escalation and arms races, which some authors argue is already happening. This is a result of destabilization of security dilemmas due to difficulty in distinguishing between offensive and defensive assets in space, as well as general perceptions of offensive favorability in space. Security dilemmas happen when one country, group, or person seeks to gain security and power, which in turn, motivates other countries, groups, or people around them to do the same (Townsend, 2020; Schreiber, 2023). Authors indicate that security dilemmas are heavily impacted by two factors: the level of distinguishability between different assets and whether offensive or defensive action holds an advantage in space. As such, the dilemma is primarily based on the relationship and perception of belligerent action, in which ambiguity and misconception can lead to escalation and arms races (Schreiber, 2023). Some believe distinguishability of offensive and defensive assets in space is highly difficult to ascertain due to the nature of space systems (Townsend, 2013). For example, satellites can gather data and transmit information. This ability itself is defensive. However, if satellites are used to support offensive actions on the ground, there is an argument to be made that satellites are a tool for offense. Additionally, there are issues surrounding use cases of orbital repair and maintenance satellites, as these satellites can disrupt or destroy another satellite just as easily as they can repair them. These issues can be seen in how many Russian and Chinese spacecraft have robotic arms that despite being meant for repair, could be used to disrupt or destroy other satellites in instances of conflict (Moltz, 2019; Schreiber, 2023). The use of these satellites depends almost entirely on the intentions of the countries operating them, further muddling the line between offensive and defensive systems in space (Townsend, 2013; Schreiber, 2023). As such, determining whether satellites are offensive or defensive is a highly complicated and situational issue, leading to instabilities in space militarization. This problem is further compounded by difficulties in determining whether the domain of space favors offensive or defensive action.

There is also the issue of understanding whether space itself favors offensive or defensive action. Authors primarily determine this through applications of offense-defense theory, which surmises that an environment that favors offensive action will result in a higher likelihood of conflict, while an environment that favors defensive action will lead to a lower probability of conflict (Goodman, 2024). While there are strong arguments on both sides, it is believed by many that space is a domain that favors offensive action.

There is a general consensus between many that space is a domain that favors offense rather than defense (Moltz, 2019). Advances in military

technology have made it cheaper and easier to negate the advantages of satellites, through the proliferation of ASAT weapons. For example, a US kinetic ASAT weapon test in 2008 would lead to the destruction of a satellite worth hundreds of millions of dollars with a missile worth only forty to sixty million dollars (Townsend, 2020). Many surmise that this creates a dynamic in which it is much easier and cheaper to destroy/diminish the utility of satellites compared to putting them up into orbit.

Some also argue that increased visibility within space contributes further to the offense-dominant nature of space. Increased visibility in space means that one, there is less uncertainty when attacking satellites and two, there is a higher probability of successful destruction when attacking satellites (Goodman, 2024). Both are advantageous factors to attackers, as decreased uncertainties results in increased confidence to strike critical satellites and the networks it supports. As well, higher probabilities of kill also makes it easier for attackers to seek and destroy satellites without much resistance.

Others also mention a counterargument to increased visibility providing advantages to attackers, due to lack of the element of surprise in space. These authors argue that the high visibility in space leads to surprise attacks being impossible due to the distances involved in space, which may lead to aggressive action being telegraphed in advance (Goodman, 2024). Other authors counter this argument, though, by mentioning other means to create surprise attacks in space such as with satellites that have unknown offensive payloads. This is exemplified by suspicions of Russia deploying a satellite with a nuclear armament, showing that there is often no knowing what payloads military satellites carry (Goodman, 2024).

Despite the general consensus among authors on the offensive nature of space, some authors have argued on the contrary, that space instead favors defensive action. They argue that the sheer quantity of satellites in space, as well as continued uncertainties in capabilities of certain satellites creates an environment advantageous for defenders (Townsend, 2020). The vast increase in the number of both civilian and military satellites in space causes several issues for attackers. First is the nature of satellites, as a method of collecting and transmitting information. Attackers need to halt this collection and transmission of information. With the large number of military and civilian satellites in space capable of both information collection and transmission, stopping this flow of information can be extremely difficult. Prepared defenders in space will have sprawling satellite networks with high levels of redundancy, where attacks on individual satellites would be largely ineffective due to the flow of information simply being rerouted through other satellites (Townsend, 2020; Turpin 2023; Moltz 2019). Because of this, these authors argue that large networks of satellites are highly defensible, contributing to their claim that space is

a primarily defensive domain.

Additionally, these authors argue that, despite advances in satellite tracking and visibility, many military satellites remain shrouded in secrecy, due to both the unwillingness of governments in sharing such sensitive information as well as both the technical and diplomatic difficulty in examining foreign satellites closely (Townsend, 2020; Schreiber, 2023). This creates a situation where satellites are able to be tracked closely, but their capabilities are largely up in the air (Townsend, 2020). They argue that these uncertainties in verifying the true purpose of newly launched military satellites creates situations in which defensive actions are misinterpreted as aggressive, which gives an advantage towards space as a defensive domain. Despite strong arguments on both sides, it is still clear that the prevailing view on this debate both from academics and governments leans towards the offense. Both the ambiguity in understanding whether satellites are offensive or defensive, combined with the general perception that space is a domain that favors aggressive action creates an environment where the risk of dangerous escalation is increased. In fact, some think an arms race is already in the process of building (Peperkamp, 2020).

When arguing about the possibility of an arms race in space, many center their arguments on the proliferation of ASAT systems, improvement in satellite technology, and the lack of substantial legal framework surrounding the use of space. An arms race is a situation that arises when two or more countries are in competition to field newer and better military systems to gain a competitive edge over the other.

Many argue that the proliferation of ASAT systems is a key indicator of a building space arms race (Sönnichsen, 2020). This proliferation is something that has been in the making since the very start of the Space Age at the start of the Cold War. Despite a brief lull in development of such capabilities with the end of the Cold War, in 2001, the US would restart development of its ASAT capabilities as a deterrent in light of US satellite network vulnerabilities. This would prompt a flurry of activity from foreign rivals, starting with a Chinese test in 2007, followed by another US test as a response in 2008. In the 2010s, Russia and India would each test their own ASAT weapons as well, showing the ever-continuing proliferation of such weapons and technologies (Sönnichsen, 2020).

Some also argue that new space technologies would push the boundaries for the possible uses of space, particularly by militaries (Steer, 2017). During the Cold War, satellites were primarily relegated to reconnaissance and communication duties. This would change with the end of the Cold War and particularly during the first Gulf War, where satellite technology would be used in the targeting of munitions and navigation of troops. The success of this technology in the war would inform other countries of its use in modern warfare. It is

considered a critical enabler for modern warfare and would be another cause for the proliferation of military satellites and thus the ASAT Arms Race (Steer, 2017).

Finally, they mention the lack of a substantial legal framework regarding the use of space as well as measures to enforce these rules and regulations as another driving factor behind this potential arms race (Sönnichsen, 2020). These lack of rules means that countries can continue to advance their capabilities in launching and destroying satellites without any repercussions. This is one of the reasons why a space race in space is so dangerous, as because of the lack of regulations as well as substantial legal entities/groups to hold countries accountable for militarization, space will continue to be militarized, increasing the risks and damage of war in space. As a result of the proliferation of ASAT technology, combined with improvements in satellite technology as well as the lack of legal restrictions on the use of space, some authors argue that a space arms race is already building.

While authors have not yet reached a general consensus on whether there is an ongoing arms race in space, the fact that it is a possibility should not be taken lightly (Peperkamp, 2020). Issues in the security dilemma and offense-defense theory also further amplify the risks of escalation and arms races. Authors have stated that, even if this current situation in space is not an arms race, it is clear that the ongoing militarization has the possibility of turning into one. The increasing militarization of space has created a setting in which the risks of escalation are highly volatile and dangerous, potentially setting the stage for future conflict in space.

Physical Damage - Kessler Syndrome

A final consequence of space militarization mentioned by authors is the costliness of physical damage due to the potential of Kessler syndrome. Kessler syndrome is a situation in which one destroyed satellite collides with others, creating a nuclear fission-like chain reaction that results in the majority of space becoming unusable. They argue that this is a possibility due to the large amount of debris that is created when a satellite is physically destroyed, and that the impact of this debris is multiplied when a weapon of mass destruction (WMD) is used in space.

When approaching this idea of Kessler syndrome, many authors emphasize the amount of debris that the physical destruction of one satellite can create (Schwartz *et al*., 2021). There have been several Direct Ascent Anti-Satellite (DA-ASAT) weapons tested during and since the Cold War and is a benchmark to explain the destruction even one satellite can cause. For instance, a Chinese test of a DA-ASAT weapon against a defunct satellite in 2007 resulted in more than 900 trackable pieces of debris (Mutschler, 2010). Given that this is just

damage from one single satellite, there are grave implications of using WMDs in space. The potential impact is illustrated in the Starfish Prime test (1962) conducted by the US Military in determining the damage of nuclear weapons detonated in Outer Space. The test damaged 8 satellites, with three ceasing operations as a result of damage taken by radiation and EMP effects (Conrad *et al.*, 2010). With the more than 10,000 satellites in orbit as of June 2024, the use of these WMDs can result in thousands of satellites becoming inoperable in an instant, with many more following them in the near future (Faleti, 2024). It should be mentioned, however, that because of the unsustainable amounts of debris generated by the physical destruction of satellites, countries like China have recently refocused onto less kinetic means of ASAT technology, namely lasers and jammers, to impede the function of satellites without destroying them (Turpin, 2023).

Because of the amount of debris satellites produce when physically destroyed, authors highlight the possibility of Kessler syndrome, a situation in which debris from a destroyed satellite strikes others, destroying them and producing even more debris (Schwartz *et al.*, 2021). This has the very real possibility of snowballing into a situation in which almost all satellites in space are rendered inert, as well as preventing the future use of space in the long-term (Mutschler, 2010). As such, space warfare may be considered in a similar lens as nuclear warfare, as warfare in either domain can result in devastating consequences, either destroying humanity or its capacity to expand (Zweibelson, 2023). Authors emphasize that the continued buildup of military equipment in space, as well as the equipment to destroy it, has led to a situation in which Kessler syndrome has become a real possibility.

Conclusion

This article asks about the potential consequences of space militarization, and what authors and academics have written on this issue. First, many authors argue that the calculations of deterrence doctrines need to be revised to suit space as a domain. Additionally, some also assert that space militarization increases the risk of dangerous escalation and arms races. Finally, they also argue that space militarization can result in heavy physical damage through Kessler syndrome. There are many debates over the intricacies in each field, especially those that analyze whether space is an offensive or defensive domain. It is clear that these debates impact global perceptions of space in offense-defense theory, which has large impacts on state actions. Though, many authors are left to speculate on this conclusion as space warfare has not yet happened. While military and civilian satellites have both seen use in many recent conflicts since the Gulf War, there have been no recorded instances of warfare in

space. At the same time, it needs to be considered that most of these approaches are based on the realist school of thought, which can be seen in the prevalence of theories that are reliant upon logic and state-centrism in actions. From this article, possible avenues to explore in the future may be deeper empirical research into Kessler syndrome, to more conclusively understand if such a situation may occur in space. Many writings on the topic of space militarization touch upon potential solutions to the issue; analyzing the feasibility of proposed solutions could also be an interesting application of this work. Additionally, approaching issues surrounding the militarization of space from a non-realist perspective could offer further unique insight. At the same time, drawing deeper connections between civilian space markets and space militarization would also provide new understandings of the issue aside from what authors and academics have written already.

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