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14. ABSTRACT

The growing military and economic importance of space pose unique challenges and risks for U.S. operations in the theatre. The best way to maintain open access to space for the United States is to focus on establishing international norms and institutions that increase the reputational cost of initiating space warfare, that deter by resilience and by cost imposition the initiation of space warfare, as well as tie the use of first strike or escalation in the space theatre to retaliatory measures in other theatres (horizontal escalation) in order to coerce through force the upholding of those international norms.

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In Space Everyone Loses: Reducing the Risk of Escalation in the Space Domain Through a Three Tiered Approach.

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Introduction

Issues of use of force and military doctrine in space warfare are an increasingly important area of both practical military and academic interest for U.S. foreign policy. The rapid progress and reduced cost of launches have drastically increased both economic and military utilization of space, for not just the United States, but also for adversaries and allies alike. While there has never been a conflict fought in the space theatre, there has never been more to lose by all interested parties than there is today. Therefore, distilling some of the ongoing issues and solutions relating to kinetic conflict in space is necessary. *The best way to maintain open access to space for the United States is to focus on establishing international norms and institutions that increase the reputational cost of initiating space warfare, that deter by resilience and by cost imposition the initiation of space warfare, as well as tie the use of first strike or escalation in the space theatre to retaliatory measures in other theatres (horizontal escalation) to coerce through force the upholding of those international norms.*[1]

The first tier focuses on space governance, normative actions and policies that can both decrease the likelihood of a conflict in space and its further militarization by changing the cost-benefit analysis a party would undertake when considering escalation. This can be achieved by increasing the reputational cost of breaking norms and binding international parties to normative structures. The second tier focuses on both policies and concrete steps that could be taken to reduce the U.S.'s vulnerability to attack in space or increase the cost of belligerent action by a third party (deterrence by resilience and collective cost imposition). By aligning the interests of the United States with its international allies in the space domain, it can decrease its vulnerability to a first strike. The third tier focuses on retaliatory steps that could be taken both inside and outside of the space theatre to impose costs and discourage adversaries from further escalation. Specifically with retaliatory measures that could cause significant damage to an aggressor while at the same time upholding international norms without posing further escalatory risk. [2]

The geography of the space environment.

While the space domain itself is not a new theatre for U.S. presence, the nature of the domain has changed drastically since it was first accessed by the USSR with Sputnik and the following U.S. space program. Initially a purely political, military and scientific theatre of operations, space has become a core part of the global economy facilitating trade, commerce, and most importantly communication. The U.S. military heavily relies on space as a means to facilitate long-distance communication and integration of various assets, provide intelligence and provide

[1] (U.S. Department of Defense 2011)

[2] Governance incorporates various formal structures within itself such as international treaties, regulations and other agreements that are explicitly agreed upon and codified in law. Norms are more amorphous but generally include not just explicit advocated agreements and statements of cooperation and understanding, but also implicit behaviors or restrictions on behaviors that states observe and may punish parties that defect from their observation of. Often norms are codified into law or treaty and thus become the structures of later governance. For an applied discussion of this in the context of space please see: (Mcclintock, et al. 2021)

the cornerstone of nuclear and missile deterrence monitoring and response capabilities. Of all concerned parties, the United States has the most extensive presence in space, and any conflict that occurs in this domain will have the biggest negative impact on U.S. economic and strategic interests, thus it is vital to act in order to reduce the likelihood of a space-based conflict.[3]

The space sector at large was worth $469 billion USD in 2021, for net growth of 9% while nations such as the United States, China and India respectively increased their government expenditure by 18%, 23% and 36% annually.[4] Satellites and free use of space are a prerequisite to civilian usage of Global Positioning Systems (GPS) for navigation and travel. The wide array of digital and technical services available will only continue to grow in the future with emerging technologies such as cheap and easy access to satellite internet and further innovation in communications. Microgravity environments in Low Earth Orbit (LEO) will be increasingly important for materials and technology research as they provide a unique environment for innovation and materials science research that cannot be replicated on Earth. Industry estimates may well understate the economic benefits from space and government technology spinoffs. As access increases so will the yields to these ventures along with decreases in launch costs.

The geography of space can be visualized with overlapping spheres of which the most prominent two being LEO (low earth orbit), and Geo-stationary Orbit (GEO) which sandwiches Medium Earth Orbit (MEO) and irregular elliptical orbits in between. For launches, the higher the target orbit, the higher the cost of the launch as more fuel is needed to send less payload (this is somewhat mitigated by being able to launch closer to the equator). As LEO has the lowest cost to place items in orbit, many satellites reside here making it the most crowded orbit trajectory and the most prone to debris. GEO while more expensive to reach and significantly further has the benefit of being the altitude at which an orbiting satellite can remain stationary relative to a specific ground position (ie it orbits at the same pace as the rotation of the earth making it ideal for communications networks and location related services), GSO has a much larger orbital circumference.

Similar to international waters, space is a domain where all parties can have access and reap the benefits, but the costs of environmental pollution and deterioration of the commons will impact all parties.[5] Even without conflict, without a solid governance framework space may very well become unusable as debris accumulates and poses a risk to already existing satellites. It is projected that by 2026 the world will be approaching 5000 satellites in orbit, and for each additional launch some debris is generated, followed by the satellite operating for its lifespan and

[3] (Krepon, Space and Nuclear Deterrence 2013, 26-30)
[4] (Space Foundation 2022)
[5] The commons refer to the concept of a shared resource that all parties benefit from and no party can be excluded. Mutual benefit depends on all parties not over utilizing the resource or damaging it. Individual parties have an incentive to extract as much as possible from the commons for personal benefit which harms the greater good and permanently decreases the total available resources. Thus the "tragedy of the commons" is a common concept in economics and game theory, with the solution being governance and distributional structures for fair use of the resources.

then becoming inactive (more recently procedures for de-orbit or graveyard orbit have been implemented). For each additional orbiting body, the increase in collision risk from launch debris and old satellites increases exponentially. Tracking the trajectories and numbers of debris items in orbit is becoming increasingly important as it accumulates, the latest counts of debris that are large enough to be tracked stands at 32,750 objects. Statistical models project over 36,500 debris items larger than 10cm, over 1 million objects between 1-10cm, 130 to over 160 million objects between 1mm to 1cm, however many other estimates greatly exceed these numbers.[6] Objects even below 1cm can cause significant damage as they orbit at an average velocity in the range of 4 to 5 miles per second, where even paint chips can cause irrecoverable damage if it impacts a satellite. In 2009 the first major satellite collision occurred (between iridium-33 and Kosmos2251) creating over 2300 trackable debris pieces.[7] Events such as debris collisions with satellites and satellite on satellite collisions will continue to increase in the future without transparency and agreements between parties for tracking debris avoidance.

The most dangerous aspect of space debris is after a critical mass of debris has accumulated, further collisions of debris may cause cascades or run-away effects otherwise known as Kessler Syndrome where debris fields impact other satellites, releasing more debris. The result is a chain reaction that could render the space commons unusable for hundreds of years in LEO, and potentially functionally permanently for higher orbits where debris doesn't deorbit itself due to atmospheric drag. The latest Chinese ASAT (anti-satellite weapon) test in 2007 created over 35,000 pieces of debris.[8] Conflict in space will likely result in the use of ASAT weapons, accelerating an already precarious situation towards an unrecoverable scenario. The vicious cycle caused by kinetic ASAT weapons use are what should make them a top concern for all parties.

Due to the specific traits and costs of utilizing kinetic ASAT weapons, the body of this paper is focused on them as the primary threat in question and does not cover either energy weapons (dazzlers, advanced jamming, lasers or other electromagnetic spectrum weapons (EM)) or orbital use of nuclear weapons to generate electromagnetic pulses (EMP) for space denial and targeting of ground-based electronics. It should be noted though that the solutions provided also apply to nuclear weapons in space, which generate significant and long-lasting radiation belts that would function in many ways similar to debris in preventing space utilization in the short term.[9]

Kinetic ASAT weapons are the most dangerous threat to all parties, due to their debris causing nature and their potential perception as a weapon that can be used in a limited or non-escalatory fashion. The theatre gives an overwhelming advantage of first strikes but any damage from a significant first strike cannot be contained to the adversaries' assets.[10] Thus, it boils down to a scenario in which two conflicting parties will judge the costs and benefits of escalation by

[6] (Mcclintock, et al. 2021); (Union of Concerned Scientists 2007)
[7] (ESA n.d.)
[8] (Mcclintock, et al. 2021)
[9] (Mueller 2013, 52)
[10] (Morgan 2010) – For an overview of first strike stability and deterrence.

assessing if they or the opponent have more to lose in a scenario of tit-for-tat or large-scale escalation. They may also anticipate that strikes on space assets may be viewed by the opposing party or international community as less serious an escalation than strikes on targets where there is a potential for loss of life. The safeguards to escalation in these scenarios are currently few, the incentives for escalation large, and the cost to all parties significant.

Conflict in space has a unique flavor of theatre specific mutually assured destruction (MAD) when it comes to kinetic ASATs. The dynamics of this system are uniquely dangerous, as even a limited ASAT strike by any party could be the figurative hair that breaks the camel's back, resulting in large scale destruction of satellites which could be interpreted as a major attack against U.S. space systems. Each subsequent impact would eliminate nodes of communication, cascading throughout the U.S. military and civilian communications infrastructure, significantly increasing the fog of war. The most worrying aspect of this is that at a critical moment, the United States may lose a significant part of its early warning and communication systems integral, to nuclear monitoring and deterrence. These same systems would be targeted in the run up to a pre-emptive nuclear strike, making misinterpretation of adversary intent a distinct possibility. [11] The lack of previous space conflict can be at least partially attributed to the dynamic between satellite systems and nuclear deterrence, with both the United States and Soviet Union recognizing that any conflict in space would have major destabilizing effects.[12]

The collateral damage of space warfare itself may not be adequate to deter it. If an adversary sees a disproportionate benefit by attacking U.S. systems and bearing the retaliation in space to its own systems, it may accept that as a net win. Adversaries may also underestimate the chance or degree of retaliation if they perceive a space attack to have a lower chance of escalation than an attack on personnel.[13]

International Norms and governance

There have been several attempts to codify norms and move them to a formal framework, both by groups of nation states and by international bodies such as the United Nations (U.N). Original agreements limiting the militarization of space were framed by the struggle between the United States and the Soviet Union during the Cold War and were focused on the militarization of space for nuclear conflict or interception capabilities, both of which were deemed destabilizing. There are a number of treaties attempting to address governance in space; the first was the Outer Space Treaty which while non-binding, outlined principles for the free use of space.[14] In a similar vein, the EU has proposed the Code of Conduct for Outer Space Activities in 2008, but it would

[11] While an opponent may attempt to avoid striking nuclear early warning system, this relies on both an opponent knowing the purpose and function of U.S. satellites and also being able to predict debris fields.
[12] (Krepon, Space and Nuclear Deterrence 2013, 15-18)
[13] (Mueller 2013, 54), (Triezenberg 2017)
[14] (United Nations Office for Outer Space Affairs 1967)

also be non-binding.[15] The Chinese and Russians have proposed the Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects (PPWT).[16] PPWT 2014 rendition would limit the use of weapons including ASATs, but not include limitations on weapon stockpiling or verifications and audits of weapons by foreign entities, thus the United States has rejected it as insufficient.

Establishing structures of norms and governance are essential in that they have the purpose of clarifying intent, reducing risk and creating incentives for maintaining peaceful use of space. They also undermine justifications for escalation and will be vital in rallying the international community against conflict spreading to the space domain. For allies and partners, they allow the global community to express support and reinforce U.S. policies. For the public, they form the basis of justification for ground-based escalation in case of a conflict in space. For neutral international parties, they establish a means of advocating for their economic interests that would be at risk during a larger conflict.

No first use policy: The first concrete and unilateral policy step the U.S. government can take to reduce the chance of a conventional conflict spilling over into the space domain is a declaration of a no first use policy for kinetic ASAT weapons. Although this ties the hands of policymakers and the military, it would be an important step towards reducing the chance of escalation for an adversary who feels compelled to engage in a first strike to degrade U.S. warfighting capacity. The United States has far more to lose, being both militarily and economically more dependent on satellite services and communications than any other actor. Consequently, in the space domain there is no viable defense yet projected against ASATs and the United States has little to lose from this strategy. ASAT capabilities themselves are ground based, which preserves the option for retaliatory strikes if needed. Thus, the United States with its reliance on space should have a distinct interest in preventing a scenario where ASATs are used and debris fields are generated.

Establishing an international forum for space fairing nations: Major space fairing nations should establish a forum for discussing policies, collaboration and communications for both peaceful and military space ventures. A forum that would enable quick wins on basic principles such as operations transparency and collision avoidance systems in order to build trust between parties and foster the foundation of future agreements (the Arctic Economic Council could serve as a template for this). Since any conflict in space will impact all parties with assets present, and not be excludable to just the warring parties, a forum where all who would be impacted can express their policy stances and work to facilitate communication is of high importance. The forum would allow parties to shape a mutually agreed upon framework for escalation and or arms treaties.

Other than explicit arms policies, the forum would provide stakeholders with the ability to collaborate on scientific projects and manned exploration. There are a range of scientific activities

[15] (European Union n.d.)
[16] (Russian Federation, People's Republic of China n.d.)

that are low hanging fruit that all parties have an interest in partaking in. The first is debris and satellite monitoring and avoidance which will enable parties to collaborate and build familiarity on an interagency basis. The second easy win would be solar weather monitoring and warning systems. Solar flares and research related to solar activity pose a risk to all parties' satellites and again present an easy win. Stretch goals could include cooperation between parties on larger scientific missions or jointly manned stations similar to the ISS International Space Station (ISS) program.

The above actions would build the basis for establishing trust and can be leveraged to form norms of communication and operation that may precede agreements and treaties. Even if not all parties present agree to a binding treaty, it will establish norms of behavior among the wider community and increase reputational damage from violating the peaceful use of space. In addition, the United States should pledge to not place offensive weapons in space, as this increases the incentive for first strikes and further militarization.[17] If at all possible, the United States should seek mutual agreements to continue the demilitarized status quo in space. There is very little to lose by pursuing dialogue and it enables the foundation of further policy.

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[17] (Morgan 2010, 34)

Type of action	Risk reduction	Impact (decrease reward of escalation)	Status quo - risk producing	Impact
Preventative, transparent and norm based	No first use policy	Reduces likelyhood that state will feel compelled to initiate first strike	Lack of clearly articulated first use policy	States anticipating conventional conflict with U.S. forces will feel compelled to strike first in space domain to inihibit U.S. force projection in other theatres
	International forums for discussion	Increased clarity of actors regarding their policies and provides de-escalatory communication channels. Multilateral pressure and wider participation of interest groups who wish to maintain stability	No current dedicated forum	Limited or no ability to inhibit or separate space domain military actions from conventional conflict or establish multilateral policies
	International governance frameworks	Increases reputational cost of initiating conflict and violating treaties or norms.	No current binding framework and weak norms	Limited or no ability to create laws or strong norms to inhibit escalation to space domain. Limited or no ability for third parties to apply diplomatic pressure to prevent escalation
	Joint or bilateral statements of intent	Provides clarity on use policy for specific scenarios or theaters	No current joint statements	Lack of clear understanding on what would trigger escalation and increased risk of regional conflict escalating to space
	Joint space operations	Changes in cost/benefit analysis	Limited to ISS and US/EU collaboration	Continued assymetry of cost/benefit for adversary to unilaterally escalate to space domain conflict

Deterrence by resilience, denial and collective cost imposition

Norms and institutions may not be individually adequate to deter space conflict, therefore the first step to reducing the chance of escalation is reducing U.S. risk in the theatre while maintaining current and future capabilities. By increasing the difficulty of destroying U.S. assets, directly tying the impact to the global economy to space interests and building interdependence with partners, the benefits of escalation can be reduced and the costs increased.[18]

Resilience through diversification: A major avenue to deterring space domain escalation is to change the cost to benefit analysis of opponents by either decreasing the likelihood that ASAT use will have a decisive impact on other theatres of engagement, decreasing the United States's vulnerability to ASAT use, or increasing the cost and consequences of ASAT use. To reduce the incentive for adversaries to strike U.S. space assets, those assets have to be either resilient to attack. They must be structured in such a way that limited strikes yield little benefit and for the opponent to achieve their operational objective, a comprehensive attack would be needed. There are multiple ways to achieve this; the United States. has already begun the process of increasing the number of smaller satellites in orbit rather than having fewer high capability centralized systems. An ASAT weapon has a fixed cost for use, it requires a launch vehicle with the necessary energy to boost the kinetic weapon into the required orbit, followed by the kinetic vehicle to track and intercept a satellite. Launching smaller satellites, allows system redundancy and increases the relative cost for an opponent to neutralize a network of systems effectively since each satellite is worth less in terms of dependency relative to the cost of an ASAT vehicle.

Similar to decentralizing satellite networks, spacing them in different orbital altitudes is another promising solution – for example a delivery vehicle may be able to launch a few satellites to a high orbit trajectory instead of more satellites to LEO. There are two benefits of staggering orbits for space assets. Higher orbits require more complex launch and delivery methods for ASATs; those diversified orbits mean that debris fields generated from ASAT hits are less of a threat to secondary U.S. military systems as they are less likely to be caught in the resulting impact debris fields.[19]

Resilience through partnership and interdependence: A third strategy that can deny an opponent from achieving their object and pose an anticipated cost is joint ownership of space assets with U.S. allies and partners. The EU has an ongoing space program as does Japan, and South Korea recently launched its first satellites. These partners represent great opportunities to build platforms and space infrastructure that shares cost burdens among partners and reduces risks to U.S. assets. An explicit and published policy of joint ownership or use of satellite systems would allow partners to gain capabilities that they otherwise would not have, increase their technical abilities and provide services to their militaries in theatres where joint action is likely. Furthermore,

[18] (U.S. Department of Defense 2022, 9)

[19] (U.S. Department of Defense 2022) - The Space Development Agency has identified these risks and has responded by diversifying its networks with smaller satellites in varying orbits beginning in 2024 with its tranche 1 transport layer.

the partnerships where for example EU, NATO, AUKUS and the Quad have rights and ownerships to satellite systems that provide intelligence and communication services for multiple regions (Europe and South East Asia) would inherently create a disincentive for a regional actor such as China to target these mutually owned systems.[20] While it is unlikely NATO member states would involve themselves if joint systems are destroyed, they would be more likely to participate in lethal retaliation in areas such as trade, finance, and providing physical assets to the U.S. or other partners. A strike against satellites would inherently then become an escalatory action in that it will more directly impact or impede third party security and economic concerns.

An additional but possibly more difficult avenue (both in function and legal ramifications) for reducing U.S. vulnerability is to mandate dual use for civilian satellite launches. For civilian satellites that could have an important function in wartime, the government could mandate that they have a figurative compatible second mode where the U.S. can temporarily commandeer the civilian satellites' functions to plug holes in the event of an attack. The advantage of this system is that due to the large number of civilian satellites as well as their coverage and capabilities, it would necessitate an opponent indiscriminately attacking all affiliated satellites to ensure that an ASAT campaign is successful. This would drastically increase the cost of initiating the conflict due to its scale, would impact worldwide systems and pose a major reputational cost on the aggressor as well as adversely impacting third parties. It may also galvanize both domestic and foreign citizens' support as services that they rely on are interrupted or destroyed. It is also likely that unless an aggressor takes purposeful steps beforehand to insulate itself against utilizing services that may be impacted, their own economy would be adversely damaged. Thus, increasing the cost for them through interdependence and accepting some level of direct vulnerability, or sacrificing economic gains by encouraging information autarky. The process of consideration and implementation of this dual-use policy is likely already underway and was outlined in the National Defense Science & Technology Strategy of 2023.[21]

Deterrence through signaling and cost imposition: The final element regards explicit policy responses and warnings. The United States should make clear and explicit policies regarding what it considers to be "redlines" or actions that if an adversary takes would incur substantial retaliation, similar to the Obama Administration's cyber policy outlining that cyber attacks will be considered an assault on U.S. core interests.[22] There is good reason for this, not only is the space domain important to the economy, it is intimately linked to the cyber domain as a conduit of information. Treating attacks on space assets as equivalent to an attack on core domestic economic infrastructure will deter attacks that aim to test U.S responses, and legitimize a broader military response in all theatres to both the domestic and international audience. It may be worth considering two discrete redlines, one for attacks that interfere but temporarily incapacitate satellite systems but do not permanently destroy them or cause debris, and another for kinetic

[20] (U.S. Department of Defense 2022, 5-6), – The U.S. has recognized and is currently pursuing expanding space cooperation with partners and allies.
[21] (U.S. Department of Defense 2023, 6)
[22] (Office of the President of the United States n.d.), (Office of the President of the United States 2015)

weapon attacks. The downside of this policy is that it does create a risk that foreign actors may hazard EM or cyber-attacks on infrastructure. However, the United States likely has more capabilities in this field and can retaliate without permanent damage to the space environment or irrecoverable destruction of assets.

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Type of action	Risk reduction	Impact (decrease reward of escalation)	Status quo - risk producing	Impact
Deterrence, denial of objective	Diversified systems (many small satellites versus fewer large ones)	Increased difficulty and cost of eliminating satellite system nodes. Increased cost of ASAT launch relative to gain. Increased chance of collateral damage to third parties.	Undisclosed - assumed that satellite constellations are currently optimized for cost and function.	Fewer nodes in similar orbits due to launch vehicle weight and altitutude limits allow for easier destruction and chance of debris taking out parallel nodes.
	Altitude staggered systems	Decreased chance destroyed satellite debris taking out other nodes in same system network. Increased cost of node destruction due to multiple ASAT launch vehicles being needed.	Undisclosed - assumed that satellite constellations are currently optimized for cost and function.	Fewer nodes in similar orbits due to launch vehicle weight and altitutude limits allow for easier destruction and chance of debris taking out parallel nodes.
	Multi state shared systems	Allows cost and capability sharing. Destruction of system nodes will impact third parties and increase the chance for their involvement. U.S. system sharing spreads risks among partners.	Majority of U.S. military space assets are U.S. exclusive assets. U.S. has limited utilization of allie's and partner's systems.	Hostile strikes can be focused on U.S. military space assets and ignore partner's and allie's space infrastructure. First strike would be more effective.
	Dual use systems	Adds redundant nodes, and necessitates targeting of civilian satellites to achieve goals. Increases cost of escalation or first strike and increases global collateral damage.	Assumes clear distinction between military and civilian assets.	Allows opponent to justify that they are only targeting military assets. Reduces fallout from destruction of economic civilian assets

Deterrence and compellence

The third and final tier of U.S. space defense policy should be to tie escalation of space conflict to other theatres where an adversary has more to lose through horizontal escalation in the event of an expanded conflict. A clear policy of escalation management and justification for that expansion are important to make an opponent evaluate the wisdom of strike that will not exclusively be responded to in the space domain.

Credible broadcasting of non-space theatre escalation: Supplementing the redline policy the United States should explicitly explain the scale of retaliation and response to a space domain attack. The response must be tailored for several specific traits for it to be a sufficient deterrent. First, the response has to be credible; for example, advocating for a policy of nuclear retaliation to an ASAT attack is neither credible (opponent will ignore the stated response) nor equivalent in its range of severity which it must be for the U.S. to retain both its domestic and foreign political support. Likewise, a stated tit-for-tat retaliation is insufficiently threatening to deter foreign ASAT attacks. Tit for tat allows the opponent to control the tempo and scale of escalation and define the parameters of damage, especially in cases where they believe they have far less to lose than the United States in the space domain.

Therefore, the retaliatory policy must be credible, the opponent believes you are both capable and willing to carry it out, and it must be sufficient in severity to make the opponent believe they will suffer more in damage from retaliation than they inflict but not cause disproportionate loss of life, and it should be focused in other theatres to avoid an opponent believing that MAD in the space theatre will translate to a disproportionate U.S. loss in capabilities. Options for responses range from minor to the equivalent of an economic "nuclear option" such as sanctions, seizure, or annulment of foreign financial assets (Chinese ownership of U.S. treasuries). Further on the severity scale actions such as trade interdiction, blockade and interception of adversary shipping are economic retaliation that have to be physically enforced. One scenario of worry is that in the case of a conflict over Taiwan where U.S. forces are already committed, the Chinese may feel they have little to lose by launching ASATs especially if they are already threatened or hit by financial and trade sanctions. Thus, it would become necessary for limited escalation in secondary theatres to impose maximum economic damage with as little loss of life as possible to not alienate third parties.

A core component in making a response more credible to a wide-ranging ASAT attack will be clearly articulating U.S. policy in response and how the response will be escalated based on the severity of an attack, with certain thresholds where the U.S. retaliation is more severe.[23] U.S. defense and security documents in the public sphere fail to specify either thresholds for retaliation or the likely nature of the retaliation. Likely these materials do exist, but remain classified and thus removed from the discourse on the topic outside of the defense community. While the opaque

[23] (Lewis 2013) – Argues that there is no credible response that can adequately deter minor attacks or non-destructive ASATs, however the goal should be to sufficiently deter not absolutely deter as with nuclear weapons.

material regarding redlines and response retain strategic ambiguity and preserves a wide range of possible responses by U.S. policymakers, they fail to adequately illustrate the magnitude of a U.S. response and thus offer literal deterrence value.

Type of action	Risk reduction	Impact (decrease reward of escalation)	Status quo - risk producing	Impact
Deterence and Compellance	Redlines	Increases legitimacy of retaliation in other theatres. Clarifies cost benefit analysis for adversary	U.S. declaration of space as a core interest. Unclear to what would necessitate U.S. retaliation and its scale.	Unclear what U.S. response to ASAT attack would be and its scale. Opponent may misunderstand thresholds that would trigger retaliation or underestimate scope of retaliation.
	Credible broadcasting of non-space domain escalation.	Increases net cost of space escalation, lends legitimacy to non-space retaliation	No clear policy on land or sea domain retalaliation to space escalation.	Opponent may underestimate retaliation to space escalation. If clear military response beforehand is not stated, retaliation that incurs casualties may be seen as the escalatory by third parties.

Conclusion

There are three avenues the United States should pursue to ensure the continued peaceful use and stability of the space domain. International norms and agreements alone are insufficient to deter a motivated adversary. However, they serve to rally allies, partners, and third parties in addition to providing justification for a military response. In the event an opponent doesn't care or discounts the political consequences of escalation, they will still need to plan and evaluate the risk and reward of an attack. The second tier of suggestions aims to increase the resilience of the U.S. space presence while increasing the direct ramifications on third parties of an opponent's attack. The final tier concretely ties the consequences of an attack to direct responses that may target an enemy's weaknesses that they otherwise believe may not be directly threatened in the case of a limited conflict. A comprehensive approach is the best means of preventing a kinetic attack in space.

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