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DETERRING CHINA'S USE OF FORCE IN THE SPACE DOMAIN

A PROPOSED SCORECARD FOR WEIGHING THE RISKS

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Executive Summary

This report examines the evolving deterrence dynamics between the United States and the People's Republic of China (PRC) in the space domain. During the Cold War, nuclear deterrence helped maintain the peace between the United States and the Soviet Union, and it remains a cornerstone of U.S. defense policy today. However, for reasons both geopolitical and technological, the ability of any country to deter another from attacking its space assets is being called into question.

China's People's Liberation Army (PLA) is acquiring and developing a range of counterspace capabilities and related technologies, including kinetic-kill missiles, ground-based lasers, and co-orbital satellites, as well as the space surveillance capabilities that enable their use. The use of these weapons against the U.S. space architecture could threaten U.S. military superiority by undermining the command, control, communications, computers, intelligence, surveillance, and reconnaissance capabilities that enable the U.S. military to operate in the Indo-Pacific and project power globally.

Applying Deterrence to the Space Domain

We define space deterrence as one country dissuading another country from interfering with systems that operate in space or support the operation of space systems from the ground. Numerous variables can complicate the success of deterrence in the space domain. Deterrence dynamics may be influenced by whether attacks are reversible or irreversible, terrestrial or space-based, kinetic or non-kinetic, and lethal or non-lethal.

The effectiveness of space deterrence could be shaped by the type of weapon. Nuclear weapons, kinetic weapons, and non-kinetic weapons, such as electronic countermeasures, directed energy weapons, and cyber weapons, could all be used against space assets. Space deterrence could also include preventing attacks against launch sites and other facilities using conventional munitions, such as bombs and missiles.

Reversibility of attacks: different types of weapons produce different types of effects. Reversible attacks, such as jamming GPS and communication signals or temporarily blinding optical sensors with a laser, may be more difficult to deter because of their low cost and reduced escalatory potential. The effects of other non-kinetic weapons, such as high-power microwave weapons, may not be reversible, so these weapons may be viewed as having a higher cost. Debris-producing kinetic attacks may be viewed as both costly and escalatory because of the long-term effects that debris can have on space systems in general.

The type of space asset targeted may also influence whether an attack can be deterred. Attacks against scientific satellites with little or no military value may generate less of a reaction, although their civilian or scientific value may discourage attacks. On the other hand, attacks against satellites that are few in number but in high demand may generate a stronger reaction. Attacks against large satellite constellations may be viewed as less

escalatory because the loss of any one satellite may not appreciably degrade the constellation's overall capability. However, an attack on large portions of a satellite constellation may be viewed as escalatory.

Space-based versus terrestrial targets: kinetic attacks against space-based assets may be viewed differently from those against terrestrial targets. Kinetic attacks against ground facilities, such as a launch site, may be more escalatory than kinetic attacks in space because the targets are located on sovereign territory. Attacks resulting in the loss of life would likely be viewed as the most escalatory, thereby receiving the strongest reaction.

DETERRENCE FACTORS AS APPLIED TO SPACE AND U.S.-PRC RELATIONS

We derived 10 factors that could affect the U.S.'s ability to deter China in the space domain. We organize these factors based on military balance of power unique to the space domain, challenger (PRC) views that could affect deterrence, and international norms.

Military balance facets unique to the space domain

In the space domain, assessing the military balance is difficult for several reasons. First, the military balance is dynamic and changing. Second, the deterrence literature is unclear on whether the local or global military balance matters more for potential attacks in space. Third, different types of weapons could be used against a variety of targets, affecting whether the attack is reversible, attributable, or lethal.

Military balance of power. The current global military balance of power may favor the U.S., but as China's military presence in space increases, the U.S. balance of power in space could degrade.

Offensive military doctrine. Space could be considered an offensive-dominant domain, which could encourage one side to act first to gain an advantage. Even if this "first mover" advantage is temporary, striking first could create decisive opportunities in other warfighting domains. Given the nature of the space domain and China's Active Defense strategy, we predict that the potential first mover advantage offered by attacks in space could decrease the potential effectiveness of U.S. deterrence vis-à-vis China. However, as low Earth orbit constellations proliferate, these more redundant systems could mitigate the first mover advantage.

Ambiguity of intentions in space. U.S. and PRC space policies remain ambiguous about whether they would pursue kinetic attacks against satellites in orbit. This uncertainty about intentions could make deterrence difficult. The lack of specificity regarding intentions also makes effective signaling a challenge, and most scholars believe that effective signaling is a necessary component of a successful deterrence strategy. U.S. and PRC ambiguity regarding their counterspace intentions could lead to inadvertent escalation.

Prevalence of uncrewed systems. The dominant employment of uncrewed systems in space likely reduces the effectiveness of deterrence. Attacks against uncrewed systems may be viewed as having fewer costs because of their lower escalatory potential.

Challenger (PRC) views

Writings on deterrence, especially those informed by prospect theory, indicate that challenger views could have an important effect on deterrence effectiveness. To assess how challenger (PRC) views could affect the U.S.'s ability to deter, we examined China's views on the international status quo, U.S. reliance on space, and China's growing dependence on space.

China is dissatisfied with status quo balance of power in space. The PRC has publicly expressed dissatisfaction with the current international order, and the PRC's space narrative parallels its larger narrative regarding the U.S.-China relationship. Given China's strong sense of grievance with the current international status quo combined with insights from prospect theory, we predict that U.S. deterrence in space could be less effective vis-à-vis the PRC. In short, the PRC may believe that the benefits of changing the current status quo outweigh the potential costs and thus be more willing to take actions that, in the past, would not have been considered.

Space asymmetry. Researchers from the PLA assess that space capabilities play an outsized role distinct from other types of military power and perceive space capabilities as a more usable and effective means of influencing an adversary before conflict or defeating an adversary during wartime. The U.S. is widely considered the leading power in space, and the U.S. military relies heavily on that space architecture. The PRC may view the operational gains from attacking U.S. space assets as worth the escalatory risk given their importance to the U.S. military. In a conflict, the PRC perception of space asymmetry vis-à-vis the U.S. may (counterintuitively) reduce the effectiveness of U.S. deterrence.

Growing PRC dependence on space. Although U.S. dominance in space may make PRC leaders more apt to consider space weapons, the PLA's own increasing dependence on space could curtail those inclinations. Advancements in China's space program may make the PRC reluctant to risk its space assets or less willing to engage in escalatory behavior that risks widening a space conflict.

International norms and signaling

The third category of factors relate to how each country views the space domain and how international norms and signaling could affect deterrence effectiveness.

Space as a warfighting domain. Treating outer space as a warfighting domain may diminish the requirement to state explicitly when or how the U.S. would respond to attacks against its space assets. The absence of sovereignty in outer space may also increase the chances of provocative actions in the space domain. Efforts to establish space as a formal warfighting domain exacerbate this likelihood and thus could lessen the chances for successful deterrence.

Weak international norms. In theory, norms could play a role in limiting the use of space weapons. However, norms are unlikely to be agreed upon by the PRC if they are

sponsored primarily by the U.S. Thus, we predict that U.S.-led efforts to promote norms in space are unlikely to increase deterrence effectiveness in the short term.

Reassurance. Some academic literature suggests that offering positive inducements to a challenger is the most effective way to avoid conflict. However, given the current state of U.S.-China competition, it is unclear whether positive inducements are feasible.

KEY FINDINGS AND RECOMMENDATIONS

In the current geopolitical climate, deterring all attacks on U.S. space assets may not be a realistic objective. If one uses an expansive definition of attacks, including cyberattacks, then these types of attacks have already occurred. Although the U.S. may be unable to deter the PRC from conducting all types of space attacks, it may be able to deter the PRC from conducting the most escalatory attacks, such as those that produce space debris or result in the loss of human life.

Of the 10 factors that we examined, only 2—the overall military balance and the PRC's growing dependence on space—are likely to increase the U.S.'s ability to deter China successfully in the space domain.

Despite the potential limitations of deterrence in the space domain, U.S. policy-makers could continue to pursue several initiatives, including building the overall resiliency of the space architecture, increasing space domain awareness (SDA), and assessing potential escalatory scenarios to determine U.S. policy responses.

Improve resiliency of U.S. space architecture

The 2022 National Defense Strategy defines resiliency as "the ability to withstand, fight through, and recover quickly from disruption." Resiliency can play an important role in strategic stability by denying a challenger the ability to gain the upper hand even if that challenger were to undertake a first strike. **Resilience of the space architecture could also increase the overall military balance in favor of the U.S. while simultaneously decreasing reliance on any specific component of that system.**

Improve SDA capabilities

Better SDA could increase strategic stability by reducing the attribution problem associated with space activities. Anomalies in space could be the result of enemy action, malfunction, or weather. More robust SDA could provide objective data on issues and determine the source of a problem. Attribution allows the U.S. to hold potential adversary actors accountable for any actions to disrupt space assets. Effective SDA could thus enhance space deterrence and reduce inadvertent escalation by allowing the U.S. military (or commercial satellite companies) to identify problems and attribute them accordingly.

Think about specific space deterrence options

U.S. space assets have already been attacked through reversible means, and whether deterrence will be effective in preventing other types of attacks in the future is uncertain.

Here we discuss two possibilities for employing deterrence measures in space that could be examined further.

Deterring PRC attacks against missile warning satellites. Missile warning satellites are part of the U.S. nuclear command and control infrastructure. These satellites are also used in the detection of conventional ballistic missile launches, so the PRC may target them to achieve conventional advantage. Therefore, PRC attacks against U.S. early warning satellites, even if intended to degrade U.S. conventional capabilities, may increase nuclear instability. In this case, a declaratory statement promising retaliation against PRC missile warning satellites may increase the effectiveness of deterrence by heightening PRC awareness of the sensitivity of attacking U.S. missile warning satellites.

Deterring debris-producing attacks. Because both the U.S. and PRC are increasingly dependent on space, the PRC may have less motivation to conduct debris-producing attacks. In this case, deterrence may resemble the mutually assured destruction doctrine of nuclear warfare, in which both sides refrain from attacking because of the costs that would be inflicted on each side.

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INTRODUCTION

Theoretical writings on the concept of deterrence had a profound influence on U.S. foreign policy during the Cold War.[1] Application of these theories to the nuclear domain helped maintain peace between the U.S. and the Soviet Union and these theories remain a cornerstone of U.S. defense policy today. Rising tensions between the People's Republic of China (PRC) and the U.S., coupled with the PRC desire for the People's Liberation Army (PLA) to be capable of invading Taiwan by 2027, have generated renewed focus on the role of deterrence in U.S. defense policy.[2]

The 2022 National Defense Strategy (NDS) directs the U.S. Department of Defense (DOD) to "act urgently to sustain and strengthen U.S. deterrence," primarily against the PRC.[3] According to the NDS, the DOD will "bolster deterrence by leveraging existing and emergent force capabilities, posture, and activities to enhance denial and by enhancing the resilience of U.S. systems the PRC may seek to target."[4]

The continued effectiveness of deterrence, however, is coming into question.[5] For reasons both geopolitical and technological, deterrence dynamics are changing. China, Russia, Iran, and North Korea seek to challenge the U.S. politically and militarily and are developing weapons and tactics that attempt to exploit their asymmetries with the U.S. Of these countries, the U.S. has identified the PRC as the pacing challenge for the U.S. military.

China's extensive long-term military modernization program has expanded the PLA's capabilities to new domains, such as outer space and the cyber realm. China's military has designated outer space as a warfighting domain, describing space as a "new commanding height of war" that China must fight for and seize if it is to win future wars. PLA officers and analysts assert that space is the ultimate high ground and that whoever controls space controls the Earth.[6] To win any potential future wars, the PLA has focused on exploiting key U.S. vulnerabilities and has identified space as a key enabler of U.S. military capabilities. Thus, it is acquiring or developing a range of counterspace capabilities, including kinetic-kill missiles, ground-based lasers, and co-orbital satellites, as well as the space surveillance capabilities that enable their use.[7]

Counterspace weapons have not been fully tested in combat operations, and there has been no formal conflict in space. Given the relative novelty of this domain, differing beliefs about the use, risk, and effectiveness of counterspace weapons may result in varying assessments of how these weapons should be employed.[8] Moreover, debates about these new technologies lack the Cold War–era nuclear rivalry, which involved negotiations, public statements, signaling, and weapons acquisition that were intended to shape perceptions and understanding of U.S. policy.[9] The combination of these factors has led experts, such as defense policy analyst Andrew Krepinevich, to conclude that "the greatest strategic challenge of the current era is neither the return of great-power rivalries nor the spread of advanced weaponry. It is the decline of deterrence."[10]

This report examines the evolving deterrence dynamics between the United States and the PRC in the space domain. We draw upon an extensive survey of the theoretical literature on deterrence, applications of deterrence in space, and case studies of deterrence failure. The international relations literature highlights the importance of nonmaterial factors and the characteristics of space technologies to understand the nature and potential limitations of deterrence in the space domain. We use Chinese primary sources to assess PRC views of the international system and the space domain. We use this range of sources to understand the conditions under which deterrence could be achieved in the outer space domain.

This study finds that deterrence dynamics are shaped by more than the military balance of power between a deterring state and a challenger state. Deterrence often fails because of a range of domestic and international political factors, including leadership motivations, challenger world views, the dominance of offensive weapons, ambiguity of signaling, and international norms. As international relations scholar Richard Ned Lebow explains, "The reality of international relations is less ordered, less comprehensible, more contradictory, and more unpredictable than deterrence theory admits."[11] Any study of deterrence thus "must sacrifice the elegance of abstract theory in favor of a more elaborate array of hypotheses based on careful empirical approach."[12] Our goal in this report is to apply this approach to the space domain.

To build a series of testable hypotheses that can be empirically examined with future research, this paper proposes a "deterrence scorecard" highlighting 10 factors that, in theory, have the potential to affect U.S.-China deterrence in the space domain.

We find that, for a range of reasons unique to the space domain or unique to U.S.-PRC dynamics, deterring the PRC from any and all attacks on U.S. space assets is extremely challenging. **Of our 10 deterrence factors, only 2 are predicted to increase the ability of the U.S. to deter China from undertaking potential operations in space.** Although additional empirical research will be needed to assess these predictions, we provide a sober picture of when and how the U.S. may be able to deter the PRC from conducting attacks in space should a conflict occur in the Indo-Pacific.

Based on this analysis, we argue that uncertainty exists to such a degree that the Joint Force may need to rethink how realistic its deterrence assumptions and outcomes will be in the context of U.S.-China relations. Although deterrence should remain a peacetime mission for the U.S. military, treating outer space as a warfighting domain shifts the emphasis from developing a force geared toward deterring conflict to one that is built to deliver effects during wartime in a contested space environment. Treating space as a warfighting domain may, in the short run, reduce deterrence effectiveness. Thus, these types of trade-offs will need to be considered carefully.

To explore these debates further, we review the deterrence literature to accomplish two objectives. First, we describe some of the limits of current deterrence theories as they apply to the space domain to provide policy-makers with a more accurate assessment of the

potential effectiveness of deterrence. Second, we apply these theoretical debates to make predictions about how deterrence would operate between the U.S. and China.

The second section details our deterrence scorecard. For each deterrence scorecard factor, we discuss (1) the limits of deterrence theory (generally), (2) applications of deterrence theory specific to the space domain, (3) empirical application of that factor as it relates to U.S.-China dynamics, and (4) predicted effects of that factor on deterrence in space. As already mentioned, these discussions are not empirically tested findings but rather serve as a set of predictions derived from the theoretical literature and in-depth knowledge of U.S.-China dynamics.

We group the 10 deterrence scorecard factors into three main categories:

- Military balance and facets of deterrence that are unique to the space domain
- Challenger (PRC) actions and views
- International norms and signaling

Although some of these categories overlap, the deterrence scorecard provides an initial starting point for assessing how the unique aspects of space and the specific dynamics of U.S.-China relations may affect the future effectiveness of deterrence. The final section offers a summary of our deterrence scorecard and some preliminary recommendations.

SPACE DETERRENCE AND ITS LIMITS

Deterrence is a form of coercion that attempts to convince an adversary *not* to take a certain action. Deterrence relies on the *possibility* of violence rather than the actual use of force.[13] Deterrence has been defined in many ways. For the purposes of this study, we define deterrence as the "prevention or discouragement, by fear or doubt, from acting."[14] Deterrence is intended to convince an adversary that the costs of an action outweigh its potential benefits.[15] Deterrence rests on the importance of perceptions, especially the ability to change the perceptions of a challenger regarding its risk calculus.[16]

Historically, deterrence theory was based on a utility model assumption: that a challenger state rationally weighs the costs and benefits of an action before it is carried out. According to this construct, states should normally work to minimize costs and maximize benefits.[17] Critics of classic deterrence theory argue that it often fails in practice because states fail to make rational decisions. The tendency for humans to base decisions on factors other than material costs and benefits restricts the utility of deterrence theory in predicting when and how states can be deterred.[18] Thus, some scholars have begun to question the utility of classic deterrence theories both in general and specifically as they relate to deterrence in space. For example, writing about cross-domain deterrence, international relations scholars Jon Lindsay and Erik Gartzke argue that the addition of the space and cyberspace domains raises "difficult questions about how to issue threats and offer reassurances that [are] credible, proportional, affordable, and above all, effective."[19]

Case studies have demonstrated that states often take actions detrimental to their material interests.[20] Many variables, from a leader's mindset to the uncertainty about perceptions, can affect whether a state can be deterred. Leaders may be irrational actors or willing to accept high levels of risk, especially if they do not perceive that a protracted conflict is likely.[21] Misperception and miscommunication may cloud a challenger state's understanding of the deterrent threat.[22] In fact, University of Toronto professor Janice Gross Stein argues that the record of deterrence success is so spotty that "robust evidence" from experimental psychology, international relations research, and neuroscience finds that it is a "category error to model rational choice as the default position and treat departures from rationality as deviant."[23]

The deficiencies found in deterrence theory have prompted new avenues of exploration to account for inconsistencies found by analysis of deterrence failures. In this section, we review a subset of that analysis and describe the specific relevance of those new avenues to understanding space deterrence. The facets of space that must be considered when evaluating deterrence effectiveness include the types of platforms (primarily uncrewed), issues of asymmetry and dependence on space, ambiguity in posture, views of space as a warfighting domain, and norms and signaling that may operate differently in this domain.

SPACE DETERRENCE: WEAPONS, TARGETS, EFFECTS

We define space deterrence as one country (referred to as the deterring state) dissuading another country (referred to as the challenger) from interfering with systems that operate in space or support the operation of space systems from the ground.[24] Numerous variables can complicate the success of deterrence in the space domain. Counterspace activities can occur along a spectrum of capabilities, and the effects of such activities differ depending on whether the attacks are reversible or irreversible, terrestrial or space-based, kinetic or non-kinetic, and lethal or non-lethal.[25]

The effectiveness of space deterrence could be shaped by the type of weapon. Differing effects of possible counterspace weapons will likely result in some weapons having a lower threshold for use. Nuclear weapons, kinetic weapons, and non-kinetic weapons, such as electronic countermeasures, directed energy weapons, and cyber weapons, could all be used against space assets.

Effectiveness of deterrence could be shaped by the location of the attack, whether terrestrial or space-based. Attacks in outer space may be viewed as less escalatory. However, because space warfare can also be directed against terrestrial targets, space deterrence can include preventing attacks against launch sites and other facilities using conventional munitions, such as bombs and missiles.

Different types of weapons produce different types of effects. Reversible attacks, such as jamming GPS and communication signals or temporarily blinding optical sensors with a laser, may be more difficult to deter because of their low cost and reduced escalatory potential.[26] The effects of other non-kinetic weapons, such as high-power microwave weapons, may not be reversible, so these weapons may be viewed as having a higher cost or escalatory potential. Debris-producing kinetic attacks may be viewed as costly and escalatory because of the long-term effects of debris.[27]

The type of space asset targeted may also influence whether an attack can be deterred. Attacks against scientific satellites with little or no military value may generate less of a reaction, although their civilian or scientific value may discourage attacks. On the other hand, attacks against satellites that are few in number but in high demand and thus strategically valuable may generate a stronger reaction. Alternatively, attacks against large satellite constellations may be viewed as less costly or escalatory because the loss of any one satellite will not appreciably degrade the constellation's overall capability. However, an attack taking out large portions of a satellite constellation may be viewed as more costly or escalatory.

Kinetic attacks may be viewed differently from non-kinetic attacks. Kinetic attacks against ground facilities, such as a launch site, may be more escalatory than kinetic attacks on a satellite in space because the ground-based targets are located on sovereign territory. Non-kinetic attacks may be viewed as less escalatory, depending on their reversibility and lethality.

Most platforms in outer space are uncrewed. The dominant employment of uncrewed systems in space likely reduces the effectiveness of deterrence. Attacks resulting in the loss of life would likely be viewed as the most escalatory, thereby receiving the strongest reaction.[28] Attacks against uncrewed systems may be viewed by a challenger as having fewer costs than attacks against crewed systems. The inhospitable space environment and the cost of crewed space systems means that spacecraft will likely continue to be largely uncrewed. Although crewed systems, such as the International Space Station and China's Tiangong space station, exist, military spacecraft are primarily operated robotically and remotely.

ASYMMETRY AND DEPENDENCE IN SPACE

Space deterrence involving the U.S. is conducted asymmetrically. Although the PRC is becoming more dependent on space as its space program expands (which we discuss later in this report), the U.S. remains the leading space power and the country most reliant on space assets to achieve its objectives in the Indo-Pacific.[29] This asymmetry creates an imbalance in dependence that could incentivize an adversary such as China to attack U.S. space assets.[30]

PLA researchers have assessed space capabilities as playing an outsized role distinct from other types of military power. In comparison to nuclear and conventional capabilities, PLA researchers perceive space capabilities as a more usable and effective means of both influencing an adversary before a conflict begins and defeating an adversary during wartime.[31] The perception that space underpins U.S. military superiority and economic performance may make U.S. space assets an irresistible target for PLA planners during a conflict and present an increasing challenge to U.S. deterrence efforts.[32]

Advancements in China's space program could make the PLA more effective in its warfighting capabilities. They may also make the PRC more reluctant to engage in space warfare. China's space program has advanced remarkably since sources advocating for offensive action in space were published. As the PRC becomes more invested in space, it will develop dependencies that could become critical to mission success. As a result, the PRC may be less willing to risk its space assets by engaging in space warfare, or at least less willing to engage in escalatory behavior that risks widening a space war to costly military action.

IS SPACE A WARFIGHTING DOMAIN?

U.S. efforts to deter China from attacking U.S. space assets will likely be challenged by U.S. and PRC strategies treating outer space as a domain in which offensive counterspace operations are permissible. Treating outer space as a warfighting domain prioritizes degrading an adversary's space assets and may result in both sides planning to conduct strikes early in an operation. China's military, for example, has designated outer space as a warfighting domain—described as a "new commanding height of war"—that China must

fight for and seize if it is to win future wars. The PLA also views U.S. military reliance on space as a critical vulnerability.[33]

The Outer Space Treaty, which has been ratified or acceded to by 114 countries, including the U.S. and China, prohibits "national appropriation by claims of sovereignty, by means of use or occupation, or by any other means."[34] To date, no country has successfully claimed sovereignty over outer space or a celestial object or portion of a celestial object. Although counterspace actions may be harmful, they do not necessarily violate another state's sovereignty. The absence of sovereignty in outer space and on celestial bodies may increase the chances of provocative actions in space and decrease the chances for successful deterrence.

According to the U.S. DOD:

> The PLA continues to acquire and develop a range of counterspace capabilities and related technologies, including kinetic-kill missiles, ground-based lasers, and orbiting space robots, as well as expanding space surveillance capabilities, which can monitor objects in space within their field of view and enable counterspace actions.[35]

The U.S. may also be planning to conduct counterspace operations during a war. One example of a dedicated U.S. counterspace system is the Counter Communications System satellite communications jammer.[36] DOD policy suggests an expansive view of offensive counterspace operations. According to the DOD's 2023 *Space Policy Review and Strategy on Protection of Satellites*, "To preserve U.S. freedom of operations and support deterrence, the U.S. must be prepared to deny adversaries the ability to utilize space capabilities and services to attack the Joint Force and prevent the U.S. from advancing critical national security objectives."[37] According to the document:

> Joint Force space operations could deny an adversary's space and counterspace capabilities and services using a variety of reversible and irreversible means, reducing the effectiveness and lethality of adversary forces across all domains. Operations to deny adversary hostile use of space could originate in any domain and target on-orbit, ground, cyber, and/or link segments to reduce the full spectrum of an adversary's ability to exploit the space domain.[38]

The inclusion of offensive actions in space operations is acknowledged in the DOD's updated publication on joint space operations. According to press reporting, the document now refers to "suppression of enemy space capabilities," a concept similar to the "suppression of enemy air defenses" in U.S. air doctrine, in lieu of "space superiority.[39] However, some of these offensive actions are framed in terms of their defensive capacity to be used only to protect other U.S. capabilities.

As in other domains, the capabilities required for warfighting effectiveness are often also the capabilities required for deterrence. For example, improved space domain awareness

(SDA) systems could make a country's space architecture more resilient to attack during a conflict and could also help that same country create a more extensive range of counterspace capabilities that improve its ability to deter. The U.S. Space Force's *White Paper on Competitive Endurance: A Proposed Theory of Success for the U.S. Space Force* states that the Space Force must be able to achieve space superiority—defined as the ability to protect space capabilities and deny an adversary the hostile uses of space.[40] To achieve space superiority, the U.S. would need to avoid operational surprise, deny first mover advantage in space, and undertake "responsible counterspace campaigning."[41]

AMBIGUITY, NORMS, AND SIGNALING

Questions over attack attribution present challenges for deterrence by introducing doubt into a deterring state's decision-making. Loss of a satellite can occur for several reasons, such as malfunction, accident, or attack. Moreover, secrecy and lack of SDA could make verifying an attack or determining an attack's origin difficult. For example, one report states that in 2009, U.S. Space Command was not aware that a Russian Cosmos satellite and an Iridium satellite had collided until Iridium notified Space Command that it had lost contact with the satellite.[42] Moreover, some types of attacks against space assets, such as cyber and electronic warfare attacks, may be harder to attribute to a specific actor or to differentiate from a malfunction.[43]

The uncertainty of space warfare can also apply to its effects. The multiplicity of targets and weapon systems makes determining the destructive and escalatory effects of space weapons difficult. Variables such as the type of weapon used, the number of satellites targeted, and the level of dependence of the targeted country on space all add uncertainty to the effects of a space war. As a result, determining the costs that can be imposed through space deterrence may be difficult for both the deterring state and the challenger state. The inability to determine the consequences of a threat may decrease the credibility of that threat and the strength of the deterrence message or it may cause miscalculation that could lead to escalation.

Lack of norms governing counterspace activities.

Norms can complement deterrence by socializing the negative effects of using certain weapons such that leaders prefer not to employ them. Space weapons have no such comprehensive norm structure, however. The most prominent treaty governing activities in outer space, the Outer Space Treaty, bans only the deployment of weapons of mass destruction in Earth orbit and on celestial bodies. Although the treaty does not specifically ban attacks against a country's space architecture, it does allow a country to call for consultations if it believes that its "peaceful" space activities have been or will be interfered with.[44] In addition, the constitution of the International Telecommunication Union, which is made up of 193 member states, including the U.S. and China, prohibits harmful interference to radio services.[45]

Other attempts to establish norms have been less successful, however. A proposal by the European Union in 2017 for a space code of conduct did not receive support from the broader international community, especially China and Russia.[46] In 2008 and 2014, China and Russia proposed language for a treaty banning the placement of weapons in outer space and employment of force (or threats of force) against objects in outer space. That proposal, however, has not been advanced mainly because of U.S. concerns that it does not include terrestrially based antisatellite weapons and lacks a verification mechanism.[47]

The U.S.'s announcement in 2022 that it will not conduct debris-producing anti-satellite tests is an effort to create this particular norm. A subsequent U.S.-sponsored United Nations (UN) resolution on the issue received 155 votes. Both China and Russia voted against this resolution, however.[48] In addition, 37 states have made a national statement or passed national legislation supporting this code of conduct.[49] Despite China's negative vote on the UN resolution, the PRC has refrained from conducting debris-producing anti-satellite tests since its 2007 kinetic-kill test, suggesting that the PRC is also restraining itself from conducting similar tests.[50] However, a norm against conducting kinetic attacks during a crisis or conflict has not yet been tested, and no country has committed to a ban on conducting debris-producing attacks.

Norms can also be formed over what weapons are permissible. The U.S. deployed the Counter Communications System in 2020 to jam satellite communications.[51] According to a State Department official, the U.S. considers wartime satellite communications jamming "to be a normal part of conflict;" peacetime jamming is not considered an act of war but would be considered "irresponsible."[52]

DETERRENCE SCORECARD

In this section, we outline a proposed deterrence scorecard that includes 10 factors to help U.S. policy-makers predict the effect of that element on the U.S.'s ability to deter in the space domain.

The scorecard was derived from three aspects of our analysis conducted for this study, namely: (1) general deterrence theory, (2) deterrence theory as applied to space, and (3) application of deterrence theories to U.S.-China relations. In this scorecard, the U.S. is the "deterring state" and the PRC is the "challenger." Table 1 summarizes each factor and then provides an overall prediction for that factor, acknowledging that many factors have countervailing or inconclusive predictions.

Table 1: Summary of deterrence scorecard factors and predicted effects for deterring state

Factor	Predicted Deterrent Effect
1. Military balance of power between U.S. and PRC in space domain.	⇧
2. Challenger has offensive military doctrine that could encourage striking first to gain an advantage.	⇩
3. Ambiguity of intentions to attack in space.	⇩
4. Prevalence of uncrewed systems in space.	⇩
5. Challenger dissatisfaction with status quo and sense of grievance.	⇩
6. Asymmetry in space capabilities between U.S. and PRC.	⇩
7. Growing PRC dependence on space architecture.	⇧
8. Treating space as a warfighting domain.	⇩
9. Weak international norms for space activities.	⇩
10. Reassurance and positive inducements from the deterring state.	⇩

Source: CNA.

For each scorecard element, we discuss the theoretic deterrence literature and how those theories would specifically apply in space, drawing upon the analysis contained in the previous section. If there are countervailing theories or predictions about how that factor might operate in the space domain or how those theories might apply to U.S.-China relations,

we raise those issues. Each factor then includes a section summarizing the predicted effect of that element on the ability of the deterring state (the U.S.) to effectively deter the challenger state (the PRC). We recognize that these predictions are preliminary and offer them to deepen our understanding of both the space domain and potential dynamics driven by the unique facets of U.S.-China relations.

FACTOR #1: MILITARY BALANCE

The military balance of power between two nation-states has been the traditional benchmark for assessing the ability of one state to deter another. Deterrence theory has held that a militarily stronger state will be able to deter a weaker state from taking military action.[53] Other studies, however, provide more nuance to the military balance argument.

University of California, Irvine professor Patrick M. Morgan argues that, based on his review of quantitative studies and game theory analyses of deterrence situations, the overall strategic balance between two states is less important than the local conventional military balance. In this case, even though the deterring state may have an overall stronger military force, a weaker challenger state may be able to create a war-winning advantage by deploying a more capable force in a localized area before the deterring state can effectively respond. A challenger state may exploit opportunities that allow it to win a quick and less costly war that avoids a drawn-out conflict.[54]

The military balance between the United States and the PRC is dynamic. The U.S. has the most powerful military in the world; it is technologically advanced and maintains a high level of professionalism. However, decades of PLA modernization focused on defeating the U.S. military in a conflict over Taiwan have resulted in dramatic advances in PLA capabilities and professionalism. According to former U.S. Indo-Pacific Command head Admiral John Aquilino, between 2021 and 2024, the PLA added more than 400 fighter aircraft and more than 20 major warships and more than doubled its inventory of ballistic and cruise missiles and nuclear warheads.[55]

Even if the PLA is not yet as technologically sophisticated as the U.S. military in the aggregate, the PRC may be able to employ a force in its immediate periphery and thus achieve a localized advantage. If the local conventional military balance favors the challenger, that could decrease deterrence. Even though the U.S. has made progress on developing capabilities to deter the PRC, the risk that the U.S. cannot deter China remains "high" and, according to Admiral Aquilino, is "trending in the wrong direction...due to delayed delivery of military construction, advanced capabilities, and resources to persistently project and maintain forces west of the International Date Line."[56] Aquilino warned that "without a credible deterrent, China, Russia, and other revisionist powers will be emboldened to take action to counter U.S. interests."[57]

Yet if the overall (global) military balance is more important than the local military balance, then a military balance in favor of the deterring state could increase deterrence, including in space. The limitation of military balance of power theories is whether to assess

overall (global) military balance or local conventional military balance and if so, how. If space-based assets affect the local military balance of power, the U.S. must consider how that perception of conventional military power might alter China's perceptions of the military balance in its immediate periphery.

In the space domain, assessing the military balance is difficult, in part because of the multiple types of targets. Moreover, a proportion of a country's space capability may not even be a formal military asset, as in the case of civilian communications satellites. Attacks against scientific or communications satellites may not directly affect the military balance but could affect other parts of the government and thus be viewed as escalatory.

Predicted effects of military balance

Given the global nature of space, the overall military balance will likely be more important than local military balance with regard to making decisions about attacking space assets. As such, **the current military balance of power could favor U.S. deterrence efforts. However, as China's military presence and space constellation become more global (and thus reliant on space), that deterrent effect could degrade.**

FACTOR #2: OFFENSIVE MILITARY DOCTRINE

Space could be considered an offense-dominant domain, which could encourage one side to act first to attempt to gain an advantage. Even if the advantage is temporary, striking first could create decisive opportunities that could be exploited through follow-on attacks.[58]

Holding satellites at risk has historically been easier and cheaper than defending them.[59] Traditionally, a country's fleet of satellites was composed of a relatively small number of expensive and highly valuable satellites that were neither hardened against attack nor defended.[60] Unlike other domains, in space there is no terrain that can aid a satellite's defense. Satellite service lives of 10 to 15 years and the inability to perform maintenance on satellites in orbit also meant that legacy satellites could not be upgraded to respond better to new threats. If these satellites were lost, replacement could take years.[61]

The offensive advantage also extends to cost. Larger satellites, such as those typically used before the advent of satellite constellations such as Starlink, cost between $150 million and $500 million. In contrast, a SM-3 missile, like the one that was used to destroy an errant U.S. satellite in 2008, costs roughly $11 million to $36 million, depending on the variant.[62] Cost ratios can be even more extreme for non-kinetic weapons. GPS jammers can cost anywhere from hundreds of dollars to tens of thousands of dollars. In contrast, the DOD awarded a $7.2 billion contract to Lockheed Martin for up to 22 GPS 3F satellites.[63]

The offensive advantage dynamic may be reversing, however. The reduction of launch costs brought about by commercial launch companies and the advent of proliferated low Earth orbit systems has significantly reduced the cost of operating in space. Starlink satellites are estimated to cost less than $500,000 each, placing them well within the cost advantage envelope.[64] In addition, the development of in-space servicing, assembly, and manufacturing

technologies may extend the life of satellites and allow them to be upgraded, further reducing cost and improving their defensive capabilities.[65] If this trend persists, eventually the deterrence calculus may also change. Nevertheless, signal jamming and directed energy weapons attacks may still be less expensive than efforts to defend against them.

Further exacerbating the offense-dominant character of the space domain is China's adoption of an offensive military doctrine under its Active Defense strategy. **China's Active Defense strategy is best described as politically defensive but operationally offensive.** At the strategic level, the PRC states that it will never start a war and that it will counterattack only in response to actions that damage its interests.[66] Despite this characterization, PRC sources describe the Active Defense strategy as having an operationally offensive component that includes preemption, especially in situations involving the PRC's perceptions of its sovereignty and territorial integrity. According to the 2020 *Science of Military Strategy*, in these situations the PRC "has the right to use military measures at any time."[67]

In addition, some PLA researchers view space as an offense-dominant domain, which suggests that deterring the PLA from conducting attacks against U.S. space assets may be difficult.[68] According to Jiang Lianju and Wang Liwen, authors of the *Textbook for the Study of Space Operations*, space warfare is inherently offensive; in a departure from some interpretations of Active Defense, these authors assert that "active offense is the only method for achieving victory in war."[69] The *Textbook* authors predict that future wars will likely begin in outer space and that "achieving space superiority and cyber superiority are critical for achieving overall superiority and being victorious over an enemy,"[70] particularly when non-debris-producing means are used.[71] The authors recommend conducting first strikes at the operational and tactical levels, writing that one should "strive to attack first at the campaign and tactical levels in order to maintain the space battlefield initiative." They argue that fighting a quick war with a quick resolution is one of the "special characteristics of space operations" and that a military should "conceal the concentration of its forces and make a decisive large-scale first strike."[72]

Predicted effects of offensive military balance

Given the potential offensive-dominant nature of the space domain and China's current Active Defense strategy**, we predict that these two aspects combined could decrease the potential effectiveness of U.S. deterrence in the space domain.**

FACTOR #3: AMBIGUITY OF INTENTIONS

U.S. and PRC ambiguity about their intentions and actions directed toward adversary space assets makes deterrence more difficult by increasing uncertainty that could lead to inadvertent escalation. The PRC government continues to remain secretive about its counterspace weapons programs. The PRC might be emphasizing what it sees as its morally superior position of publicly advocating for a ban on space weapons while at the same time

pursuing unacknowledged counterspace capabilities that have been conducted largely outside the public domain.

The U.S. is also ambiguous about how it plans to deter potential attacks against its space assets. The National Space Policy, for example, intimates a deterrence-by-punishment policy without offering specifics. According to the policy, "any purposeful interference with or an attack upon the space systems of the United States or its allies that directly affects national rights will be met with a deliberate response at a time, place, manner, and domain of our choosing."[73]

Secrecy surrounding the U.S. military's space program to retain a warfighting advantage could conceal capabilities that may otherwise reinforce U.S. deterrence efforts. In the outer space domain there is secrecy surrounding the type and number of U.S. systems and their capabilities, their supporting infrastructure, and basing. The high level of secrecy accompanying space technologies, although understandable from a protection perspective, may reduce the effectiveness of deterrence by concealing capabilities that could improve signaling.

Although ambiguity allows both sides to hint at consequences without committing themselves to carrying out these consequences, ambiguity appears to be contrary to a country's ability to communicate to a potential adversary the capability and will to defend its interests. Not knowing what actions may trigger a reaction, the PRC may bank on the U.S. remaining cautious by not challenging the PRC or by engaging in conduct that falls below the PRC's threshold for reaction.

Predicted effects of ambiguity

Ambiguous statements regarding how the U.S. will respond to attacks against its space architecture **allow the U.S. more freedom of action but could lack the specificity necessary for effective signaling,** a necessary component of effective deterrence. Moreover, **U.S. and PRC ambiguity regarding counterspace intentions could lead to inadvertent escalation.**

FACTOR #4: PREVALENCE OF UNCREWED SYSTEMS

The predominance of uncrewed military systems in space affects the risk calculus of potential offensive operations in this domain. The inhospitable space environment and cost of crewed space systems mean that spacecraft will largely remain uncrewed for the foreseeable future. Although crewed systems such as the International Space Station and China's Tiangong space station exist, most military spacecraft are operated robotically and remotely.

Predicted effects of uncrewed systems

The predominance of uncrewed systems in space likely reduces the effectiveness of deterrence. **Attacks against uncrewed systems may be viewed by a challenger as having**

fewer costs than attacks against crewed systems because of their lower escalatory potential.

FACTOR #5: CHALLENGER DISSATISFACTION

Whether a challenger is satisfied with the current status quo may affect the effectiveness of deterrence. According to proponents of prospect theory, the most important variable that predicts deterrence success is perceptions of the status quo.[74] When both actors are satisfied with the gains that they receive from the status quo, they will be less likely to want to overturn the system, making deterrence more effective. On the other hand, if one or both states perceive that the status quo is causing them to lose (a "loss frame"), then deterrence will be less likely to succeed. One or both states may be more likely to try to overturn the status quo to prevent further loss. According to this explanation, feelings of dissatisfaction can overcome disparities in capabilities, leading weaker states to confront stronger states.[75]

Prospect theory also proposes that judgments are based on biases, or how people frame a situation.[76] Most relevant for prospect theory is whether people frame a situation as good or bad for them. According to professor of international relations Rose McDermott, "differences between options will seem more important if they are *framed* in terms of losses or negative aspects rather than if they are *framed* in terms of positive aspects of gains."[77]

Prospect theory argues that people do not maximize gains but prefer to minimize losses. People do not want to risk what they have but will take risks to regain what they have lost. In short, "losses hurt more than a gain feels good."[78] This tendency makes people "risk averse when confronted with choices between gains while risk acceptant when confronted with losses."[79] Because humans tend to emphasize averting or recovering losses rather than maximizing gains, decision-makers may "[act] more aggressively to avoid a loss than to secure an equal gain" and pursue "loss aversion beyond a rational expectation of benefits."[80] Applying this theory to Taiwan, PRC leaders will likely view the risks through a loss mindset, which may make decision-makers more aggressive in order to prevent that loss.

China's dissatisfaction with current status quo

The PRC has publicly expressed dissatisfaction with the current international order. Although it does not mention the U.S. by name, Xi Jinping's work report for the Chinese Communist Party's (CCP's) Twentieth National Congress in October 2022 stated that "hegemonic, high-handed, and bullying acts of using strength to intimidate the weak, taking from others by force and subterfuge, and playing zero-sum games are exerting grave harm."[81] Xi appeared to double down on this sentiment in a speech to delegates from the Chinese People's Political Consultative Conference held in May 2023, this time mentioning the U.S. by name as the source of the PRC's troubles. According to Xi, "Western countries led by the U.S. have implemented all-round containment, encirclement, and suppression of China, which has brought unprecedented severe challenges to our country's development."[82]

The 2024 National People's Congress work report reiterated China's firm opposition to "hegemonic, high-handed, and bullying acts."[83]

Related to China's dissatisfaction with the status quo, PRC leaders continue to assert a narrative of grievance. Janice Gross Stein writes that "leaders who come from cultures of honor and have a strong sense of grievance are especially likely to escalate in response to deterrent threats."[84] Grievance can make leaders more sensitive to perceived slights and intimidation and may cause them to act in ways that they perceive will enhance their prestige or demand others to show respect.

The PRC is characterized as having a strong sense of grievance and a "victimization narrative" derived from the "Century of Humiliation."[85] The CCP's victimization narrative plays out in several ways:

- PRC leaders remain extraordinarily sensitive to perceived threats to (or disrespect of) China's territorial integrity and sovereignty.[86]
- The PRC takes a hard line toward foreign entities that appear to ignore or criticize its assertions regarding its sovereignty and territorial integrity.[87]
- PRC leaders view Western forces as waging wars of conquest to subjugate China.[88]

The CCP still believes that it must regain China's "lost territory" and maintain (or increase) China's international standing and dignity.[89] Official Party reports often reiterate these themes; for example, the Twentieth Party Congress report states, "We have resolutely fought against separatism and countered interference, demonstrating our resolve and ability to safeguard China's sovereignty and territorial integrity."[90]

In addition to its dissatisfaction with the international order, the PRC is dissatisfied with the global order in space. The PRC's space narrative parallels its larger narrative of the U.S.-China relationship. The PRC depicts itself as committed to peaceful solutions, economic development, and cooperation with all countries regardless of political system and level of economic development. The PRC Foreign Ministry has repeatedly emphasized that China's space program is peaceful, stating in 2024: "China's position on space arms control is consistent and clear. We advocate the peaceful use of space and oppose arms race in space or weaponizing space."[91]

In contrast, PRC sources portray the U.S. as the malevolent actor that is trying to dominate space. PLA analysis of the U.S. military's intentions in space focuses on the establishment of the U.S. Space Force, the development of space technologies by the U.S. military, and the publication of U.S. military doctrinal and strategic writings perceived to be evidence that the U.S. is developing offensive counterspace capabilities. According to the PRC Ministry of Defense, "It is known to all that the U.S., in pursuit of space hegemony, has formed the Space Force, spent enormous amounts of money on enhancing space combat readiness and unilaterally initiated an arms race in the space."[92]

As a result, the PRC's perceptions that it is a moral force in the use of space and that the U.S. is a destabilizing and malign force may be used to justify actions in space as a necessary means to stop what China sees as the illegitimate use of space power by the U.S.[93]

Predicted effects of challenger dissatisfaction

Given China's strong sense of grievance and dissatisfaction with the current international status quo and insights from prospect theory, **we predict that U.S. deterrence in space will be less effective vis-à-vis the PRC.**

FACTOR #6: SPACE ASYMMETRY

Space deterrence involving the U.S. is conducted asymmetrically. Although the PRC is becoming more dependent on space (discussed next), the U.S. remains the leading space power and the country most reliant on space.[94] This asymmetry creates an imbalance in dependence that could create incentives for China to attack U.S. space assets.[95]

PLA researchers have assessed space capabilities as playing an outsized role distinct from other types of military power. PLA researchers perceive space capabilities as a more usable and effective means of both influencing an adversary before a conflict begins and defeating an adversary during wartime than nuclear and conventional capabilities.[96] The perception that space underpins U.S. military superiority and economic performance may make U.S. space assets an irresistible target for PLA planners and challenge U.S. deterrence efforts.[97]

PLA analysts view the U.S. military's reliance on space as a critical vulnerability. According to PRC sources, the U.S. military relies on space for more than 70 percent of its communications needs, 80 to 95 percent of its intelligence collection needs, 100 percent of its meteorological forecasting, and 90 percent of its precision guidance for munitions.[98] Articles in China's military media on U.S. satellite capabilities highlight the U.S. military's reliance on satellites for operations.[99] One article from the *Winged Missiles Journal*, a monthly periodical from the China Aerospace Science and Industry Corporation, described U.S. satellites as an "indispensable means for direct support of battlefield operations" and stated that the U.S. would "lose its military advantage" if its satellites were destroyed.[100]

Predicted effects of space asymmetry

The U.S. remains the leading space power and the country most reliant on space. The PRC may view the operational gains from attacking U.S. space assets as worth the escalatory risk in a conflict. **Thus, the current U.S.-China asymmetry in space may actually reduce the effectiveness of U.S. deterrence.**

FACTOR #7: GROWING PRC DEPENDENCE ON SPACE

While **PLA researchers perceive space capabilities as a more usable and effective means of both influencing an adversary,**[101] as the PLA increasingly uses space assets such as Beidou for its own command, control, communications, computers, intelligence,

surveillance, and reconnaissance (C4ISR) architecture, the PRC has the potential to grow more dependent on space.[102] Thus, although U.S. dominance in space may have made PRC leaders more apt to consider space weapons, PRC dependence on space could eventually curtail those inclinations.

Predicted effects of growing PRC dependency on space

Advancements in China's space program may make the PRC more reluctant to engage in space warfare, or at least less willing to engage in escalatory behavior that risks widening a space war. **As such, as PRC dependence on space increases, the U.S.'s ability to deter China from attacking space assets could increase.**

FACTOR #8: SPACE AS A WARFIGHTING DOMAIN

U.S. efforts to deter China from attacking U.S. space assets will likely be challenged by U.S. and PRC strategies treating outer space as a domain permissible for offensive counterspace operations. Treating outer space as a warfighting domain prioritizes degrading an adversary's space assets over deterrence and may result in both sides planning to conduct strikes early in an operation. According to the DOD, the PLA views space superiority, the ability to control the space-enabled information sphere and to deny adversaries their own space-based information gathering and communication capabilities, as critical to conducting modern "informatized warfare."[103] Counterspace measures could be used to deter and counter "a U.S. intervention during a regional military conflict."[104]

Predicted effects of space as a warfighting domain

Treating outer space like other warfighting domains may diminish the requirement to state explicitly when or how the U.S. would respond to attacks against its space assets. **The absence of sovereignty in outer space may increase the chances of provocative actions in space. Efforts to establish space as a formal warfighting domain exacerbate this likelihood and thus could lessen the chances for successful deterrence.**

FACTOR #9: WEAK INTERNATIONAL NORMS

International norms can include treaties, laws, agreements, and customs.[105] Examples include the shared practiced of not using nuclear weapons and more formal agreements such as the Chemical Weapons Convention. Norms can be imperfect and at times a hindrance to a deterring state, however. Norms can limit a deterring state's actions while failing to restrict a challenger's actions.[106]

Proponents of norms argue that norms establish a clear set of predictable and acceptable behaviors that states can apply toward rational actors that can increase transparency and help to determine whether a challenger state purposefully defies a norm or whether it has hostile intent.[107] Norms can also ensure stability by creating "rules of the road" for states and a platform for states to support a response.[108] For example, weapons-testing limits can lower the perception of a challenger state's success, speed up the warning signs of a potential attack,

and reduce the possibility of an arms race.[109] Norms practiced by multiple states can create coalitions that make it possible for a deterring state to be assisted or supported by others, perhaps with additional deterrent effects.[110]

Space weapons already being used in peacetime

The lack of norms against attacks on space assets has resulted in attacks against satellites and ground infrastructure. According to the U.S. Space Force's Vice Chief of Space Operations, "Both China and Russia are regularly attacking U.S. satellites with non-kinetic means."[111] Russia, for example, is widely believed to be behind cyberattacks that shut down the American company Viasat's satellite internet service to Ukraine in 2022.[112] Russia has also conducted cyber and electronic warfare attacks against Starlink satellites[113] and has conducted activities that have jammed the GPS signal in Russia, Ukraine, and surrounding areas.[114] Iran has been implicated in attacks against two Eutelsat satellites that affected the transmission of Persian-language television and radio broadcasts.[115]

The lack of norms against the use of space weapons and their use in peacetime suggests that space weapons may be viewed as a type of conventional weapon.[116] Although the denial of space capabilities could have significant consequences for a country's military and economy, their loss would not have the same consequences as a nuclear strike. The loss of human life resulting from a nuclear attack, in particular, is one of the main characteristics that strengthens nuclear deterrence. Attacks against space systems, on the other hand, may result in no loss of life.[117] Thus, predictions based on nuclear deterrence may not apply in the space domain.

Predicted effects of weak international norms

In theory, norms could play a role in limiting the use of space weapons. However, norms are unlikely to be agreed upon by the PRC if they are sponsored primarily by the U.S. **We predict that U.S.-led efforts to promote norms in space, at least in the short term, are unlikely to increase deterrence effectiveness vis-à-vis China.** Yet international norms may still be useful for establishing commonly accepted practices that define hostile behaviors or may help avoid miscommunication and misperception. Building norms about accepted practices in space could also garner support for U.S. space policies with U.S. allies and partners, which could create the foundation for international norms over the long term.

FACTOR #10: REASSURANCE

Whether the deterring state is willing to offer positive inducements or reassurance to the challenger is a final factor that could influence space deterrence. Some academic literature suggests that offering positive inducements and reassurances to a challenger is the most effective way to avoid conflict.[118] Other academic sources suggest that offering positive inducements and reassurances to a challenger might lessen its loss mindset and reduce the need for military force.[119] According to prospect theory, deterrence strategies that do not consider a challenger's historical grievances by offering inducements and signaling respect

could exacerbate the interplay of cognitive and cultural factors that lead to deterrence failures.[120]

Offering positive inducements and reassurance to a challenger is one of the most effective ways to avoid conflict, especially if the leader comes from a country whose history involves grievances.[121] Stein argues, for example, that positive inducements should be offered at the beginning of the deterrence process to "reduce the emotional sting" of deterrence threats, "especially in uncertain and complex environments."[122]

However, the reassurance literature is somewhat underdeveloped when compared with the deterrence literature, so more empirical research on this topic should be done. Moreover, given the current state of competition between the U.S. and China, positive inducements and reassurances from the U.S. are unlikely to be forthcoming or sufficient to placate some dimensions of the PRC's dissatisfaction with the current international status quo.

Predicted effects of reassurance

Recent scholarship argues that the U.S. and PRC are in a dangerous action-reaction cycle in which both sides increasingly view the relationship as zero sum. These studies recommend that both sides engage in less antagonistic behavior,[123] which in the space domain could mean engaging in cooperative activities and, for the U.S., removing sanctions over technology transfer. **Given the current state of competition between the two countries, however, whether these types of reassurance activities are feasible at present is unclear.**

CONCLUSION AND RECOMMENDATIONS

This report examined the evolving deterrence dynamics between the U.S. and PRC in the space domain. We find that deterrence is shaped by more than the military balance of power between a deterring state and a challenger. Deterrence often fails because of a range of domestic and international political factors, including leadership motivations, challenger world views, the dominance of offensive weapons, ambiguity of signaling, and international norms. As such, deterrence theory and its applications to the space domain need to be examined further.

Research on deterrence and security dilemmas, however, suggests that achieving an end state in which the U.S. is so powerful that it dissuades others from attacking it in space may also be impossible. As a result, achieving a desired balance between warfighting and deterrence will require trade-offs between opposing end states. International relations scholar Robert Jervis once wrote that security dilemmas—when one state's actions to increase its security are perceived by another state as weakening its security—are the most intractable when a state's commitments, strategy, or technology leave conflict as the only method to achieve security.[124] In the case of deterring China from attacking U.S. space assets, all three factors appear to be working against avoiding a security dilemma.

PRC writings on space coercion and development of space capabilities suggest that the U.S. and PRC have already entered into a security dilemma that could be a destabilizing influence on the military interactions between the two countries. Arguably, this security dilemma is exacerbated by the zero-sum competitive aspects of the overall U.S.-China relationship. PRC anti-access/area denial capabilities, coupled with the Active Defense strategy and the possibility of the U.S. military striking PLA C4ISR systems to defeat those capabilities, suggest that an unstable situation may occur in which it is advantageous for both sides to conduct offensive actions against space assets in a conflict to negate the precision firepower of the other.

Of the 10 factors examined as part of the space deterrence scorecard, only 2—the overall military balance and the PRC's growing dependency on space—are likely to increase the U.S.'s ability to deter China successfully.

Military factors suggest that space deterrence will be difficult to achieve in the China context. The PLA requirement to develop the capabilities to take Taiwan by 2027, for example, appears to be an implicit indication that the PRC may be less influenced by U.S. deterrence actions. The worsening military balance between the U.S. and PRC is also exacerbated by the offensive operational nature of PRC military strategy, which may make the PRC more open to conducting a first strike, especially if it can achieve a localized advantage.

These preliminary hypotheses suggest that the U.S. is unlikely to be able to deter the PRC from all attacks on U.S. space assets. However, we recognize that more empirical

and theoretic research should be done on all these factors. The PRC's emphasis on offensive action and the U.S. military's dependence on space may make U.S. space assets irresistible targets. However, not all space attacks are necessarily undeterrable. For example, whether the PRC would conduct the most escalatory attacks or attacks that produce space debris is unclear.

Given the lack of real-world precedents in this specific domain, policy-makers should consider the space domain and its unique facets carefully. Practitioners will also need to examine cross-domain deterrence in the context of U.S.-China strategic competition. For example, in the outer space domain, the inclination to strike first may be exacerbated by both the U.S. and PRC treating outer space as a warfighting domain. Miscalculation by either side that leads to deterrence failure may be worsened by the ambiguous position of the U.S. and PRC regarding their intentions to use weapons against space assets. This study argues that China is dissatisfied with the status quo in space and regards the U.S. as a malign actor in space and thus traditional theories of deterrence may not reflect the current reality.

Despite some of the seemingly pessimistic predictions, opportunities for cooperation may still exist. Developing shared norms in space with the PRC may be a best case scenario, but even if norms cannot be fully established, U.S.-China dialogue on appropriate actions in space could improve signaling between the two countries and reduce ambiguity and miscommunication.

RECOMMENDATIONS

The challenges to deterring China from attacking U.S. space assets suggest that strategic stability—the condition in which there is no incentive to strike first—has not been achieved in the outer space domain.[125] As a result, U.S. efforts to respond to the China military threat in space may be better focused on developing space as a warfighting domain with a secondary deterrence objective. In doing so, the primary consideration for U.S. planners would be to deny the PRC the advantage of a first strike rather than deterring conflict in space.

Nevertheless, treating outer space like other warfighting domains would still require developing many of the same capabilities needed for deterrence. These actions include improving deterrence by denial capabilities such as SDA and the resiliency of the space architecture, developing deterrence-by-punishment capabilities through an expanded range of space weapons, and improving space norms.

Improve resiliency of the U.S. space architecture

The 2022 NDS defines resiliency as "the ability to withstand, fight through, and recover quickly from disruption."[126] Resiliency can play an important role in strategic stability through a strategy of deterrence by denial and by denying a challenger adversary the ability to gain the upper hand even if it undertakes a first strike.

- Resiliency can enable the U.S. military to absorb and recover from a first strike better by spreading capabilities across multiple platforms so that the loss of any one satellite or satellite type does not critically affect military operations. It allows the U.S. to take actions to preserve remaining capabilities and conduct counteractions.
- Resiliency can also ameliorate the attribution problem associated with space operations by providing additional time to determine whether loss of a capability is due to malfunction, the environment, or hostile action. In this way, resiliency can help avoid miscalculation that can lead to inadvertent military action or unnecessary escalation.

The DOD identifies six ways to achieve resiliency:

1. **Disaggregation** separates dissimilar capabilities into distinct platforms or payloads, such as separating tactical and strategic communications.
2. **Distribution** uses multiple nodes, working together, to perform the same mission or functions to ensure that no individual satellite or ground node is fundamental to the success of that mission.
3. **Diversification** leverages alternative means to contribute to the same mission in multiple ways, using different platforms, different orbits, or systems and capabilities of civil, commercial, or international partners.
4. **Protection** comprises active and passive measures to ensure that space systems are able to provide a service in support of any operating environment or condition, such as onboard jam protection and nuclear hardening.
5. **Proliferation** deploys large numbers of the same platform or payload or systems of the same types to perform the same mission.
6. **Deception** comprises measures taken to confuse or mislead an adversary with respect to the location, capability, operational status, mission type, or robustness of a national security system or payload.[127]

Develop and deploy expanded counterspace capabilities

Counterspace capabilities add to strategic stability through a deterrence-by-punishment strategy that increases the costs of attacking the U.S. space architecture for a potential challenger. An expanded range of space weapons would allow U.S. military planners additional options in responding to attacks across all levels of escalation and allow the U.S. to tailor its actions appropriately to PRC provocations. Weapons to be developed and deployed could include communication jammers and spoofers, high-powered lasers, high-powered microwaves, co-orbital capabilities, and cyber capabilities.

Improve SDA capabilities

The U.S. Space Force defines SDA as the "effective identification, characterization, and understanding of any factor associated with the space domain that could affect space operations."[128] SDA is focused primarily on understanding the disposition of friendly, adversary, and third-party actors in space and the physical environment of space. It can also include understanding actions on Earth that affect space-based capabilities or the provision of space support, such as the employment of ground-based anti-satellite systems.[129]

The U.S. Space Force uses 600 sensors to prioritize collection against 1,000 targets out of approximately 9,500 satellites orbiting Earth.[130] According to the DOD's 2023 *Space Policy Review and Strategy on the Protection of Satellites*, however, U.S. SDA capabilities are "stove piped and disaggregated" in ways that prevent SDA from being most effective.[131] According to one analysis, "In an era where competitors desire to hold U.S. space capabilities...at risk, it has become far more difficult to anticipate satellite activity."[132] Without a comprehensive SDA capability, activities can go undetected, and even when they are detected, determining attribution can be difficult.

Better SDA can increase strategic stability by reducing the attribution problem associated with space activities. Anomalies in space can be the result of enemy action, but they can also be due to malfunction or space weather. Effective SDA enhances space deterrence and reduces inadvertent escalation by allowing the U.S. military to identify actions, which could provide the ability to deter adversaries from taking "opportunistic acts of aggression...that would result in a fait accompli."[133]

During a crisis or prelude to war, effective SDA can also identify mobilization activities related to space, such as prepositioning satellites in certain orbits and deploying counterspace capabilities. During war, SDA could inform decisions to escalate by determining whether an attack is limited.[134] The intelligence provided by SDA could enhance attribution, determine the nature of the threat, and provide information that can be used to publicize activities and provide options to decision-makers to forestall an adversary's intended actions.

Build international norms to enhance deterrence

Norms or accepted standards of appropriate behavior constrain some freedom of action. Although agreement between China, Russia, and the U.S. is unlikely at present, we should not assume that PRC and Russian views on the outer space domain are identical. Even if the PRC is dissatisfied with the status quo, PRC leaders do care about how China is viewed by the international community, which could be one avenue to discuss agreed-upon norms for outer space. Norms can play a useful role in promoting deterrence by establishing commonly accepted practices that define hostile behaviors and "help prevent crises based on miscommunication or misperception from escalating into conflict."[135]

Norms for conduct in space can also be agreed upon by U.S. allies and partners or international organizations, such as the European Union. Norms practiced by multiple states can create coalitions that make it possible for a deterring state to be assisted or supported by

others.[136] If a large coalition of states establishes norms for behavior that is (or is not) acceptable in the space domain, that could increase the U.S.'s ability to deter countries from conducting attacks in space.

Think about specific space deterrence options

U.S. space assets have already been attacked through reversible means, and whether deterrence will be effective in preventing other types of attacks is uncertain. Here we discuss two possibilities for employing deterrence measures in space that could be examined further.

Deterring attacks against missile warning satellites

Missile warning satellites form part of the U.S. nuclear command and control infrastructure. At the same time, their use in the detection of conventional ballistic missile launches may result in the PRC targeting them to achieve conventional advantage. As a result, PRC attacks against U.S. early warning satellites, even if intended to degrade U.S. conventional capabilities, may increase nuclear instability. In this case, a declaratory statement promising retaliation against PRC missile warning satellites may increase the effectiveness of deterrence by heightening PRC awareness of the sensitivity of attacking U.S. missile warning satellites.

Deterring debris-producing attacks

Symmetries in dependence between the U.S. and PRC may decrease PRC motivation to conduct debris-producing attacks. In this case, deterrence may resemble the mutually assured destruction doctrine of nuclear warfare, in which both sides refrain from attacking each other because of costs that would be inflicted on each side. However, two factors may challenge the ability to deter debris-producing attacks.

PLA assessment of relative dependence on space

According to the U.S. Space Force, the PLA intends to build a large number of direct ascent kinetic-kill launchers, suggesting a warfighting use that goes beyond deterrence.[137] Given its asymmetric advantage in dependence, the PRC may determine that any self-inflicted losses caused by debris against its own satellite constellations is acceptable if it results in an advantage for the PLA.

Difficulties of responding in kind

U.S. retaliation in kind against PRC satellites may be counterproductive, however. U.S. attacks against PRC satellites that produce space debris could further degrade U.S. space capabilities. In this case, the U.S. may need to threaten massive retaliation using non-debris-producing means to make deterrence more credible.

APPENDIX: A REVIEW OF DETERRENCE THEORY

Deterrence is a form of coercion that relies on the possibility of force to convince another state to avoid a particular action; actual force is not used, but the dissuasion relies on the threat of violence.[138] Deterrence has been defined in many ways. For the purposes of this study, we define deterrence as the "prevention or discouragement, by fear or doubt, from acting."[139] It is intended to convince an adversary that the costs of an action outweigh its potential benefits.[140] Deterrence rests on the importance of perceptions, especially the ability to change the perceptions of a challenger regarding its risk calculus.[141]

Historically, deterrence theory was based on a utility model that assumes that a challenger state rationally weighs the costs and benefits of an action before it is carried out. According to this construct, states should normally work to minimize costs and maximize benefits.[142]

THE THREE ELEMENTS OF EFFECTIVE DETERRENCE

In nearly all definitions of deterrence—including those highlighted in PRC publications on the topic—effective deterrence requires three elements: capability, commitment, and communication.

A state must possess a deterrent capability. Capabilities can include technologies, military forces, and diplomatic or economic sanctions.

A state must be committed to carrying out the deterrent threat. A state must be prepared to execute the threat that it makes.

A state must be able to communicate that it is capable and willing to carry out the deterrent. The challenger must be made to believe that the deterring state has both the capability and the will to carry out its threats in what the father of modern deterrence theory, Thomas Schelling, called the "diplomacy of violence."[143]

DETERRENCE DISTINCTIONS

Deterrence is different from other concepts such as compellence and defense. *Compellence* can be defined as forcing a side to act.[144] Using this definition, the difference between deterrence and compellence is the initiator of the action. In short, deterrence is to prevent an action, whereas compellence is to force an action.[145] Taken together, compellence and deterrence are more broadly defined as elements of coercion.[146]

Deterrence is also different from defense. Whereas deterrence focuses on discouraging adversary actions, defense focuses on preparing for conflict "in the event that deterrence fails." According to this construct, "deterrence works on the enemy's *intentions*….Defense reduces the enemy's *capability* to damage."[147] As a result, some weapons may have both deterrent and defense uses, whereas others may have only a deterrent use.[148]

TYPES OF DETERRENCE

A range of terms are used to describe types of deterrence. Each of them relies on one of three approaches the deterrer might take: "imposing costs, denying benefits, and encouraging restraint."[149] In this section, we provide brief definitions and examples of the different types of deterrence used in this paper. They are summarized in Table 2.

Deterrence by punishment

Deterrence by punishment involves the threat of punitive action.[150] It is akin to retaliation because it consists of threats to impose significant costs on an asset that the challenger values.[151] An example of deterrence by punishment is the December 2023 U.S.–South Korea joint statement that "any nuclear attack by the DPRK [Democratic People's Republic of Korea] against the ROK [Republic of Korea] will be met with a swift, overwhelming, and decisive response" by the U.S.[152]

Deterrence by denial

Deterrence by denial discourages challenger actions by increasing the difficulty of achieving an objective.[153] For example, former DOD official Elbridge Colby argues, "The focus of U.S. defense planning should therefore be to deny China's ability to effectuate a fait accompli against its [U.S.] allies within the anti-hegemonic coalition."[154] Thus, a deterrence-by-denial strategy for Taiwan is based on the notion that the U.S. could "deny China the ability to invade and hold Taiwan."[155]

General deterrence

General deterrence refers to long-term deterrence measures.[156] An example is mutually assured destruction during the Cold War, when the U.S. and Soviet Union both had the capability to attack the other with nuclear strikes.

Immediate deterrence

Immediate deterrence strives to prevent an imminent attack, typically during a crisis.[157] An example is the 1962 Cuban Missile Crisis, when the U.S. quickly responded to the potential Soviet launch of a nuclear weapon from Cuba by threatening retaliation.[158]

Table 2: Types of deterrence

Type of Deterrence	Definition	Real-Life Example
Deterrence by punishment	Threaten massive retaliation or that any potential gains cost too much	Khruschev threat to destroy U.S. tanks if they enter Berlin
Deterrence by denial	Convince the challenger state that the cost of attack outweighs any potential gain	U.S. troops deployed near Strait of Hormuz
General deterrence	Long-term focus, most often not during a crisis	Mutually assured destruction during Cold War
Immediate deterrence	Short-term focus, most often during a crisis	Cuban Missile Crisis

Source: CNA.

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