Strengthening the U.S.-Japan Alliance in Outer Space*

In articles about outer space's importance to national security there is almost always an obligatory paragraph describing the domain's important role in our modern lives. There are often several surprising examples of this role, meant to awaken the reader to space's centrality in our modern lives. For example, timing data from GPS satellites is the foundation for financial trades and cellphone networks. Similarly, a modern military's global communications networks flows through datalinks in space. These crucial missions are then juxtaposed with an observation that these economic and military lines of communication have not escaped the notice of hostile governments and future conflicts almost certainly will extend into the outer space domain as states seek to threaten the military and economic activity of their competitors. This paper will dispel with this obligation because readers of this paper—drawn from defense and space communities—almost certainly are already well-versed in space's importance and that it has become a strategic Achilles Heel. In order to safeguard the domain and deter potential adversaries the U.S. and Japan must be prepared.

This paper's aims are threefold: i) to document how American and Japanese national security policymakers are addressing the outer space domain in their defense strategies; ii) to discuss current Japanese defense trends' impact on the future space capabilities of the US-Japan alliance, and; iii) to identify opportunities for accelerating alliance cooperation while highlighting key obstacles to deepening the relationship in the space domain. The work will argue that a deterrence by denial strategy—implemented with an eye toward building resiliency—is best for protecting U.S. and Japanese space assets and there are several opportunities to strengthen the Tokyo-Washington axis by cooperating to build constellations that are mutually reinforcing and resilient.

Space's Place in 21st Century Security

Many articles,[1,2,3,4] books[5] and speeches[6] have persuasively argued that space-based services—like communications, GPS and imagery satellites—play an increasing central role in the day-to-day lives of billions, underpin key economic activity and are crucial to the national defense of the United States and its allies. The 2011 Obama Administration's U.S. National Security Space Strategy advanced this argument in the strongest possible terms:

---

* The opinions and views expressed in this presentation represent the views of the author and do not necessarily reflect the policy or position of Lawrence Livermore National Laboratory or any agency of the U.S. government.

> *"Space is vital to U.S. national security and our ability to understand emerging threats, project power globally, conduct operations, support diplomatic efforts, and enable global economic viability…our National Security Space Strategy seeks to maintain and enhance the national security benefits we derive from our activities and capabilities in space while addressing and shaping the strategic environment and strengthening the foundations of our enterprise."*[7]

The Trump administration's 2017 National Security Strategy echoed the Obama Administration's views on space and underlined the trend toward increased military dependence on space services. It also acknowledged the potential threat that adversaries posed to U.S. space assets because of this dependence:

> *"As U.S. dependence on space has increased, other actors have gained access to space-based systems and information…Many countries are purchasing satellites to support their own strategic military activities. Others believe that the ability to attack space assets offers an asymmetric advantage and as a result, are pursuing a range of anti-satellite (ASAT) weapons. The United States considers unfettered access to and freedom to operate in space to be a vital interest."*[8]

The American continuity and bipartisan consensus on space—and recognition of a growing threat to destroy the benefit—is remarkable and unique. Key U.S. allies, most notably Japan, have also highlighted the same security environment in their major defense policy documents and cited the rising tide of threats to drive major policy shifts. Japan's policy guidance for its Self Defense Forces (SDF)—the National Defense Program Guidelines (NDPG)—has stressed importance of securing space while underscoring the role that the U.S. plays in executing that mission in a similar manner over the last decade. The 2013 NDPG stated:

> *"Moreover, in light of society's growing dependence on outer space…the SDF will secure effective, stable use of outer space so that satellites can continuously exercise their capabilities even in contingencies by enhancing the survivability of satellites through such initiatives as space situational awareness. In implementing such initiatives, the SDF will form organic partnerships with research and development institutions in Japan, as well as with the U.S."*[9]

The update to this view in the 2018 NDPG sought to integrate Japan's defense across domains with the implicit understanding that space was now a warfighting domain. The new NDPG also reiterated the importance of working with allies to buttress Tokyo's defense.

> *"…it has become vitally important to adapt to warfare that combines capabilities in new domains—space, cyberspace and electromagnetic spectrum—and traditional domains—land, sea and air…In light of the foregoing, Japan will henceforth build a truly effective defense*

> *capability, "Multi-Domain Defense Force," which: organically fuses capabilities in all domains including space, cyberspace and electromagnetic spectrum; and is capable of sustained conduct of flexible and strategic activities during all phases from peacetime to armed contingencies…In addition, in light of the society's growing dependence on space and cyberspace, SDF will contribute to comprehensive, whole-of-government efforts concerning these domains under appropriate partnership and shared responsibility with relevant organizations."* [10]

The Japanese desire to build a partnership with the US to enhance survivability was echoed in 2017 in the Department of Defense International Space Cooperation Strategy (DOD ISCS):

> *"… DoD ISCS emphasizes the importance of collaborating with trusted allies and partners to address shared security challenges by leveraging allies' and partners' capabilities to enhance space mission assurance and by improving space and multi-domain interoperability of U.S. forces with allies and partners…"*[11]

A shared and growing realization that space threats had worsened dramatically in the past decade and that the space domain was a critical enabler of economic prosperity and military operations drove a rapid policy evolution in Tokyo and Washington. Once policymakers realized their views were in alignment both parties began outreach to alliance partners.

Washington's Changing Inclination

For most of the post-Cold War era the space domain's greatest military promises were realized by Washington. American armed forces leveraged space to devastate foreign conventional forces and project global power. Washington's politicians and diplomats used space superiority to coerce and deter potential adversaries. When Winston Churchill argued "the power of an air force is terrific when there is nothing to oppose it"[12] he could have been describing the new American space hegemony. These U.S. developments occurred, however, in a benign security environment—described by Michael O'Hanlon as a "sanctuary;"[13] adversaries, like China and Russia, quickly realized they needed to threaten key U.S. space systems and oppose the U.S. in the space domain to check Washington's 'terrific power.' American policymakers anticipate the next decade will see a space domain that is increasingly "congested, contested and competitive"[14] as states maximize their space power and seek to undermine Washington's dominance.

Washington's space policy experts largely agree on the weaknesses associated with America's current strategic space posture but consensus on the potential solutions has so far remained elusive. Included on the long list of challenges is: a failure to build cohorts of space experts across the military services, an underwhelming response to a changing security environment, and an inefficient acquisition process that takes too long, costs too much and, at times, buys the wrong systems. Current policy discussions on how best to address these problems, however, have become intertwined with debate on a future reorganization in the Defense Department; answers to underlying problems on procurement, human capital and the evolving threat environment are unlikely to surface until after reorganization policies are resolved.

Tokyo's Space Policy Revolution

The Japanese Diet in 2008 passed the Basic Space Law and drove Japan's defense officials to take a fresh look at the space domain. A decade later Tokyo, like Washington, faces a similarly well-diagnosed problem with several potential solutions. While Japan has rapidly expanded its national security space capabilities—by executing a roadmap established nearly a decade ago—Tokyo has reached the edge of its initial vision. Continued iterative improvements to the current architecture will not solve the problems and threats Japan faces; blazing a new trail, however, increases the risk that Japan could proceed down the wrong path.

The Basic Space Law of 2008 had two major goals. The first was to break the byzantine space policymaking process and centralize authority under a new organization, the Strategic Headquarters for Space Development[†] (SHSD). The second goal of the legislation was to empower Japanese commercial space companies and spur innovative R&D. These goals were intended to be mutually reinforcing.[15] The lawmakers hoped the new streamlined policymaking authority vested in the SHSD would help establish the government as a key customer for space services[16] and most of the purchases aimed at bolstering national security. These government investments, in turn, would encourage additional R&D investments from the commercial sector in new capabilities that would further enhance Japanese national security in a virtuous cycle.

Japan's execution of its space strategy—embodied in the roadmap—thus far yielded multiple ISR satellites (including both optical and SAR satellites), data relay satellites for the ISR network, dedicated military X-Band communications satellites, and an indigenous PNT[‡] constellation that is

---

[†] The Japanese term used in the 2008 Basic Space Law, 宇宙開発戦略本部, can be translated several ways. This paper references the organization as the Strategic Headquarters for Space Development (SHSD), but several other translations, including Strategic Headquarters for National Space Policy or the Strategic Headquarters for Space Policy, are in common usage too.

[‡] Positioning, Navigation, and Timing (PNT) satellites, like the US GPS or the Japanese Quasi-Zenith Satellites, provide positioning and timing signals to terrestrial sensors. Space-based PNT signals underpin critical military and civilian activities and are an integral pillar to any space-enabled

intended to augment Japanese use of the U.S. GPS signal (see **Table 1**). Furthermore, Japanese R&D on early warning sensors for ballistic missile defense, responsive launch capabilities, space-based laser communications and space situational awareness (SSA) networks and a follow-on rocket for their current generation of SLV workhorses is also under study. In addition to the ongoing work intended to bolster Japan's national security Tokyo still maintains a robust civil space program, managed by Japan Aerospace Exploration Agency (JAXA), that executes cutting edge science through deep space and astronomical missions as well as ongoing support to the International Space Station. All of these burgeoning capabilities have been developed on a relatively static budget (see **Figure 1**).

---

economy or military.

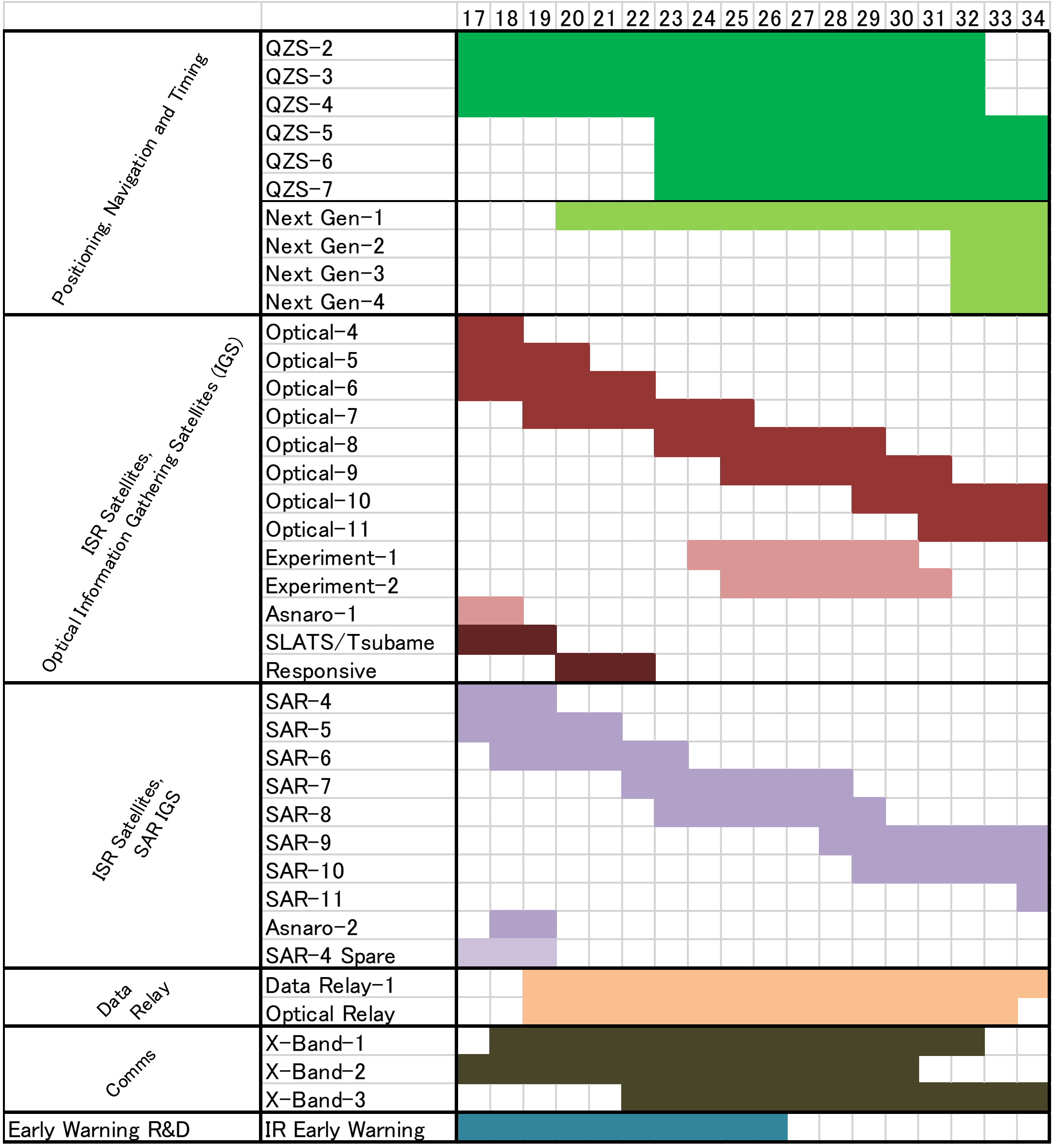

Table 1. ***Summary of Japanese Basic Space Plan****. This table summarizes the expected operational timelines for a variety of Japan's national security-related space capabilities. The Basic Space Plan includes several other categories of satellite and R&D that were not included in this table. Tokyo does not plan to operate more than four Information Gathering Satellites (IGS)—IGS are Cabinet Secretariat-operated, dedicated-ISR satellites for national security missions—at any point before 2034 although Japan almost certainly will augment the IGS constellation with compact ISR sensors on small satellites[17] and commercial ISR providers.*

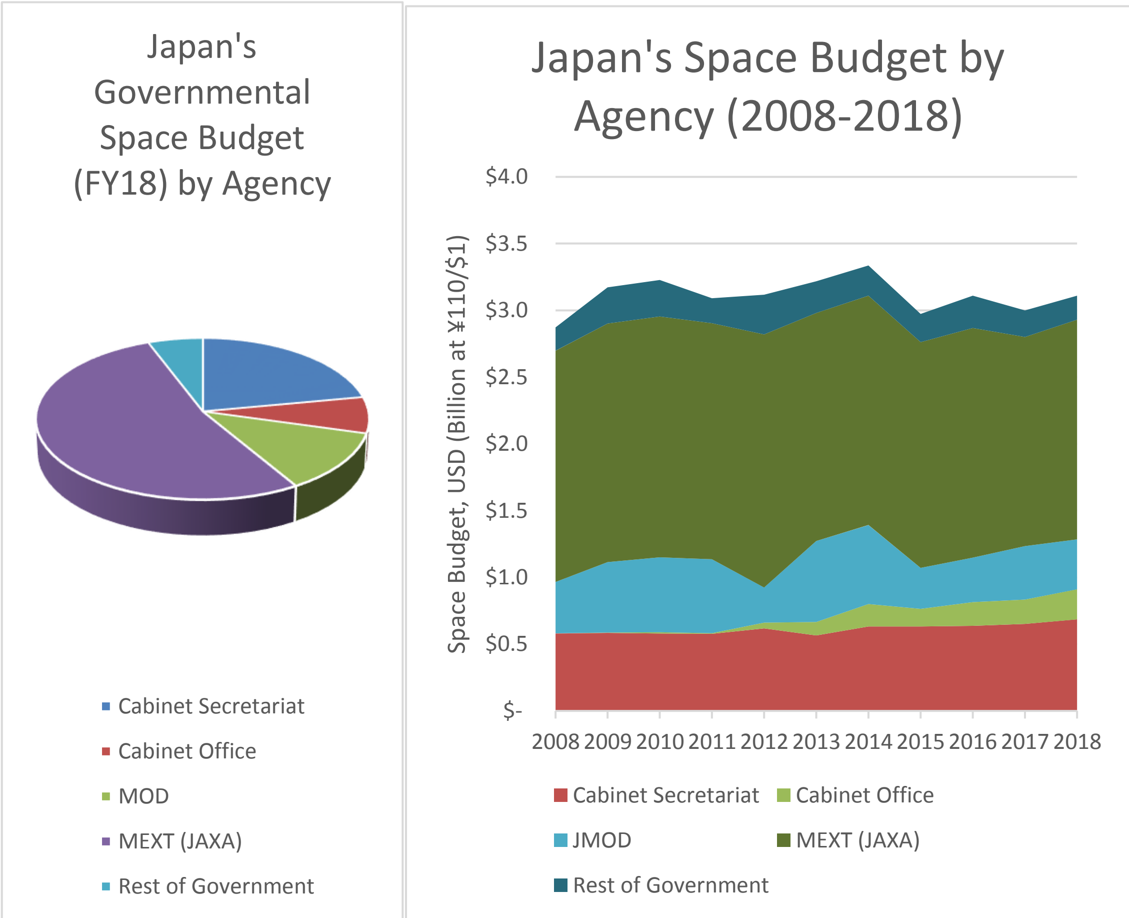

Figure 1. ***Japanese Government Spending on Space.*** *Japan's government spending on space has steadily increased from ¥300B in 2009 to about ¥340B in 2018, with about half going to JAXA's predominantly civil space applications and ~40% being expended by the Cabinet and the Ministry of Defense for national security purposes.*[18]

The relatively small budget is also spread across several different agencies and ministries meaning that national security mission capabilities are spread across several organizations and agencies (see **Table 2**). As use of space for national security missions intensifies, consolidation of capabilities within one ministry or agency could occur—to prompt growth of expertise, cost-savings or synergistic integration of missions. Even as the U.S. contemplates standing up a new military branch for the outer space domain, few Japanese interview subjects or government officials expressed enthusiasm to merge Japanese capabilities under one management structure or create a new organizations within the Defense Ministry to oversee Japan's space assets in the near term.

Constellation Purpose	Managing Ministry

(Japanese Satellite Name)	
Positioning, Navigation and Timing *(Quasi-Zenith Satellite System)*	Cabinet Office
Electro-Optical Imagery *(Information Gathering Satellites)*	Cabinet Secretariat
Synthetic Aperture Radar Imagery *(Information Gathering Satellites)*	Cabinet Secretariat
Synthetic Aperture Radar Imagery *(ALOS-2)*	JAXA
Weather Satellite *(Himawari Satellites)*	Japanese Meteorological Agency
Military Communications Satellites *(Kirameki)*	Ministry of Defense

Table 2. ***Major Japanese Satellite Constellations.*** *The major pillars of Japan's national security mission-capable satellites are spread across several different ministry's and agencies. The development of this posture owes more to budgetary constraints and compromises than a concerted strategic plan. Continued development of satellite constellations necessary for MOD missions outside of the MOD could threaten the MOD's ability to exploit space-derived intelligence information in a timely fashion. Deep interoperability and integration of MOD personnel in other ministries, however, could help mitigate this threat.*

While Japanese strategists were gaining a new appreciation for the role of space in the defense of Japan over the past decade, Tokyo's position on broader defense issues was also broadening. Not only was the Self Defense Force (SDF) being called on to perform new missions in the area around Japan—like deterring gray zone challenges in the Senkaku archipelago—but Tokyo was taking a more active role outside of East Asia by providing forces for counterpiracy operations. Senior civilian and military leaders in Tokyo now accept the centrality and importance of the space domain and understand that, while the required quantity and quality of space services would vary according to the operation, Tokyo's ability to confront its diverse security issues depends on Japan's continued access to space services.

For example, counterpiracy activities in East Africa almost certainly will require positioning, navigation and timing (PNT) data and communications links between Japanese Maritime Self Defense Forces (JMSDF) forces and the Ministry of Defense in Tokyo. Furthermore, periodic updates of intelligence, surveillance and reconnaissance (ISR) data generated on orbit and passed to JMSDF assets via satellite communications links, will also enhance Japan's counterpiracy capabilities. The data requirements for counter-piracy missions, although robust, pale in comparison to armed conflict against a near-peer competitor.

High-intensity confrontations with China, on the other hand, almost certainly will see attempts by Beijing to jam, interrupt or degrade Japanese space services. A conventional military confrontations probably would occur in the seas or skies hundreds of kilometers from major U.S. and Japanese military bases and communicating between allied military units almost certainly will require the use of satellites. Moreover the use of precision-guided munitions (PGM) to strike Chinese targets almost certainly will require satellite-provided PNT data from GPS or a similar constellation. Furthermore, targeting data—and timely updates of target location and movement—will also almost certainly require a robust ISR posture. If the confrontation escalates to the point that American or Japanese ballistic missile defenses (BMD) become necessary then Beijing can be expected to attempt to degrade any space-based assets that contribute to allied missile defenses. Beijing almost certainly has a similar, pronounced reliance on space services for finding, targeting and attacking U.S. and Japanese targets and Chinese military thinkers often indicate the centrality of space in waging "local wars under conditions of informatization."[19]

As both Chinese and allied forces would rely on space for prosecuting a future conflict, a natural space strategy centers on ensuring continued access to space services while possibly degrading or denying the adversary's use of space. The next section will examine several different analytic frameworks for anchoring a future space strategy. Alliance agreement on—or at least common understanding of—a space strategy is critical to establishing a cooperative framework.

Applying the Deterrence Toolkit to Space

"The power to hurt is bargaining power. To exploit it is diplomacy…"

-Thomas Schelling

The velocity necessary to reach orbit means that satellites and other space objects—like debris from past collisions or stray rocket bodies—are moving at dangerous speeds. Objects in low-Earth orbit (LEO), for example, travel more than 15,000 miles per hour and impacts can be catastrophic at such speeds. Armoring satellites against objects larger than a golf ball probably is cost prohibitive.[§]

Maneuvering away from a potential kinetic impact is another protective strategy, but depends on advance warnings from a robust SSA network and sufficient fuel for evasive maneuvers. While collisions with other satellites and known pieces of debris could be calculated well in advance, a satellite attempting to avoid an ASAT weapon's impact would need constant data updates and larger fuel reserves as the systems react to one another's tactics. Similarly, protecting satellites against other types of attack, like directed energy weapons or nuclear weapons, presents enormous costs and engineering complications.

If protecting individual satellites is prohibitively expensive (or technically challenging) and other defensive schemes offer only limited protection, then attempts to deter aggression against satellites appears the best strategy for preserving US and Japanese space assets. Deterrence strategies are usually broken into two major divisions: deterrence by punishment and deterrence by denial.

At the outset, some caution and caveats should be highlighted. Deterrence is aimed at constraining adversaries; it is intended to prevent an adversary from taking specific actions.[**] While there is cause for optimism that a robust deterrence posture can prevent attacks against allied satellites in some cases—namely political-military crises and low-intensity conflicts—Beijing and Moscow almost certainly will seek to destroy critical space assets if a conflict escalates into high-intensity direct conflict.[††]

Deterring an Adversary from Striking Space Assets by Threatening Punishment

Deterrence by punishment is intuitive to most people; many have personal experience with the strategy, owing to common parenting technique of threatening punishment (e.g. being grounded for a certain period of time) if some behavioral norm is breached (e.g. staying out past curfew). Formalized, deterrence by punishment strategy threatens to impose costs that outstrip the perceived benefit the aggressor hopes to gain. In the case of a deterrence by punishment strategy for space,

---

[§] The kinetic energy released from a golf-ball sized (50g) object with a collision velocity of 10 km/s impacting a satellite is equivalent roughly to the detonation of two sticks of dynamite.

[**] There is a separate conceptual framework built around the forcing a target to take specific actions. This related, but distinct, concept is "coercion."

[††] For additional information on Chinese and Russian investments in counterspace capabilities and emerging capabilities, please see: Director of National Intelligence, "Worldwide Threat Assessment of the US Intelligence Community," 13 February 2018, https://www.dni.gov/files/documents/Newsroom/Testimonies/2018-ATA---Unclassified-SSCI.pdf

we find that while the goal is clear—stopping an adversary from striking space assets—but the implementation is difficult.

Deterring attacks against space assets with a deterrence by punishment strategy depends on threatening punishment and imposing a cost that is prompt and proportional. For the sake of clarity we will examine the punishment deterrence strategy in two parts: first, we will examine options of punishing an adversary in the space domain and we will then evaluate cross-domain deterrence by punishment strategies.

Deterring an Adversary in Space by Threating In-Domain Punishment

U.S. and Japanese space capabilities currently outstrip those of our potential adversaries. Similarly, U.S. and Japanese conventional forces almost certainly will be more dependent on space services than potential adversaries because in the most likely conflict scenarios allied forces are operating in territory closer to the adversaries' home territories than the continental U.S. or Japanese home islands. This relative asymmetry in total assets and usage of satellites means that finding a proportional and costly punishment strategy against Chinese or Russian satellites is difficult. Tokyo and Washington could choose to deter an attack by adopting a tit-for-tat punishment (i.e. destroying or disabling the same types of satellite(s) that were lost to aggression in the initial attack) or they can adopt a punishment posture that focuses on capability lost (i.e. denying adversary use of the space-based service lost to aggression in the initial attack).

A deterrence by punishment strategy that relies on threatening tit-for-tat punishment and appears to mirror the initial strike—for example, threatening an enemy's communications constellation to deter attacks against friendly communications satellites—seems proportional at first blush. Such strikes, however, almost certainly will not have the same effect on Beijing or Moscow's battle plans as it will to U.S. and Japanese forces; adversary forces are likely to be operating close to home and as such are not as dependent on space-based services for battlefield management or command and control functions. The asymmetry in stakes in the space domain undermines the utility of tit-for-tat punishment in the space domain because a rational adversary would willingly trade their marginally useful satellites for allied satellites that form the backbone of U.S. and Japanese military operations.

Another option, therefore, is to focus on the lost capability. Rather than exchanging tit-for-tat attacks against communications satellite, Tokyo and Washington could threaten to strike different classes of satellites in response to ASAT strikes in order to impose much greater costs on the aggressor that are commensurate with the loss of allied warfighting power. For example, enemy attacks against U.S. or Japanese military communications satellites in a conflict around the Senkakus would degrade allied military operations dramatically, but similar attacks against Chinese military communications satellites would not produce the same effect since Chinese aircraft and naval vessels would be operating within radio range of the Chinese mainland. Striking Chinese ISR satellites, on the other hand, could dramatically degrade Beijing's ability to locate and target high-value U.S. or Japanese ships and could have a larger deterrent effect on Chinese policymaker's decisions during a crisis. This stance and focus on a larger, more proportionally relevant target set, however, runs a paradoxically greater risk of disproportionality and potential escalation instability. Whereas allied forces perceive the punishment was a proportional demonstration of resolve because their conventional forces were hobbled by the adversary strikes on communications satellites, the Chinese could perceive a dramatic escalation because their ISR satellites may also be used to monitor U.S. strategic nuclear readiness levels.

Threatening Cross-Domain Punishment to Deter Attacks in Space

If a deterrence by punishment strategy is difficult to implement within the space domain because of challenges associated with determining which adversary space asset should be threatened as part of a proportional, deterrence by punishment strategy, then a similar dynamic is at play in building a cross-domain deterrence by punishment strategy. Chinese or Russian planners will seek to strike friendly satellites to hamstring allied military operations. If the ASAT campaign met its objectives, allied forces would have difficulty conducting traditional, conventional military operations; a proportional cross-domain response could then be kinetic attacks that similarly paralyze Chinese or Russian forces. A Japanese or U.S. cross-domain punishment strike might kill dozens or hundreds of Chinese or Russian military personnel to have a similarly deleterious effect on Chinese or Russian war potential, whereas the enemy's ASAT strike did not take any human lives. Although one could argue both operations resulted in similar degradations of military warfighting potential, perceptions regarding what was, and was not, proportional would be difficult and the dynamic almost certainly would be ripe for additional escalation. Appropriate signaling in a cross-domain deterrence strategy in which both sides have decades of experience operating in the domains is often complicated; inclusion of a new domain in which neither side has similar operational experience almost certainly will increase uncertainty and raise the risk of additional miscues.

Applying the Deterrence by Denial Approach

Many of the key tenets of the deterrence by punishment school focus on questions of proportionality and escalation. Addressing such questions in regards to a new domain is even more difficult because of the lack of empirical data about bargaining in past crises. An alternative deterrence strategy, however, may offer some key advantages in the space domain over the punishment school by sidestepping some of the uncertainty associated with punishment's proportionality and escalation concerns. This alternative approach is deterrence by denial.

The key difference between the punishment and denial posture hinges on what aspect of the attacker's cost/benefit calculation the defenders' actions are aimed. When the formalization of deterrence theory was introduced in the 1960s,[20] punishment strategies focused on imposing costs that outstripped the potential benefits gained by the attack; the hope was that by increasing costs the benefits looked much less appealing. While punishment can be meted out during the initial aggression, punishment could occur at a time and place of defender's choosing. Such a posture, however, can lack credibility if the aggressor believes it can deliver a fait accompli. In other words, if the punishment is not automatic it can sometimes drive crisis instability.

A denial strategy, on the other hand, seeks to impose some costs at the time and place of the aggression, but it mainly seeks to deny the adversary the benefits of their attack. This strategy runs counter to the punishment strategy because it seeks to reduce the benefits, rather than increase the enemy's costs. A denial strategy aims to deter aggression by operating on the other side of the cost/benefit calculation and is effective against enemies who appear insensitive to costs and accepting of risk when the perceived benefit is large. Deterrence by denial, in other words, does not require a well-calibrated sensitivity analysis of the adversary's trade-off calculations between costs and benefits, but rather the ability to convince an adversary that the desired benefit will be denied.

Applied specifically to the space domain, a deterrence by denial strategy seeks to negate benefits the adversary believe they obtain by attacking space assets. Put simply the deterrence by denial posture seeks to convince Beijing and Moscow that counterspace attacks intended to vitiate U.S. or Japanese military forces will fail. In order to have a successful deterrence campaign, Chinese or Russian policymakers need to be convinced that allied constellations have inherent resiliency, an ability to regenerate themselves quickly or the allies have credible alternatives in other domains for space-based military missions. This paper is not intended to discuss terrestrial or airborne substitutes to space-based services so we will turn to the topic of resiliency and regeneration on which deterrence by denial strategies hinge.

Resilience and Regeneration

The goal of most attacks on allied space assets would be the degradation of space-based services. The C_3ISR data flows from these satellites are the foundation of allied conventional military dominance and potential enemies, like China and Russia, would seek to deny this advantage to the allies. In order to deny the attacker the benefit of these strikes—and deter the strikes—the data must continue to flow in the face of a counterspace operation. Building a more resilient space architecture helps to achieve this goal.

In the face of concerted attempts to destroy or deny access to space assets, the best case for U.S.

and Japanese armed forces would be the graceful degradation of space services. The best concept for ensuring this controlled decline in satellite operations is resiliency. In a September 2015 the Office of the Assistant Secretary of Defense for Homeland Defense & Global Security released a White Paper, "Space Domain Mission Assurance: A Resilience Taxonomy," that offered a framework for thinking through the problem of resiliency and offered six categories could be used to build resilience.[21] (see **Table 3**).

Diversification	Accomplish the mission via multiple different ways (orbits, constellations, satellites), ensuring the mission continues despite the loss of one category of asset
Disaggregation	Separate capabilities on separate satellites; does not directly enhance resilience but empowers other resilience activities
Distribution	Many nodes contribute to the mission, ensuring that the mission continues with the loss of one (or more) satellites
Protection	Active and passive schemes to harden satellites against loss and/or enemy attack
Proliferation	Large numbers of the same satellite or payload to execute the mission so that the loss of one or more systems does not endanger the mission
Deception	Confusing the enemy regarding the location, identity and/or mission of satellites or payloads

Table 3. ***Brief Summary of Resiliency Concepts.*** *The major tenets of resiliency presented in the U.S. White Paper are summarized here.*

Rapid regeneration of space assets in case of attack is another critical capability for a deterrence by denial strategy. (see **Table** 4) If satellites lost in an initial attack can be replaced quickly then the benefit the enemy gained is limited. The most obvious way to adopt a regenerative posture is construct several spare satellites while planning a constellation. These reserve satellites can be mated to space launch vehicles in times of crisis and made ready for launch. Ideally, the launch vehicles will be able to launch from a variety of small launch sites—eliminating the enemy's incentives to strike large, known spaceports—with minimal preparation time and small crews. Current capabilities for such a regenerative posture, however, are far from the ideal. Designing and building space launch vehicles that can be reliably quick-launched from a variety of locations continues to confound space agencies and aerospace firms. Furthermore, creating spare satellites and keeping them on the ground and ready to launch is a large investment that is economical in only a small handful of business cases.[‡‡]

Regeneration, however, need not only be dependent on launches of satellites. Another strategy for regeneration is to have the replacement satellites already on orbit in stand-by mode and waiting in a nearby orbit. In case of attack, satellites can be activated and moved from nearby parking orbits into the correct orbital parameters to accomplish the mission. This solution almost certainly regenerates the constellation more quickly than launching replacements from the ground, but it potentially exposes the reserves to the same initial attacks that destroyed or degraded the constellation.

Another regeneration strategy would be to build flexibility into families of satellites, allowing them to adapt and adopt missions in the face of attacks. This regeneration measure is an extension of the Diversification resiliency tenet and uses the potential of the software-enabled hardware revolution—like breakthroughs in software-enabled radios—by building satellites that can chimerically pivot away from primary missions to replace capabilities lost in a conflict. There are some obvious caveats to this posture, namely a communications satellite cannot become an electro-optical ISR satellite regardless of the flexibility of the engineering; the potential for one communications satellite to replace another related satellite communications satellite, however, is attainable. Similarly, software-enabled hardware could also provide the ability to present new or unexpected configurations to confound jamming attacks if policymakers make adequate investments in the enabling R&D. Not only would this ability give allies the ability to regenerate some lost services, an enemy would be unable to predict which satellites have the ability to backfill the targeted mission growing the potential target set to (perhaps) unmanageable numbers.

	Pro	Con
Regeneration via Responsive Launch	Reserves are secure from enemy attack prior to launch	Expensive; Potentially limited to a handful of launch sites

[‡‡] Apart from the deterrence value, some commercial companies will set aside a few spare satellites when launching a new fleet of satellites. The spares can be used as experimental testbeds to study anomalies that arise on the orbiting satellites or can be launched to replace malfunctioning satellites, after requisite fixes have been made.

Regeneration via On-Orbit Replacement	Timely replacement; Extra satellites can be used for other purposes	Reserves are vulnerable to attack before beginning their mission
Regeneration via System Flexibility	Offers regenerative ability with relatively low costs; Presents enemy with large target list	Pivot is limited to similar satellites (comms cannot regenerate ISR missions)

Table 4. ***Comparing the Pros and Cons of Different Regeneration Concepts.*** *The different strategies for regeneration are summarized in this table. Although responsive launch offers the most secure regenerative ability, it almost certainly is also the most costly to pursue. It also relies on existing launch sites, which are potential chokepoints, or the development of a new space launch vehicle that can be launched reliably from other sites. On-orbit spares are arguably cheaper than on-ground sparing—because they can be utilized for purposes other than purely a deterrent—but are more vulnerable to enemy action limiting their deterrent value. System flexibility offers the most affordable regenerative option, but is not a panacea.*

Advancing the Alliance into the Final Frontier

The U.S. Defense Department in January 2017 published their strategy for cooperating with allies in space. The strategy, "DOD International Space Cooperation Strategy," outlined three major purposes for tightening the alliance network in the space domain: a) enhance deterrence by demonstrating a U.S.-Allied combined approach to space security; b) assist allies in developing space capabilities that augment and complement U.S. capabilities, and; c) enhance interoperability and develop a common operational framework to dissuade and deter adversaries or, in case of a failure to deter, prevail.[22] One could argue that underlying all three of the International Space Cooperation Strategy (ISCS) goals was an attempt to enhance resiliency by developing redundant capabilities that could be used by the U.S. and allies alike in the event of attack on space assets.

The first step of the ISCS—enhancing deterrence by showing a combined approach to space security—must be accomplished before joint development of space capabilities or interoperability can tackled. This paper argues that deterrence by denial is best strategy for protecting U.S. and Japanese space assets and the strategy can be implemented by adopting a doctrine that emphasizes resilience and regeneration. A commitment from Tokyo and Washington to work together to strengthen resilience and regeneration provides the "combined policy approach" and roadmap for future cooperation. While national level policy documents, like the Trump Administration's National Security Strategy and Japan's latest National Defense Policy Guidelines, provide the proper backdrop in which to formalize and regiment future cooperation, they almost certainly are insufficient to meet the ISCS "combined policy approach" requirement. Mid-to-senior officials in the MOD and DOD must be tasked to produce joint declarations and statements regarding the role of space in the alliance and the importance of resiliency and regeneration; this document, for example, must clarify that attacks in space against Japan would trigger the treaty's Article V requirements.[23§§] Furthermore, enhancing resilience and regeneration—vice a more offensive or aggressive space posture—will not raise diplomatic or legal hurdles for either the U.S. or Japan allowing full-throated support from policymakers on both sides of the Pacific.

Once this policy foundation is established, in depth discussions on joint development of space capabilities can occur. As noted in the ISCS, Washington will advocate for the development of Japanese capabilities that "augment and complement U.S. capabilities," but one would expect Tokyo to argue for the development of U.S. assets that augment and complement Japan's capabilities as well. There are already several avenues of emerging cooperation that have been publicly broached and discussed. For example, Japan's ongoing development of optical and radar SSA capabilities—in central and western Japan, respectively—as well as future research interest in optical space-based SSA systems could serve to strengthen existing U.S. investments in SSA abilities. Similarly, sharing of U.S. ground stations—or real estate at U.S. ground stations for more independent SDF operations—would allow Japan to expand its global footprint and begin robust 24/7 satellite operations in an expedited manner. Japanese moves to ruggedize signals from QZSS and develop military-grade receivers could augment and diversify Washington and Tokyo's reliance on GPS constellation for PNT missions. Additionally, such a move would also present Tokyo and Washington a handy testcase for "enhancing interoperability," because U.S. and Japanese forces would need to develop dual-capability PNT receivers for GPS and QZSS. The development for dual-capable PNT receivers would also be an opportunity for joint R&D.

Other possibilities exist for the third step—"enhancing interoperability"—also exist. Some Japanese government officials have proposed an initiative to install Japanese-flagged payloads on U.S. satellites or American payloads on Japanese satellites; this idea often is discussed in shorthand as co-hosted payloads. The co-hosting proposal faces some stiff obstacles, including bureaucratic, legal and process-related hurdles, but also has the potential for enhancing the collective deterrence by denial posture. Not only would co-hosting allow for Japan and the U.S. to launch more sensors and payloads in a cost-effective manner—meeting the proliferation tenet of resiliency—but adversaries would need to contend with the possibility that an attack meant to erode only Japanese or U.S.

[§§] Article V of the 1960 Treaty of Mutual Cooperation and Security between the United States of American and Japan states, "Each Party recognizes that an armed attack against either Party in the territories under the administration of Japan would be dangerous to its own peace and safety and declares that it would act to meet the common danger in accordance with its constitutional provisions and processes." Applicability of the security guarantee to other areas, like outer space and the Senkaku Islands, have been questioned by some independent observers; U.S. policymakers have repeatedly stipulated the treaty extends to Senkaku Islands capabilities would now be seen as a potential casus belli against both nations.

As cooperation under the U.S.-Japan alliance framework matures in the new domain, Tokyo and Washington can begin thinking about additional steps to strengthen the allied posture in the space domain. Although the sharing of ISR data generated by government-owned satellites will never be seamless, careful consultations almost certainly can reduce the bureaucratic and diplomatic friction associated with passing data and would be a natural next step.

Japan could also consider the "forward deployment" of a handful of launch vehicles and reserve satellites at U.S. launch sites to meet regenerative requirements during a crisis or conflict. As previously discussed, the costs associated with this strategy are high, but adversaries probably would perceive it as a powerful signal that the U.S. and Japan were deepening their strategic trust and cooperation in the space domain. Furthermore, incentives for an adversary, like China, to deny Japan access to orbit by attacking Japan's launch sites would be dramatically reduced if Japan could reconstitute its constellations from Cape Canaveral or Vandenberg.

Finally, the strategic geography of Japan is an irreplaceable asset for ground stations but this logic applies to space situational awareness and ASAT operations too. Japan's longitude straddles the first- and second-island chain in the Pacific and thus Tokyo is well-suited to conduct ground-based ASAT operations against any satellites that have just begun or finished their ISR missions over those island chains. Although Japan has not yet formulated a policy on anti-satellite missions, should Tokyo open the door to anti-satellite weapons it would provide a ripe opportunity for staging and deploying such weapons.

Many of these cooperative proposals will require large investments of diplomatic and military time and effort. Indeed, some may be too difficult for the alliance to tackle in the next decade. Discussions about goals and cooperative work, however, is an incredibly important step forward in shoring up the alliance's deterrence posture in outer space. Furthermore, agreements to move forward jointly on some aspects of a national security agenda will set the stage for additional work and send a powerful signal to potential adversaries that Japanese and American policymakers are united in their view to deter aggression in space and, barring that, are positioned to persevere and win future space wars.

---

[1] Powell, Thomas, et al, "America's critical dependence on satellite-based services-and the regulatory threats they face," 25 January 2018, https://spacenews.com/op-ed-americas-critical-dependence-on-satellite-based-services-and-the-regulatory-threats-they-face/

[2] Logsdon, David, "A Day Without Space," 6 June 2016,

http://www.spacenewsmag.com/commentary/a-day-without-space/

[3] Dvorsky, George, “What would happen if all our satellites were suddenly destroyed?” 4 June 2015, https://io9.gizmodo.com/what-would-happen-if-all-our-satellites-were-suddenly-d-1709006681

[4] Hollingham, Richad, “What would happen if all satellites stopped working?,” 10 June 2013, http://www.bbc.com/future/story/20130609-the-day-without-satellites

[5] Friedman, George and Meredith, “The Future of War: Power Technology and American World Dominance in the Twenty-First Century,” (1998)

[6] Rose, Frank, “Using Diplomacy to Advance the Long-Term Sustainability and Security of the Outer Space Environment,” 3 March 2016, Assistant Security of State for the Bureau of Arms Control, Verification and Compliance Remarks at International Symposium on Ensuring Stable Use of Outer Space: Enhancing Space Security and Resiliency, https://2009-2017.state.gov/t/avc/rls/253947.htm

[7] “National Security Space Strategy Unclassified Summary,” January 2011, https://www.hsdl.org/mwg-internal/de5fs23hu73ds/progress?id=emq8o-yEbHYYuaHjiqV1iy3IKmRC9zGDnb1r7MvtUR0,&dl

[8] “National Security Strategy of the United States of America,” December 2017, https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf

[9] “National Defense Program Guidelines for FY2014 and beyond,” 13 December 2013, http://www.mod.go.jp/j/approach/agenda/guideline/2014/pdf/20131217_e2.pdf

[10] “National Defense Program Guidelines for FY2019 and beyond,” 18 December 2018, http://www.mod.go.jp/j/approach/agenda/guideline/2019/pdf/20181218_e.pdf

[11] “DoD International Space Cooperation Strategy,” January 2017, www.dtic.mil/dtic/tr/fulltext/u2/1034871.pdf

[12] Winston Churchill, “The Gathering Storm,” 1948

[13] Hanlon, Michael, “Neither Star Wars Nor Sanctuary: Constraining the Military Uses of Space,” 2004

[14] “National Security Space Strategy Unclassified Summary,” January 2011, https://www.hsdl.org/mwg-internal/de5fs23hu73ds/progress?id=emq8o-yEbHYYuaHjiqV1iy3IKmRC9zGDnb1r7MvtUR0,&dl

[15] Author Interviews with Japanese Academics, Policymakers and Defense Officials, Aug-Dec 2018

[16] Japan, Basic Space Law (Law No.43 of 2008), Enacted on 21 May 2008 and Effective as from 27 August 2008, Article 16 & 18

[17] Cabinet Satellite Intelligence Center, “情報収集衛星に係る平成３１年度概算要求について,” Fiscal Year Request Pertaining to Information Gathering Satellites, https://www8.cao.go.jp/space/comittee/27-anpo/anpo-dai29/siryou1-2.pdf, 20 September 2018

[18] Cabinet Office of Japan, “内閣府宇宙開発戦略推進事務局/Cabinet Office’s Space Development Strategy Promotion Office,”平成３０年度　概算要求. FY18 Budget, http://www8.cao.go.jp/space/budget/h29/fy30gaisan.pdf

[19] The Diplomat, "No Surprises on China Military," 20 May 2012, https://thediplomat.com/2012/05/no-surprises-on-china-military/

[20] Glenn Snyder, Deterrence and Defense: Toward a Theory of National Security (Princeton, N.J.: Princeton Univ. Press, 1961), 14-16.

[21] Office of the Assistance Secretary of Defense for Homeland Defense & Global Security, "Space Domain Mission Assurance: A Resilience Taxonomy," September 2015

[22] U.S. Department of Defense, "Unclassified Department of Defense International Space Cooperation Strategy," January 2017. Released via memo 25 May 2017.

[23] TREATY OF MUTUAL COOPERATION AND SECURITY BETWEEN JAPAN AND THE UNITED STATES OF AMERICA, January 1960, https://www.mofa.go.jp/region/n-america/us/q&a/ref/1.html