Atlantic Council

STRATEGY PAPERS

Toward a New National Security Space Strategy

Time for a Strategic Rebalancing

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Toward a New National Security Space Strategy: Time for a Strategic Rebalancing

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Cover art credit: The Starry Night by Vincent van Gogh, ca. June 1889.

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Atlantic Council Strategy Papers Editorial Board

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Foreword

Space was once called the "final frontier." Today, it is a domain that is integral to all parts of human activity on the planet from commerce and entertainment to navigation and defense. As a result, secure and stable access to space is a key component of our everyday lives. Even though we may not appreciate it, access to and the use of space is a vital national interest.

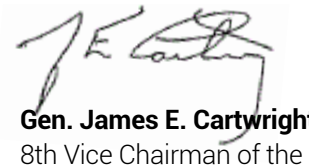
Increased access to space has made space less stable and secure. As Russia and China augment their space capabilities and the private-sector continues to alter how we get to and operate in space, the domain is now famously "congested, contested, and competitive." The barriers to entry in space are lower, and the benefits offered, greater than they have ever been. Thus, the question now becomes: How does the United States ensure space remains a stable and secure environment as part of the global commons, while being a reliable place to explore and expand human operations on Earth?

The authors of this fifth *Atlantic Council Strategy Paper* believe the United States needs to conduct a "strategic rebalance" in space. In their mind, the United States, along with government allies, partners and non-governmental space actors, should put an "emphasis on strategic restraint in the near term, as well as a continued focus on diplomacy" in addition to norms, rules, and frameworks for space conduct. The days of "space dominance" are over and we need to move from thinking of space as a military domain of offense and defense to a more complex environment that needs to be managed by a wide range of international players. Doing so would calm growing tensions in space and, with deft management, lead to a more stable, peaceful space domain.

This is the right time to reconsider our actions in space, as a new presidential administration takes over in January 2017. As technologies further improve the world's ability to access and operate in space, the new administration will need to rethink how the United States wants to act alongside its fellow nations. In addition, the exciting developments in the private sector will only continue to shape and evolve the space domain to the point that consistent strategic decisions will be required. This *Atlantic Council Strategy Paper* does a great job initiating this important conversation at a very important time.

Whether you agree with all the elements of this paper or not, I believe this is an important discussion to have, particularly as we approach a new presidency. The paper was successful in

its mission: it projected a future space environment; challenged assumptions; set boundaries for America; identified strategic priorities; and looked for ways to measure the strategy's success. All of its elements are fodder for broader debate about our strategy for space defense. In the end, the success of this paper will lie in whether or not it stimulated the right kind of strategic thinking within the public- and private-sectors. I believe it will do just that and lead us to a state where the "final frontier" becomes a safe space.



Gen. James E. Cartwright, USMC (Ret.)
8th Vice Chairman of the Joint Chiefs of Staff

Executive Summary

INTRODUCTION

The administration of President Barack Obama issued a National Space Policy (NSP) in 2010. The first-ever National Security Space Strategy (NSSS) was later issued in 2011. With the NSP and the NSSS, the Obama administration redirected the United States toward a more cooperative, civilian, and commercial-oriented program overall, and a more traditional space security strategy of "strategic restraint." That is, under Obama, the United States would once again restrain itself from introducing offensive capabilities in hopes of moderating the behavior of both friends and potential foes.

Until 2013, US national security space policy pursued "strategic restraint" in a multi-tiered manner, through diplomatic channels at the multilateral and bilateral levels, public diplomacy that eschewed saber rattling, and discrete budgetary investment in dual-use space technologies, with an emphasis on those that provided better space situational awareness (SSA, the ability to see and understand the orbital environment).

However, the consensus on this approach began to unravel in May 2013, when China launched what it claimed was a science mission that nearly reached geostationary orbit (GEO, some 36,000 kilometers above the Earth). US satellite operators formerly considered this important orbital altitude a sanctuary, free from major threats. The Chinese test, coming on the heels of both Russia and China testing maneuverable satellites in low Earth orbit—a capability that, until recently, had been demonstrated only by the United States—led to something of a "quiet panic" within the US national space security community. This renewed threat perception, and the renewed fear about the "inevitability" of space war, was elevated all the way to President Obama (which is somewhat rare in the space strategy world), triggering a summer 2014 National Security Council-led Strategic Portfolio Review.

Consequent to that exercise, changes in force posture, development programs, and budgets have been initiated to forge a more muscular national security space strategy. This includes reconsideration and reprioritization of several key elements: defense against the anticipated use of offensive counterspace capabilities against US satellites; the value of space diplomacy; and the future requirement of US weapons to defeat adversary satellites, providing the same advantage to adversary military forces as US satellites do today. Defense against counterspace capabilities has taken on a top priority, followed by in order, a diminished view of space diplomacy, and an increased interest in offensive capabilities. In particular, the increased threat

perception was accompanied by more aggressive public diplomacy by the Pentagon and US Air Force, aimed at making it very clear that the United States would respond to threats in space with the use of force—with rhetoric slipping back toward the "dominance and control" motif of the Bush administration's space policy.

Clearly, there are growing risks and threats to US satellites, civilian and military alike, and challenges to stated US goals in space. The question for the new administration, however, is whether hegemonic means to address those challenges are likely to achieve US goals. It is this paper's assertion that they are not. Instead, a rebalancing of means used to address US goals in space is now necessary, based on a comprehensive assessment of the strategic space environment through the next ten to twenty years, toward ensuring that the ways and means being pursued to address those goals are in alignment. This assessment must extend beyond the Pentagon as well, to include the rapidly expanding cast of governmental and nongovernmental space actors. In particular, industry representatives should be brought into a process of dialogue with the national space security community to discuss priorities and concerns.

Such a rebalancing would require a continued emphasis on strategic restraint in the very near term, as well as a continued focus on diplomacy. The best-case scenario would be for the United States to convince others, particularly China and Russia, to similarly take a step back and re-evaluate their own goals—something that is only going to happen through improved dialogue and/or "signaling." However, this may not be feasible at the current moment, due to the lack of dialogue and the high level of geostrategic tensions. Even without a reciprocal move on the part of the two near-peer competitors in space, however, the United States will benefit internally by taking the time to seriously reassess its space security house, potentially including consideration of the structures and organizational charts dictating who is in charge.

Indeed, the point is to reassess whether US goals in space are feasible and reasonable in a changing environment, and to develop a strategy that ensures the ways and means to achieve them. If the current US goals remain relevant and viable, as the authors believe they do, then a national security space strategy must be premised on prevention—both of space warfare in general, and of attacks on US space assets—rather than on the concept that "the best defense is a good offense."

Therefore, it is this paper's intent to offer an initial strategic assessment, based on a review of goals, ways, and means, as bounded by the strategic environment and budget considerations, to demonstrate the rationale for a rebalancing. A new, alternative approach we call "proactive prevention" is then offered, based on goal achievement and viability. We offer it as a catalyst and starting point for grounded discussions on space security policy for the next administration.

A focus on "proactive prevention" would gain the United States several strategic advantages. It would:

1. Provide a chance to stop activities and actions that would degrade the space environment, and consequently impair the beneficial uses of space by all, through development of norms and rules that establish the lines between acceptable and unacceptable behaviors;

2. Create space to establish better dialogue, with Russia and China in particular, about US "bright lines" in space, and mutual assurance measures that would reduce risks of misconception and conflict, as well as establish "breakers" to dangerous conflict escalation;

3. Avoid the opportunity costs that an arms race in space would engender;

4. Buy time (and resources, per avoiding opportunity costs) for private industry, which is in the middle of a renaissance, to develop low-cost solutions to space resiliency that can help the US national security space community get out of the situation of having space be a potential single-point failure in a conflict, as well as complicate an attacker's abilities to degrade or defeat the advantages provided to the US military by space assets;

5. Allow the US Air Force and intelligence community to figure out protection strategies and technologies for those space assets that will be more difficult to commercialize, otherwise disaggregate, or offload missions from; and,

6. Allow the US government and industry the time and budgetary leeway to develop next-generation technologies that might keep a leading edge in space, both for commercial benefits and military hedging or advantage.

A proactive preventative strategy—that is, a strategy aimed squarely at preventing a space conflict, while also preparing to win one if need be—presupposes establishing strategic restraint by all, and must be based upon a clear understanding of potential adversaries' goals in space, not simply their capabilities.

ESTABLISHING WAYS AND MEANS

Diplomacy First

The need for the United States to engage in meaningful space security dialogue with Russia, and especially China, cannot be overstated. In particular, US-China dialogue has been weak and scattershot, with blame on both sides for a lack of transparency. This makes paramount the use of signaling regarding US "bright lines"—that is, actions by potential adversaries that will provoke negative US responses, military or otherwise. Again, while the geopolitical barriers

to dialogue are currently high, the United States must continue to press for such dialogue and leave the door open for any and all diplomatic possibilities, including finding ways to insert the space security conversation into other aspects of bilateral diplomacy.

Though bilateral diplomacy with Russia and China is a critical and immediate need if a preventative strategy is to be successful, elucidation and agreement on multilateral norms or space activities also become paramount, as the way to implement such a strategy. While there is a widespread international consensus that norms of behavior in space are required, multilateral progress toward development of such norms has been stymied in recent years, largely due to geopolitical tensions between Russia and the West over Russian military actions in Ukraine and Syria.

Technology Next

Obviously, diplomacy must be underpinned by technological capabilities, both for deterrence and for hedging against threat breakout. Under a preventative strategy, technological focus would necessarily be put on understanding the environment and deterrence-by-denial capabilities, as well as cooperative opportunities for mutually beneficial activities, such as cleaning up space debris. Although hedging activities should also be a component of technology development, they should be a secondary priority. Importantly, technologies to execute "deterrence by punishment"—that is, systems aimed at ensuring the price paid by an opponent will be greater than the advantages gained by an attack (the underpinning of "mutually assured destruction" in the nuclear domain)—can, and should, be carefully considered and pursued, but with a transparent intention of "use of last resort." With regard to offensive systems, even more caution is required.

STRUCTURAL REFORM

It is necessary to point out that a large part of the problem of fitting together goals, ways, and means in the national security space domain is the organization and structure of the US national security space community, as well as overarching space governance. There is a plethora of organizational actors—including the intelligence community, the Department of Defense, NASA, the Federal Communications Commission (FCC), the Federal Aviation Administration (FAA), and the Department of State—that each have an impact on national space security, but have different priorities and responsibilities. The Department of Defense itself is fractured regarding space responsibilities, and there is disconnect among the military services, which all benefit from space assets. This results in some issues—such as the question of Cubesat governance, and the oversight of any eventual space resource-extraction activities—to fall between cracks. Alternatively, for years, competing bureaucratic rules from the Departments of Commerce and Defense regarding licensing commercial satellites for export created confusion, havoc, and, at times, gridlock. Systemic neglect, lack of accountability, and overlap

also result in inefficiencies and duplication of effort regarding space-systems development, and a broken process for space-asset management. Within the Pentagon, there is a lack of unity of command, responsibility, and accountability. Most importantly, the longstanding disconnect, and, indeed, outright squabbling, between the "black" space world—the NRO, the National Geospatial Intelligence Agency, the Central Intelligence Agency (CIA), the National Security Agency (NSA), etc.—and the "white" space world—the Air Force and other military services—remains a serious issue.

BUDGET CONSIDERATIONS

Even the most well thought out space security strategy will flounder if it is not supported by the means to execute it, both in terms of budgetary resources and attention by leadership. Arguably, the Bush administration failed at implementing its national space strategy because of a failure to budget funds to cover the extremely high costs required to meet what were essentially unviable goals of space dominance and control. And yet, Secretary of Defense Ash Carter stated in March 2016 that the Pentagon would spend $22 billion on space in 2017; $2 billion of that money will be slated toward space control.[1] Determining the right amount to allocate to space control, versus multiple other means to achieve goals, must be part of a strategic assessment. The space environment and the technical challenges of space inherently make it an expensive domain in which to operate, as does the desire for autonomous capability. Prudent stewardship of funding is essential to maximize the funding available.

CONCLUSION

The next US administration will have the time to undertake a thorough review of both National Space Policy and the underlying National Security Space Strategy. While the risks and threats to safety, sustainability, and security in space are indubitably increasing, there are no immediate threats that require either panic or rushed decision-making. Developing a new NSSS for a changing space environment will require consideration of ends, ways, and means in a proactive, rather than reactive, manner—based on a realistic, holistic understanding of the current and future risk and threat environments. Diplomacy and positive deterrence should be valued and supported as ways to achieve a preventative strategy that, first and foremost, seeks to avoid conflict in space—which, for the foreseeable future, would harm US interests more than those of any potential adversary.

It is further inevitable that other nations will continue to seek the national security benefits provided by satellites. The United States cannot expect to prevent them from doing so, by any means. Thus, it is necessary that any US assessment of its own national security in space take into account the security interests of others, and the need for a secure and stable international space environment. It is imperative for US policymakers to understand that "do as I say, and not as I do" is not a viable security strategy in space, or in any other domain. While it would be

patently silly for the United States to forgo hedging research on technologies and capabilities that would help it win a conflict that included space as a warfighting domain, if it comes to that very bad end, the US national space security community must be careful what it wishes for.

All things considered, a posture of inferred deterrence regarding offensive space activities is most valuable in helping shape a strategic environment where US space assets are best protected. Finally, the United States, above all, must not be driven into a space-arms competition that includes indiscriminate weapons—weapons that could destroy the space environment for the very commercial and civil uses that are so benefiting the country, and the world at large. Norm setting to avoid these worst-case scenarios thus continues to be a critical requirement, and an area in which the United States must show continued leadership. There is no getting around the fact that what any one actor does in space has the potential to affect all, for better or for worse. This means that cooperation among all space actors—military, civilian, and commercial, at both the national and international levels—must be a paramount piece of any nation's space security approach. The United States has the most to gain from a stable and secure space environment, and the most to lose if space becomes a battlefield.

Introduction

It is déjà vu all over again. In the wake of concerns about Russian and Chinese space activities, and provocative geopolitical actions on the ground, US rhetoric and program attention seem to be once again drifting toward concepts of "domination" and "control" of space as viable space security goals—largely to be achieved through technology and military force application, and renewed zeal for offensive counterspace options. This focus on prepping the US military for war in space is reminiscent of the George W. Bush administration's 2006 National Space Policy. While not without allure, and even some logic, a strategy too heavily weighted toward warfighting in space will again prove unviable at best, and counterproductive at worst. When the next US administration enters office, a consideration of a more balanced approach to the growing risks in the space environment, more proportionally using all tools of US national power, would better serve US interests.

The Barack Obama administration entered office under a banner of "Hope and Change." Those in the US space community waited anxiously to see how much change would permeate national space policy, traditionally a subset of more macro policy considerations. Somewhat surprisingly, the wait was relatively short: the administration issued a National Space Policy (NSP) in 2010, subsequent to the completion of the Review of United States Human Space Flight Plans Committee (also known as the Augustine Commission) in May 2009. The findings of that Committee were heavily relied upon by the administration to refocus the National Aeronautics and Space Administration (NASA) and the NSP. The National Security Space Strategy (NSSS) was later issued in 2011. With the NSP and the NSSS, the Obama administration redirected the United States away from the national-security-oriented, hegemonic strategy focused on US "domination and control" of space that had generally guided the George W. Bush administration, and toward a more cooperative, civilian, and commercial-oriented program overall, and a more traditional space security strategy of "strategic restraint." That is, under Obama, the United States would once again restrain itself from introducing offensive capabilities, in hopes of moderating the behavior of both friends and potential foes. Instead, it would focus on using diplomacy to set a foundation of norms and rules, designed to keep national security space competition to a dull roar.

Until 2013, US national security space policy pursued "strategic restraint" in a multi-tiered manner, through diplomatic channels at the multilateral and bilateral levels, public diplomacy that eschewed saber rattling, and discrete budgetary investment in dual-use space

President Barack Obama hosts Astronomy Night on the South Lawn of the White House on October 7, 2009 in celebration of the International Year of Astronomy, marking the 400th anniversary of Galileo Galilei's first use of a telescope. In attendance were 150 local school students as well as notable American astronauts including Buzz Aldrin, Mae Jemison, and Sally Ride. Here the President observes the constellation Lyra through a diffraction telescope. *Photo credit:* White House.

technologies, with an emphasis on those that provided better space situational awareness (SSA, the ability to see and understand the orbital environment).

However, the consensus on this approach began to unravel in May 2013, when China launched what it claimed was a science mission that nearly reached geostationary orbit (GEO, some 36,000 kilometers above the Earth). US satellite operators formerly considered this important orbital altitude a sanctuary, free from major threats. The Chinese test, coming on the heels of both Russia and China testing maneuverable satellites in low Earth orbit (LEO)—a capability that, until recently, had been demonstrated only by the United States—led to something of a "quiet panic" within the US national space security community. This was especially true among those in the intelligence community who saw the Chinese launch as an anti-satellite (ASAT) weapons test, demonstrating that the sanctuary of GEO (where many high-value intelligence satellites reside) was no more, thereby placing all US space systems at unprecedented risk. US rhetoric about space began to change consequent to that launch—subtly at first, but clearly indicating a heightened threat perception. This renewed threat perception, and the renewed fear about the "inevitability" of space war, was elevated all the way to President Obama (which is somewhat rare in the space-strategy world), triggering a summer 2014 National Security Council-led Strategic Portfolio Review.

Consequent to that exercise, changes in force posture, development programs, and budgets have been initiated to forge a more muscular national security space strategy. This includes reconsideration and reprioritization of several key elements: defense against the anticipated use of offensive counterspace capabilities against US satellites; the value of space diplomacy; and the future requirement of US weapons to defeat adversary satellites, providing the same advantage to adversary military forces as US satellites do today. Defense against counterspace capabilities has taken on a top priority, followed by, in order, a diminished view of space diplomacy, and an increased interest in offensive capabilities. In particular, the increased threat perception was accompanied by more aggressive public diplomacy by the Pentagon and US Air Force, aimed at making it very clear that the United States would respond to threats in space with the use of force—with rhetoric slipping back toward the "dominance and control" motif of the Bush administration's space policy.

With a presidential election now on the horizon, the space community is once again waiting to see what strategy the new administration will pursue. While space policy is a subset of larger geopolitics—especially space security policy, because of the size and breadth of the US program and the technology gaps subsequently created—it can also drive, or temper, dangerous geopolitical security dilemmas with other countries through US policies, actions, and rhetoric. The more recent militaristic stance of the United States has not gone unnoticed internationally.

Clearly, there are growing risks and threats to US satellites, civilian and military alike, and challenges to stated US goals in space. The question for the new administration, however, is

whether hegemonic means to address those challenges—including a national security space strategy focused on "active defense" and offensive weapons (a decidedly grey distinction)—are likely to achieve US goals. It is this paper's assertion that they are not. Instead, a rebalancing of means used to address US goals in space is now necessary, based on a comprehensive assessment of the strategic space environment through the next ten to twenty years, toward ensuring that the ways and means being pursued to address those goals are in alignment. This assessment must extend beyond the Pentagon as well, to include the rapidly expanding cast of governmental and nongovernmental space actors. In particular, industry representatives should be brought into a process of dialogue with the national space security community to discuss priorities and concerns.

Such a rebalancing would require a continued emphasis on strategic restraint in the very near term, as well as a continued focus on diplomacy. The best-case scenario would be for the United States to convince others, particularly China and Russia, to similarly take a step back and re-evaluate their own goals—something that is only going to happen through improved dialogue and/or "signaling." However, this may not be feasible at the current moment, due to the lack of dialogue and the high level of geostrategic tensions. Even without a reciprocal move on the part of the two near-peer competitors in space, however, the United States will benefit internally by taking the time to seriously reassess its space security house, potentially including consideration of the structures and organizational charts dictating who is in charge.

While there will undoubtedly be pressure from some quarters to move ahead swiftly with a more aggressive approach, no country currently has the capability to directly threaten the ability of the United States to successfully utilize its space assets in a conflict, thus allowing time for a strategic reassessment. Space assets are vital to US interests, too important to be guided by a "ready, shoot, aim" approach based on fear, rather than on actual goals. Indeed, the point is to reassess whether US goals in space are feasible and reasonable in a changing environment, and to develop a strategy that ensures the ways and means to achieve them. If the current US goals (as discussed below) remain relevant and viable, as the authors believe they do, then a national security space strategy must be premised on prevention—both of space warfare in general, and of attacks on US space assets—rather than on the concept that "the best defense is a good offense."

Therefore, it is this paper's intent to offer an initial strategic assessment, based on a review of goals, ways, and means, as bounded by the strategic environment and budget considerations, to demonstrate the rationale for a rebalancing. It begins by reviewing the evolution of policy to date, including how misalignment can and has occurred. A new, alternative approach we call "proactive prevention" is then offered, based on goal achievement and viability. We offer it as a catalyst and starting point for grounded discussions on space security policy for the next administration.

The Past as Prelude

Strategic restraint had prevailed as the baseline US strategy, even during the "space race" years with the Soviet Union, because of a desire to avoid an expensive, and dangerous, space arms race considered unwinnable by either side. That strategy supported restraint of military actions in space, and favored passive military systems to active systems. Even after the Anti-Ballistic Missile (ABM) Treaty was signed by the United States and the Soviet Union in 1972, both countries pursued policies of contingent restraint regarding ASAT technology, whereby restraint by one was contingent upon restraint of the other.[2]The difficult imperative was then, and remains, maintaining a technical hedge in case of mutual-restraint failure, without creating an arms race.

The US move away from strategic restraint in space began during the Ronald Reagan years, and crept further during the Bill Clinton years, with the influence of a strong anti-China block in Congress. With the Cold War over and the United States enjoying its unipolar moment, primacy—emphasizing preservation of the United States' hegemonic status for its own good and, assumedly, the rest of the world's—emerged, reaching its pinnacle during the presidency of George W. Bush. The international reaction to Bush's 2006 National Space Policy, even from US allies, illustrates the resistance and resentment a hegemonic space strategy can engender. An October 19, 2006 article in the *Times* of London epitomized the international perspective in an article entitled "America Wants It All—Life, the Universe, and Everything." According to the article, the 2006 policy no longer considered space the final frontier, but the fifty-first state. Further, it stated that, "The new National Space Policy that President Bush has signed is comically proprietary in tone about the US right to control access to the rest of the solar system."[3]

A 2010 RAND report directly addressed the negative impact of such muscular rhetoric on US space security:

> While efforts to develop such [counterspace] plans and capabilities may be prudent, openly expressing U.S. intentions to dominate space does nothing to deter others from attacking U.S. space systems; rather, given the first-strike advantage so prevalent in the space strategic environment, it animates the efforts of potential adversaries to develop similar capabilities and, in a crisis, would provide motive and justification for their preemptive employment. A national space policy more conducive to deterring attacks on U.S. space systems would avoid provocative rhetoric about denying others from the use

> of space and would, instead, explicitly condemn any use of force to, from, or in that domain, except in retribution for attacks on one's own space systems.[4]

Obama's 2010 NSP and 2011 NSSS reflected the RAND report's sentiments, and proved a global relief in terms of both rhetorical tone and the perceived aspirational intentions of the United States regarding the future of space and the US role.

Domestically, responses to the 2011 NSSS varied. The Defense Department referred to it as a "pragmatic approach to maintain the advantages derived from space while confronting the challenges of an evolving space strategic environment."[5] One space analyst considered the 2011 NSSS a "thoughtful" document, offering an "approach to security with an improved balance of commercial, civil, and military views of space; [it] emphasizes international cooperation; and uses a multilayered approach to securing satellite capabilities, including norms and building resilience into U.S. space systems."[6] Another, more skeptical, analyst praised the continuity it brought from the Bush years, but questioned the wisdom of introducing new elements, specifically those focusing more on diplomacy. "And most disturbingly, the security space strategy sets out a goal for the United States to establish norms of behavior in space…The danger of introducing them now is that the implications and consequences, intended and unintended, have not been thoroughly considered, have not been discussed publicly, and lack a common framework needed to understand their meanings."[7] More pointedly, the NSSS was also criticized as advocating a false deterrence, thereby making the United States vulnerable.[8]

Reluctance to support norms stemmed from the view that "rules" largely helped others countries seeking to catch up to the United States, the nation with the most and most advanced space assets.

The Obama space policies were a welcome change to many in the national space community, and to other countries. At the same time, internal domestic concerns continued to be voiced by hawks in the national security community regarding what they perceived to be too much reliance on "deterrence by denial"—that is, making US space assets less attractive targets—rather than more robust "deterrence by punishment," as well as about introducing international norms, rules, and laws. Reluctance to support norms stemmed from the view that "rules" largely helped others countries seeking to catch up to the United States, the nation with the most and most advanced space assets. Those supportive of norms saw the space environment

Arriving at the Scitor Complex for the 2015 Space Symposium, Deputy Defense Secretary Bob Work, left, shakes hands with Air Force Gen. John Hyten, commander, Air Force Space Command, and Secretary of the Air Force Deborah Lee James in on April 15, 2015 in Colorado Springs, Colorado. *Photo credit:* US Department of Defense.

as inherently evolving from "the high ground" held by the United States to one of distributed vulnerability as more countries launched more assets and became dependent on them, and more commercial players entered the field. Hawkish concerns were largely tamped down until the May 2013 Chinese launch—which, in particular, rattled the US intelligence community, as many of its expensive, exquisite reconnaissance satellites are in GEO—and subsequently returned to the fore.

But the dangers of reverting to a more muscular policy without a thorough consideration of the consequences, intended and unintended, are just as great as—or greater than—continuing with strategic restraint and moving to establishment of norms of behavior in space. Even General John Hyten, commander of Air Force Space Command, has recently indicated support for norm building.[9] The current space environment, just like the past one, demands cooperation among space players, just as it inherently creates aspects of competition.

Goals

Any US national security space strategy must consist of three parts: goals, ways, and means. Goals must be set before effective strategic thought can be put into developing the ways and means to reach those goals. The 2010 National Space Policy states "the United States considers the sustainability, stability, and free access to, and use of, space vital to its national interests."[10] Therefore, it is reasonable to consider that sustainability, stability, and free access to, and use of, space are US policy goals. Stability is a means to achieve sustainability, toward the ability to utilize free access. The same goals are stated in the NSSS, along with others more directly related to security.

Those security-specific NSSS goals are stated as: strengthen safety, stability, and security in space; maintain and enhance the strategic national security advantages afforded to the United States by space; and energize the space industrial base that supports US national security. The NSSS means to achieving those goals are clearly stated:

> The National Security Space Strategy draws upon all elements of national power and requires active U.S. leadership in space. The United States will pursue a set of interrelated strategic approaches to meet our national security space objectives:
>
> - Promote responsible, peaceful, and safe use of space;
> - Provide improved U.S. space capabilities;
> - Partner with responsible nations, international organizations, and commercial firms;
> - Prevent and deter aggression against space infrastructure that supports U.S. national security and;
> - Prepare to defeat attacks and to operate in a degraded environment.

While the last two bullets include development of military capabilities to "deter, defend against, and defeat aggression," language drawn from the 2010 Quadrennial Defense Review (QDR) and cited in the NSSS, use of "all elements of national power" is specifically called for, in acknowledgement that not all problems have military solutions.[11] Just as guns cannot win

A RIM-161 Standard Missile 3 (SM-3) is launched to destroy the failed NRO-L 21 satellite orbiting in low Earth orbit (LEO). While nations argue anti-satellite strikes are necessary to reduce the danger to humans from falling debris or hazardous materials, many fear this technology can be used against strategic satellites as an offensive capability to disable forces operating on Earth. *Photo credit:* US Navy.

hearts and minds or defeat ideologies, there are limits to the protection technology can provide space assets, given the tyrannies of distance and physics.

The NSSS also recognizes the importance of working with all spacefaring nations, due to the nature of the space environment as "a domain that no nation owns, but on which all rely."[12] Specifically, because the United States does not own space, "partnering with responsible nations, international organizations, and commercial firms," as well as seeking "common ground among all space faring nations" to maintain stability and address issues relevant to all, becomes imperative.[13]

But what constitutes a "responsible nation?" Other than the 2007 debris-producing ASAT test for which China was roundly and rightly condemned, China has done nothing in space that violates international law, and nothing that the United States has not done before, including ASAT testing. While Russia and the United States are at geopolitical loggerheads, and Russia is developing much the same technology as China, cooperation on the International Space Station continues. The United States has yet to clearly state what it considers acceptable or unacceptable behavior in space, or in terms of terrestrial behavior that will affect space relations. This is counterproductive. If others, including potential adversaries, are unaware of what constitutes US "bright lines" regarding negative behavior in space, during either peacetime or wartime, the risk of unwanted escalation grows. As an example, the Defense Department's 2016 report to Congress on Chinese military power states that China may be considering using counterspace capabilities to target US early warning and navigation satellites.[14] If this is true, it shows that there is an enormous misunderstanding by China of the importance to the United States of early warning satellites in the nuclear kill chain—something even the Soviet Union understood, hence the mutual ban on attacking these assets embedded in US-USSR bilateral nuclear-arms-control agreements.

Further, the United States does not own space. Other countries share many of the same space goals as the United States, including—perhaps most importantly—access to space. But these other countries, particularly China and increasingly Russia, perceive the United States as actively developing capabilities to potentially deny them access to space. This perception is shaped by US policy, rhetoric, program development, and spending.

In particular, the US Air Force concept of "space control" continues to worry many in the international space community, especially Russia and China. "Space control," one of four Air Force space missions defined in joint military doctrine, was defined in 2002:

> Space control operations provide freedom of action in space for friendly forces while, when directed, denying it to an adversary, and include the broad aspect of protection of U.S. and allied space systems and the negation of enemy space systems. Space control operations encompass all elements of space

President Barack Obama, joined by Congressman C.A. "Dutch" Ruppersberger (D-MD) and middle school children, speaks with the crew of the International Space Station from the Roosevelt Room of the White House, February 17, 2010. *Photo Credit:* NASA/Bill Ingalls

> defense mission and include offensive and defensive operations by friendly forces to gain and maintain space superiority and situational awareness if events impact space operations.[15]

If it is perceived that the United States intends to be able to deny adversaries access to space, it should not be unexpected that these potential adversaries will develop capabilities to thwart that intent.

Similarly, in 2004, the Air Force defined "space dominance" in a manner strikingly similar to the Defense Department's definition of air superiority, in the first-ever doctrine paper on counterspace operations (that is, US operations to deal with adversary space capabilities in a conflict): "The degree of dominance in space of one force over another that permits the conduct of operations by the former and its related land, sea, air, space, and special operations forces at a given time and place without prohibitive interference by the opposing force."[16] The difficulty with transference of this concept is that an air battle takes place in a relatively small area, over a relatively short period of time, with a relatively high degree of ability for commanders to know

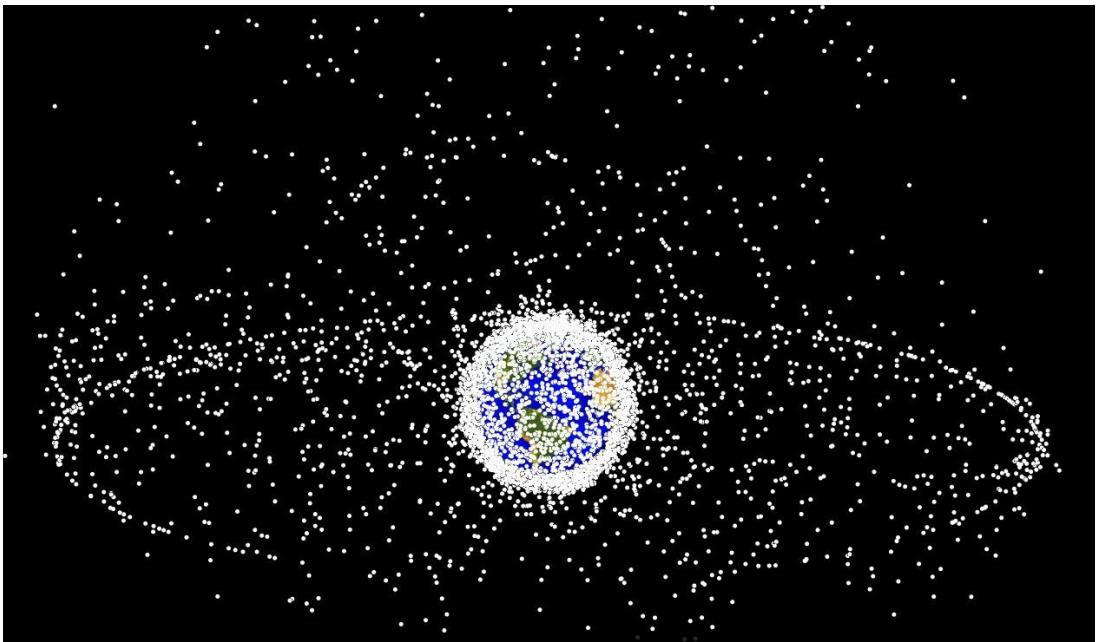
what is going on and who is responsible for what actions; in space, none of that may be true. That creates opportunities for mishaps, misperceptions, and miscalculations.

During the Bush administration, the space-control and dominance rhetoric emanating from the US military created external perceptions of aggressive US intentions in space. These perceptions were initially soothed by the Obama administration's policies, rhetoric, and focus on multilateral diplomacy. Recent rhetoric, however, is once again changing the US profile. For example, in statements as recently as 2014, Assistant Secretary of State for Arms Control, Verification, and Compliance Frank Rose stated that the United States was amenable to space arms-control agreements if they are "equitable, effectively verifiable, and enhance the security of *all nations* [emphasis added]."[17] By contrast, in his November 2015 remarks, Rose stated that the United States would consider arms-control measures if they are "equitable, effectively verifiable, and enhance the national security of the United States *and its allies* [emphasis added]."[18] This distinction was reminiscent of the "us" and "them" view of the world after 9/11, and of language in the Bush administration space policy that focused almost exclusively on US rights in space. Since this phrase is an often-heard talking point of US space policy, it is unlikely the recently selected wording was simply a misstep.

Given the danger of space warfare and its escalation potential, Bruce MacDonald pointed out how the hegemonic space strategy of the Bush administration was misaligned, in a 2008 report for the Council on Foreign Relations. First, the 2002 US space doctrine included language about the imperative of being able to deny the use of space assets by US adversaries—language that has caused considerable angst among countries increasingly using space in many of the same ways as the United States. The United States has ranged from hinting to overtly stating its desire to "control" space. Second, since the 2006 National Space Policy, space has been considered a US "vital interest" that must be protected. MacDonald highlighted the incongruous nature of those two points:

> Identifying one's own space capabilities as a vital national interest while reserving the right to attack others in space (which would likely provoke retaliatory attacks against our "vital" space assets), appears internally inconsistent, even contradictory…Attacking other's satellites would invite retaliation, putting at risk a "vital national interest" where the United States has much more to lose than the attacker.[19]

Rational decision-making is goal directed, with internally consistent choices. Therefore, if the United States wants to maintain access to its vital interests, avoiding an attack becomes just as important as defending against and defeating an attack. Yet, since the 2013 Chinese launch, the United States is once again considering systems to attack adversary counterspace capabilities, as well as offensive actions against adversary satellites—including potential first-strike, preemptive options—which could lead to a similar misalignment of goals with means.



A computer-generated image of objects in Earth orbit, as plotted by NASA, that are currently being tracked. Approximately 95% of the objects in this illustration are orbital debris, meaning they are not functional satellites. The image depicts the concentration greatest orbital debris populations and is not scaled to Earth. *Photo credit:* NASA.

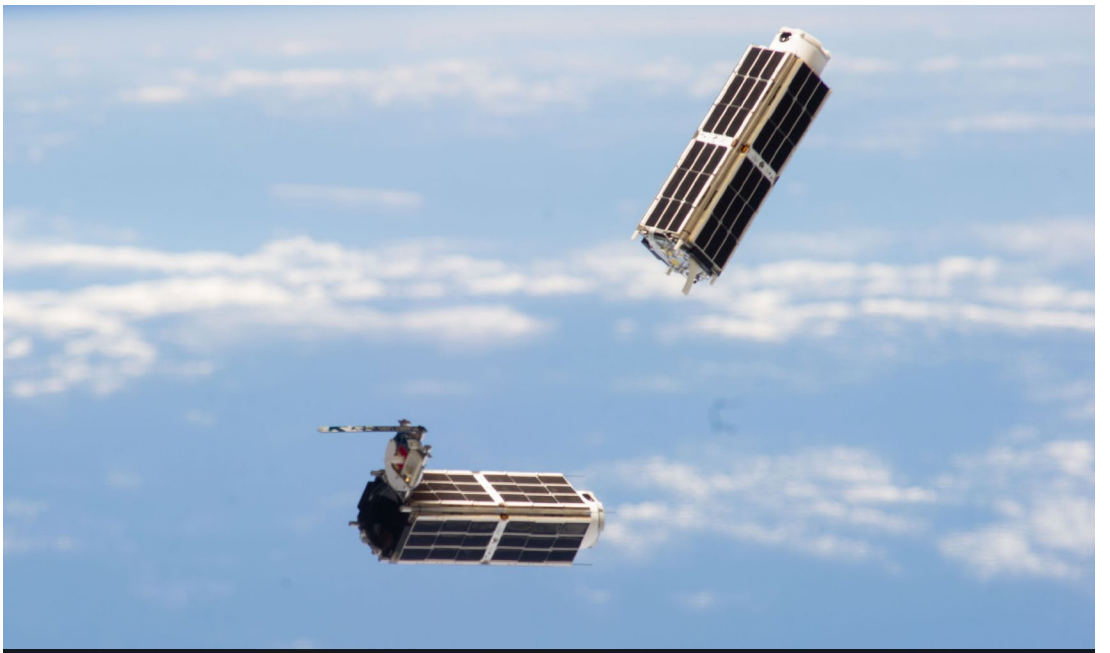
A closer look at the "congested, contested, and competitive" space environment (as characterized by current US policy) is important to understand the backdrop within which threat assessments and strategies are being developed. While management of the environment is both useful and necessary, control of the environment is already out of the reach of any one country. Though a politically potent objective, pursuing space control and domination is a futile, costly quest, and can be counterproductive. In some cases, it already has been. The United States attempted to control satellite technology through the International Trafficking and Arms Regulations (ITAR), until revisions were made in 2014. In a globalized market, the primary effect of those controls was to see satellite sales go to other countries. Not only is unilateral control of space technology and the space environment now impossible, but attempts at control create the perception of denying other countries benefits from space that the United States enjoys. If the United States is to be the leader of the family of spacefaring nations, it must be seen to hold the moral high ground in terms of upholding the principle of "access to space," as codified in the 1967 Outer Space Treaty, and seeking to avert space warfare.

The Space Environment

Though it was unofficially used earlier, the 2011 National Security Space Strategy officially introduced the description of space as "congested, contested, and competitive" into the space lexicon, and that description quickly became accepted as fact. However, it took longer to discern what that phrase specifically meant. Deputy Assistant Secretary of Defense for Space Policy Gregory L. Schulte provided useful definitions in 2012.[20] Schulte stated that space is congested by virtue of the quantity of "stuff" in orbit, including both active systems and trackable debris. Space is considered increasingly competitive, based on the growing number of actors in space, including countries, consortiums, and companies. There is considerable overlap between congestion and competition. It is the contested aspect of space, defined as the number of countries developing counterspace capabilities and integrating them into their military doctrine and forces, that currently drives US strategic thinking about national security in space.

Congestion. Space is increasingly congested because of the growing number of countries, companies, and organizations with launch capability, allowing more and more "stuff" to be placed in orbit. That "stuff" creates issues regarding debris, radio-frequency access and potential interference, and competition for orbital real estate.[21] The increased number of small satellites of various sizes that could be launched in the future, and even space tourism, will further exacerbate the relatively congested nature of space, simply in terms of the number of objects in orbit. In the near term though, debris is the most potentially threatening congestion issue.

Debris issues are created not just through the increasing quantity in various orbits, but also through the inability to keep track of it all in order to avoid collisions. Everything from tools left by astronauts to rocket stages to moribund satellites is among the tens of thousands of pieces of space debris larger than ten centimeters that are detected, tracked, identified, and catalogued by the US Space Surveillance Network (SSN), and there are hundreds of thousands of smaller pieces that could still damage satellites. The SSN encompasses the assets used to track space debris, and follow-on operations to characterize it. It is operated through the Joint Space Operations Center (JSpOC), and some of that data is shared with operators through the Space Track program. However, while the United States has the most robust space situational awareness (SSA) capabilities (capabilities to "see" and analyze what is happening in space), even the US system cannot adequately survey and track the growing amount of space junk. Furthermore, because of national security concerns, not all non-US operators have access to



A set of NanoRacks CubeSats are deployed by the Small Satellite Orbital Deployer (SSOD) from the International Space Station on February 11, 2014. The CubeSats program researches a variety of conditions, including experiments such as Earth observations and advanced electronics testing. *Photo credit:* NASA.

the US data and analyses of possible collisions, nor their own SSA capabilities. The dangerous nature of this situation, whereby some operators are essentially flying blind, should be evident to all.

Debris is created in a variety of ways, including: simple carelessness; malfunctions; accidental or purposeful kinetic impact of one spacecraft by another; or by an antisatellite weapon. Debris from the 2007 Chinese ASAT test high in low Earth orbit, and the collision of a moribund Russian satellite with an operational Intelsat satellite in 2009, together increased the amount of space debris by near orders of magnitude. The debris problem is such that in 2015, Hyten, at least tacitly, added debris avoidance to the list of US space goals. Hyten said that not creating debris is "the one limiting factor" to space war. "Whatever you do," he has said, "don't create debris."[22]

Addressing the debris problem, however, inherently requires cooperation and restraint with regard to testing and/or warfighting activities that create debris. Accurately tracking debris requires sharing data, and there has not always been a propensity to do so within the US

national space security community—or, to be fair, on the part of other countries. In terms of remediation, there are no salvage laws in space. The launching country or countries own each piece of debris, and it is often simply impossible to identify what junk belongs to which country.[23] Further, most technical approaches for clearing debris out of space, known as "active debris removal," have potential uses as ASAT weapons. Thus, simply dealing with today's debris threat, much less the more polluted environment that is expected in the medium term, is complicated. It cannot be done unilaterally.

It is useful to note that there are three separate aspects to keeping track of what is going on in space, each likely to be done by different organizations. The first is SSA, which involves gathering data and making projections. The second is notification. Having data and delivering conjunction warnings (warnings that two satellites, or a satellite and a piece of debris, are coming close enough to create a risk of collision) are different. Private companies and organizations share data about the whereabouts of their satellites and, where possible, debris. Although Russia, China, France, and some other European countries have some degree of space-tracking capability, the extent to which they share information varies greatly. Only the United States government routinely shares notifications of potential collisions with other countries. The third aspect, management, involves "the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space, and return from outer space to Earth free from physical or radio-frequency interference" and requires public-public and private-public cooperation.[24]

The private sector has already shown more of a willingness to work together than governments on SSA, doing so through the Space Data Association (SDA)— a group of space operators who have pooled resources to enable them to stay out of each other's way in space. Additionally, while SDA only shares data among member satellite operators, in 2014 a US commercial company, Analytic Graphics, Inc. (AGI), began offering SSA data and products, including: conjunction analysis, maneuver modeling, orbit-trajectory modeling, orbit determination, and rendezvous-and-proximity operations.[25] AGI's Commercial Space Operations Center (ComSpOC) utilizes seventy telescopes aimed primarily at GEO, along with two radar sensors for LEO, to update its space observations on an hourly basis. In March 2016, AGI announced confidence that, by the end of the 2016, ComSpOC would be able to track the same number of objects in space as the US military's JSpOC is currently tracking.[26] AGI officials have stated that, at that point, industry should be able to handle "80 to 90 percent of the solution" to the tracking problem.[27]

Space-traffic management (STM) is the terrestrial equivalent of air-traffic management. Nobody wants the more than five thousand planes in the air over the United States at any given time to operate without rules. The International Civil Aviation Organization (ICAO) regulates international air traffic, though it does not have the authority to pass or enforce internationally binding laws. Rather, it establishes standards and recommended practices for

passage within each member nation. Increased space congestion suggests that the same type of standards and recommended practices will soon be needed in space. While STM has been the subject of study for more than a decade, STM will inherently limit some freedom of use of outer space, with consequent military implications.[28] Overall, however, the larger point is that congestion questions do not have solely, or even primarily, a military answer. Rather, they require cooperation both among domestic players and internationally; therefore, US policy must engender that cooperation.

Competitive. If there are more actors in space challenging each other for resources, orbital slots, bandwidth, and all the opportunities space has to offer—and there are—and if all countries want the right to pursue their own aims in space—and they do—then, by definition, space is more competitive than it was in the past. It also means there is less relative dominance of space by the United States. But competition is an inherent part of development, and traditionally seen as positive. Harvard historian Niall Ferguson cited competition among warring European countries as the spur to competition, and to technical advances, that allowed the West to eventually triumph over a formerly globally and culturally dominant China.[29]

Competition comes not just from other state actors, but also from the private sector, especially the so-called "NewSpace actors"—a group of individuals who created companies with their own money or venture capital, and were thus willing and able to take large risks. Launch costs, long considered too high to allow space development to reach the economic projections put forth since the 1980s, began to come down after NewSpace company SpaceX showed itself competitive with the established commercial aerospace companies that have long enjoyed a monopoly on government business, with prices accordingly high. Now there are a bevy of companies working on a variety of new launch and habitat capabilities, including for space tourism.

The passage of the 2015 US Commercial Space Launch Competitiveness Act (or US Space Act) signaled a new era of space development, one that will inherently include competition.[30] A key provision protects private spaceflight from governmental regulatory oversight for at least the next eight years. That leaves NewSpace developers relatively free to compete for business with established companies, domestic and international. Another key aspect of the Space Act dealt with space mining, which has been called a potential multitrillion-dollar industry.[31]

US companies have taken the lead in the emergent field of mining celestial bodies. Planetary Resources, Deep Space Industries, and Shackleton Energy have all expressed intent to lead the way in various resource-extraction activities in space. Clearly, these companies aim to make money. That means that all the legal bases for claiming rights to minerals, such as platinum, palladium, osmium, and iridium, as well as water, have to be covered in some manner by the US government.

A controversial section of the 2015 US Space Act recognized the rights of American citizens to own the resources they obtain through the mining of asteroids.[32]Prior to the signing of that law, whether the United States would recognize that individuals had such a right was tenuous, given the 1967 Outer Space Treaty provision that "outer space should be the common heritage of mankind to be used for the peaceful purposes in the interests of all nations, limiting state sovereignty."[33] To reassure investors, commercial companies want as much certainty in regulation as possible. They need those rules to be relatively understood and stable through a business cycle. Referencing the 2015 US Commercial Space Launch Competitiveness Act, Eric Anderson, co-founder of space mining company Planetary Resources said, "This is the single greatest recognition of property rights in history."[34]

The pivotal fact regarding the space environment is that space is becoming "democratized," in the sense of diffusion of power and control—not just among countries, but also among commercial actors.

Non-US companies and other countries (including Luxembourg and the United Arab Emirates) have expressed interest in space mining as well, seeing it as the basis for a potential celestial gold rush. As with other resources, there will be competition among and between companies and countries. There is also disagreement among global lawyers regarding whether or not the 2015 US Space Act is in accordance with the provisions of the Outer Space Treaty that prohibit a country from claiming ownership of a celestial body. In other words, it remains unclear—at least in the minds of the international space-law community—whether celestial property rights are actually legal. Indeed, the question of whether, and how, mining of celestial bodies is consistent with the Outer Space Treaty has been put on the discussion agenda of the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space (COPUOS) in Vienna, the multilateral body that creates and oversees international space law.[35]

The pivotal fact regarding the space environment is that space is becoming "democratized," in the sense of diffusion of power and control—not just among countries, but also among commercial actors. Eventually, the issues created as a consequence of international commercial competition will likely require national and international governance and management, but not a military response.

The democratization of space will play an important role in future space scenarios. RAND Professors Dave Baiocchi and William Welser, IV, outline issues created by and left unattended

(and in some cases, unrecognized) by "The Democratization of Space" in their so-named 2015 *Foreign Affairs* article. They argue state and nonstate actors alike will be involved in what they call "the new space race," and that nonstate actors may want to be involved in more than just commercial activities.

> Nongovernmental organizations may start pursuing missions that undermine governments' objectives. An activist billionaire wanting to promote transparency could deploy a constellation of satellites to monitor and then tweet the movements of troops worldwide. Criminal syndicates could use satellites to monitor the patterns of law enforcement in order to elude capture, or a junta could use them to track rivals after a coup.[36]

These possibilities, the authors point out, raise issues that governments have thought little about. But if nation states do not overcome their often-self-inflicted myopia, events may well overcome them. The United States must take the lead in that regard, which requires a broader focus than that of the military.

Contested. It is the contested aspect of space that appears to be driving US space policy since 2013. There is unquestionably a growing number of countries developing counterspace capabilities, and potentially integrating them into their military doctrine and forces. What is questionable, however, is the best means for ameliorating the consequent risk to US space assets. The "space protection" approach put forth after the Strategic Portfolio Review appears heavily focused on deterrence by punishment. There are several problems with such a focus. First, effective deterrence requires both promised benefits and punishment to the party to be deterred, or the party has nothing to lose. Second, the dual-use nature of space technology effectively means that almost all space technology can be perceived as threatening, and of having counterspace-capability potential. And third, offense is cheaper and easier than defense in space, inherently creating the conditions for an unwinnable and dangerous arms race if unchecked by leadership. The United States must provide that leadership to maintain a relatively safe space environment, rather than be the country to spark or exacerbate an arms race.

American economist, professor of national security, and game theorist Thomas Schelling presented deterrence concepts critical to space security in his seminal 1966 book *Arms and Influence.*[37] Whether the circumstances in play are total war—where annihilation of the opponent is the central aim—or, more likely and relevant to this discussion, during peacetime or limited war, makes a significant difference, as Schelling explains:

> In the world of coercive diplomacy *threats* and *assurances* [emphasis added] must be balanced through a process of clear and credible signaling, and enforceable bargains must be struck short of total defeat or victory for

> either side. Without credible threats, coercion is obviously ineffective. *But what is less well understood is that coercion is also unlikely to be effective without simultaneously transmitted credible assurances that the threat is fully conditional upon the target's behavior and that the target's key security interests will not be harmed if it complies with the demands of those leveling the threats. Without receiving both threats and assurances in concert, the target of a coercive threat has little incentive to comply with the demands being made.* [Emphasis added.][38]

Deterrence requires both threats and assurances. Threats of punishment alone are not just insufficient, but potentially counterproductive. This is as true in international affairs as it is in child rearing. Therefore, the question of what the United States is offering in terms of benefits to countries that comply with some still-unstated demands for acceptable behavior in space is highly relevant. The problem with answering that question clearly relates to the dual-use nature of space technology.

China, Russia, India, North Korea, Iran, and a growing list of countries are not only developing space capabilities, but also considering how those might be integrated into their military structures. The United States has let it be known that it sees those developments as threatening. Unfortunately, that places the United States in a position of "do as we say and not as we do," given that its military space budget is larger than those of the rest of the world combined, affording it a menu of military space capabilities that offer both offensive and defensive advantages. Consequently, it becomes all the more imperative that the United States be seen as actively seeking to prevent hostilities in space, through a balanced approach to deterrence.

A majority of the capabilities being developed by other countries are dual use. This includes missile-defense capabilities, which are perhaps most cited by other countries as evidencing US hypocrisy. The United States presents its program as purely defensive, and within its right of self-defense. However, the 2008 use of modified missile-defense technology to shoot down one of its own faltering satellites in Operation Burnt Frost heightened external threat perceptions, and perhaps provided the model for development of similar capabilities. China claimed it conducted missile-defense tests within its right of self-defense in 2013 and 2014, and Russia in 2015—tests considered threatening ASAT tests by the United States. In other words, Washington seems to be saying that US missile-defense testing and deployment is acceptable, but Chinese testing is a cover for aggressive intent. On the flip side, India has an active missile-defense-cum-ASAT program, and South Korea is buying US THAAD technology, much to China's consternation.[39]

Other dual-use capabilities also raise reciprocal concerns in the United States, and in other countries. Maneuverable satellites being developed in the United States and elsewhere for

rendezvous-and-proximity operations (RPO) are often considered nefarious capabilities by potential adversaries, causing finger pointing in both directions. Laser technology used for painting satellites for location verification can also be used to temporarily dazzle or permanently blind a satellite. Jamming and spoofing are reaching new levels of sophistication. The United States, Russia, and China are all developing hypersonic missiles that will considerably cut into decision-making times regarding usage, thus raising the already-high risks of conflict escalation where space assets are involved.

Militaries are rapidly moving to be better able to use space technology in terrestrial operations.

Conflict-escalation risks cannot be dismissed. While plans have been suggested for a space war bounded by agreed-upon targets and limits, war games have consistently shown that the tyranny of distance, together with dual-use technology, create a use-or-lose, no-holds-barred approach to space conflict.[40] Further, the desire for limits requires clear signaling of such, which has not been evidenced. Communication of the potential benefits of deterrence, what that would involve, and the desire for conflict limits (and even consideration of what an endgame would look like) are being drowned out by the drumbeat of inevitable war. This may not be the intention of the current administration. Nonetheless, rhetoric has a way of becoming reality via the perceptions it creates. Unfortunately, rhetoric from the US military has shifted to "winning the fight," rhetoric from Russia has veered again into the bombastic, and Chinese rhetoric remains focused on US ambitions in space as a threat.

Beyond technology development, militaries are rapidly moving to be better able to use space technology in terrestrial operations. Russia created a new branch of its armed forces in 2015, called the Aerospace Forces, integrating air and space forces. The Chinese Second Artillery, previously responsible for strategic missile forces, was renamed the Rocket Force on December 31, 2015. The Rocket Force will be responsible for all three legs of China's nuclear triad, rather than just the land-based nuclear missile under the control of the Second Artillery, as well as conventional missiles. The US Air Force stood up its first Space Mission Force in February 2016, as part of reorganization toward streamlining the chain of command, and better integrating and synchronizing air, space, and cyber forces.[41] Part of the US rationale has been to better prepare and utilize experienced operators. India has been trying for years to strengthen its military space organization, stymied largely by roadblocks stemming from the bureaucratic domination of the Indian army.

There is considerable mirror imaging going on in terms of capabilities development, integration of those capabilities into military operations, and how space is generally viewed. China analyst Kevin Pollpeter, for example, finds space being referenced as the high ground in Chinese space

analyses, much as it has long been in US military analyses. "Chinese writers make the oft-repeated statement that 'whoever controls space will control the Earth' and that outer space is the new high ground of military operations."[42] Because of the size and breath of the US military space program, it has considerable influence on shaping the programs of other countries.

The new US policy direction—supported by a budget boost from Congress, largely directed at development of counterspace capabilities and strategies—will inherently cause or justify reflective activities in other countries. While the development of these capabilities must be part of a larger strategy, it should not be the only, or primarily emphasized, part. There are better options.

Time for a Strategic Rebalancing

Inertia should not drive US space security policy. A new US administration taking over the White House presents an opportunity for a rebalancing of US policy to officially correct the tendencies toward "overcorrection" that emerged consequent to the Strategic Portfolio Review.

While the National Security Council's recent Strategic Portfolio Review looked at space assets for both defensive and offensive operations, it appears to reflect a worst-case presumption of the threats from Chinese and Russian research and development. As the Strategic Portfolio Review's assumptions and decisions are classified, it is impossible to fully assess, except based on public diplomacy by top US space policymakers and practitioners. Unfortunately, the messages being sent by various officials in various contexts (from congressional testimony to speeches at industry conferences) have been mixed. Some play up the threat assessment more than others; some reflect a more aggressive tone.

Nonetheless, it is reasonable to assume that a new administration would want to, at a minimum, consider whether current National Space Policy and National Security Space Strategy goals are in line with administration perspectives, and whether the goals, ways, and means are reasonable, viable, and aligned.

The first step in developing a new National Security Space Strategy must be a realistic, and holistic, assessment of risks and threats (these are not the same thing). This must be developed with the participation of the State Department, NASA, and the National Oceanic and Atmospheric Administration (NOAA), as well as the Pentagon and intelligence community, and should look at both the near and long terms. It would be wise to solicit participation by the private sector as well, to understand where private-sector concerns may or may not coincide with those of government satellite users and operators. This can be done by setting up a process for allowing industry representatives an occasional seat at the table during National Security Council discussions on space, or by setting up an industry council of advisers across space-industry sectors (as different industry sectors have different, and often competing, goals), somewhat along the lines of the 1990 Augustine Commission.[43]

It is important to reiterate that, at this stage, the United States does *not* face an imminent threat to national security space missions. Capabilities demonstrations by Russia and China are just that—demonstrations, and perhaps signaling. There is no Russian or Chinese ASAT fleet deployed that could defeat US space operations in a conflict; both nations are still behind the

United States in the integration of space assets into military operations, as well as in on-orbit technology development. And no other potential adversary is even close to achieving equivalent space power. Further, no strategy should be based alone on perceptions of the current threats from nations deemed potential adversaries. The geopolitical stage shifts, sometimes rapidly, and former enemies become allies or vice versa. Countries' fortunes rise and fall, including through domestic crises, and regional balances sometimes become upended. Risks, including the risk of unchecked conflict escalation, must also be considered.

Further, the biggest current threats to US space operations arguably come from debris and overcrowding in usable orbits, both problems that will get worse before they get better, especially as the small-satellite revolution grows. Neither of these problems can be solved unilaterally by the United States, nor with military power. However, a sober understanding of the possible evolution of the risk/threat environment is critical, in order to guide strategy on how to shape the future space environment.

The biggest current threats to US space operations arguably come from debris and overcrowding in usable orbits.

The second step is a review of US goals for national security in space. Goal setting must be informed by an in-depth assessment of risks and threats, in order to figure out the ways and means of achieving those strategic goals. But that exercise also should be based on an analysis of what is a best-case scenario for US interests, and should aim for that result. In other words, goals should be set on a proactive, rather than reactive, foundation. This cannot be overstated: US National Security Space Strategy must be focused on the end state that the United States *wants*, rather than be driven by fears about the strategic environment that others might want. The key question is, are there any compelling reasons to revise the goals as laid out in the current NSP and NSSS—safety, stability, and security, including freedom of action? If, as this paper would argue, there is not, then prevention of conflict in space should return to being a top US priority. The bottom line remains that preserving US freedom of action in space and protecting space assets is best achieved by avoidance of war in space or, at a minimum, lowering the risks thereof.

A focus on "proactive prevention" would gain the United States several strategic advantages. It would:

1. Provide a chance to stop activities and actions that would degrade the space environment, and consequently impair the beneficial uses of space by all, through

development of norms and rules that establish the lines between acceptable and unacceptable behaviors;

2. Create space to establish better dialogue, with Russia and China in particular, about US "bright lines" in space, and mutual-assurance measures that would reduce risks of misconception and conflict, as well as establish "breakers" to dangerous conflict escalation.

3. Avoid the opportunity costs that an arms race in space would engender;

4. Buy time (and resources, per avoiding opportunity costs) for private industry, which is in the middle of a renaissance, to develop low-cost solutions to space resiliency that can help the US national security space community get out of the situation of having space be a potential single-point failure in a conflict, as well as complicate an attacker's abilities to degrade or defeat the advantages provided to the US military by space assets;

5. Allow the US Air Force and intelligence community to figure out protection strategies and technologies for those space assets that will be more difficult to commercialize, otherwise disaggregate, or offload missions from; and,

6. Allow the US government and industry the time and budgetary leeway to develop next-generation technologies that might keep a leading edge in space, both for commercial benefits and military hedging or advantage.

A proactive preventative strategy—that is, a strategy aimed squarely at preventing a space conflict, while also preparing to win one if need be—presupposes establishing strategic restraint by all, and must be based upon a clear understanding of potential adversaries' goals in space, not simply their capabilities. Developing a better understanding of Russian and Chinese national security space goals will, in turn, require intensified dialogue and diplomacy, including making clear US intentions, "bright lines," and beneficial tradeoffs the United States is willing to make to avoid threatening behavior. There is no way that the United States can avoid the fact that other nations are going to seek the national security benefits of space that it has long enjoyed. The capabilities gap between the United States and potential rivals will continue to shrink, because of the laws of physics, the march of technological innovation, and the reality of economics. As noted, Russia, China, and the United States have all either demonstrated or deployed counterspace capabilities, both terrestrially and space based, that each perceive as threats. What assurances can be given, and what balance of capabilities and vulnerabilities can be established that is mutually acceptable? Again, *deterrence is not only about sticks; it is also about carrots*. Thus, any deterrent strategy must include assurances to adversaries against attacks that one does not wish to see perpetuated on oneself, something Karl Mueller of RAND calls "positive deterrence."[44] Positive deterrence includes taking into account the interests of potential adversaries and seeking to mitigate threat perceptions of one's own actions and

Robonaut 2, a dexterous humanoid robot, receives an upgrade aboard the International Space station. The Robonaut series was developed in an effort to build machines that help humans work and explore space, especially where the risks are too great for crew members. The Robonaut 2 or R2 is the first dexterous humanoid robot in space. *Photo credit:* NASA.

intentions. Further, positive deterrence is, ipso facto, undercut by overly muscular US rhetoric on dominance, offensive dissuasion, and punitive threat.

Regrettably, dialogue with Russia and China is glaringly missing. Since the Ukraine crisis in 2013, US constraints on diplomacy with Russia have been ever tighter, on all fronts. On the Russian side, dialogue has been almost totally eliminated in favor of aggressive, provocative rhetoric and actions. Meaningful dialogue with China on space has also been severely constrained, ever since the Clinton administration, by the China hawk faction in Congress. Wariness on the part of China toward transparency (in general, not just in space) has contributed to the gap in understanding. This situation will not be easily overcome, but that does not mean it is time for Washington to give up. Serious engagement in multilateral fora is one way to compensate for the problems in bilateral dialogue. And, if anything, the blockage in direct dialogue heightens the need for US public diplomacy to tread softly, in order not to backfire and undercut US strategic goals.

Establishing Ways and Means

Diplomacy First

The need for the United States to engage in meaningful space security dialogue with Russia, and especially China, cannot be overstated. In particular, US-China dialogue has been weak and scattershot, with blame on both sides for a lack of transparency. This makes paramount the use of signaling regarding US "bright lines"—that is, actions by potential adversaries that will provoke negative US responses, military or otherwise. Again, while the geopolitical barriers to dialogue are currently high, the United States must continue to press for such dialogue and leave the door open for any and all diplomatic possibilities, including finding ways to insert the space security conversation into other aspects of bilateral diplomacy.

Though bilateral diplomacy with Russia and China is a critical and immediate need if a preventative strategy is to be successful, elucidation and agreement on multilateral norms or space activities also become paramount, as the way to implement such a strategy. While there is a widespread international consensus that norms of behavior in space are required, multilateral progress toward development of such norms has been stymied in recent years, largely due to geopolitical tensions between Russia and the West over Russian military actions in Ukraine and Syria.

Despite Russia's recent success in playing the spoiler, there remains a high level of accord on certain necessary steps, such as increased transparency and improved space situational awareness for all space operators, to ensure sustainability and security in space. This was attested to during the February 15-26, 2016, meeting of the Working Group on the Long-Term Sustainability of Outer Space Activities (LTS) of the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Space (COPUOS) in Vienna. During that meeting, all delegations—with the exception of Russia's—wanted to move forward with an interim set of agreed guidelines (based on the January 28, 2016, report of the Working Group Chair) to be presented to the COPUOS plenary in June. That group included China and Brazil, which had previously shown some reluctance in the LTS discussions. Although Russia blocked this outcome (COPUOS actions require consensus), the Working Group decided to continue its efforts in an intersessional meeting June 6-7, 2016.[45][46] Moscow has vowed to boycotted that meeting.

Nonetheless, if there is otherwise general consensus on some of the draft guidelines, the Russian veto could be circumvented by taking agreed language directly to the United Nations

(UN) General Assembly in the form of a resolution. This could allow implementation by individual states, thus creating an initial set of norms that could serve to put pressure on Moscow. Given Russia's currently belligerent mood, it may be that an approach of diplomatic encirclement would be more likely to constrain negative actions than would threats of military response, which will almost certainly backfire. Might the United States thus take the lead in pushing forward the COPUOS effort, as well as the recommendations in the 2013 report of the UN Group of Governmental Experts on Transparency and Confidence Building Measures in Outer Space Security?[47] How else can the United States shape thinking and build consensus among spacefaring nations about rules of behavior in peacetime, and rules of engagement in conflict, that best meet US goals for prevention of conflict and protection of US space assets? How can the United States encourage allies and likeminded nations to work on bridging with Russia and China?

The point is that diplomacy also requires the United States to take proactive measures, rather than simply reacting to others. As a positive example, the Obama administration has been vocal in its public diplomacy regarding debris-creating ASATs, criticizing any moves in that direction, by China in particular, as well as vowing to refrain from use of such weapons. Hyten told reporters at a December 2015 breakfast at the Capitol Hill Club that he is "concerned about any potential threat that would create debris in space," particularly Russia and China's construction of "kinetic energy antisatellite weapons." He said, "It creates an environment that will be there for decades, if not centuries. And you can't get rid of it. So I don't want to go down that path, and Russia and China are going down that path."[48]

The prevention of debris-creating weapons use would be firmly in US interests, as well as in the interests of all spacefaring nations.

However, there is much more that could be done. If the United States does not want to see the advent of debris-creating ASATs, then Washington should seriously consider proposing a ban on testing and use of such weapons. If a ban focused on testing and use of any technologies that deliberately created long-lasting space debris, the current argument over the definition of a weapon could be avoided—although there would obviously need to be negotiation of the exact parameters of activities to be banned. Still, a ban on testing and use would be a verifiable alternative to the treaty proposal by Moscow and Beijing on Prevention of the Placement of Weapons in Outer Space, and the Use or Threat of Force against Outer Space Objects (PPWT), which has garnered support outside of the West despite many shortcomings. The prevention of debris-creating weapons use would be firmly in US interests, as well as in the interests of all spacefaring nations. A ban on testing and use would also go a long way toward reestablishing

…the key to success for a preventative strategy, and for achieving strategic restraint as a norm, will be that the United States emphasizes diplomatic solutions, rather than technological ones…

in the international community the notion of the United States as holding the moral high ground in space.

Whatever the specifics, the key to success for a preventative strategy, and for achieving strategic restraint as a norm, will be that the United States emphasizes diplomatic solutions, rather than technological ones, and that Washington puts political will behind developing those solutions. It also means that pugilistic rhetoric regarding military prowess must be avoided, so as not to undermine those solutions. More robust diplomacy will require more resources as well, both within the US Department of State and within the Office of the Secretary of Defense. The State Department bureau responsible for space diplomacy is the Bureau of Arms Control, Verification and Compliance (AVC), currently under the direction of the aforementioned Assistant Secretary Frank A. Rose. The bureau is responsible for all arms-control-related affairs, including nuclear weapons and missile-defense issues. As of fiscal year 2013, it had 141 employees and a budget of $31.2 million.[49]

By way of contrast, there was $32.3 million programmed for fiscal year 2015 in the joint Department of Defense/Office of the Director of National Intelligence (ODNI) Space Security and Defense Program, a little research-and-development "talk shop" that studies options for defensive, and now primarily offensive, space control.

Within the Department of Defense, space policy—including diplomacy—is within the purview of the Deputy Assistant Secretary of Defense for Space Policy, currently Douglas Loverro. In the often-lengthy Defense Department reporting chain, however, space policy is multiple rungs down from the top, which can make it difficult to get attention and have needs fulfilled. Loverro's shop of about fifteen people provides military advisers to diplomatic discussions, such as those at the COPUOS—but is also responsible for myriad other tasks, including reviewing space acquisitions. Therefore, there are often only one or two people under Loverro responsible for multilateral diplomatic efforts. This is not enough, according to insiders.

It would be wise for the next administration to examine the allocation of resources put to space diplomacy, as well as to diplomacy overall, as part of a strategic-balancing assessment.

Gen. William L. Shelton, commander, Air Force Space Command, Peterson Air Force Base, Colorado, talks with Douglas L. Loverro, deputy assistant secretary of defense for space policy, before they testified in front of the U.S. Senate Committee on Armed Services' Subcommittee on Strategic Forces on March 12, 2014, in Washington, DC. *Photo credit:* US Air Force.

Unfortunately, space diplomacy is also being stymied by structural impediments embedded in the international system, which was largely designed during the Cold War. The false dichotomy between COPUOS's mandate on the "peaceful uses" of outer space, and the Conference on Disarmament's mandate to negotiate arms-control treaties, including the Prevention of an Arms Race in Outer Space (PAROS), is one problem. This false dichotomy is also reflected in the bifurcation of space in the mandates of the Fourth and First Committees of the UN General Assembly. As noted earlier, space technology is primarily, if not always, dual use. While a fighter jet is unquestionably a weapon, a maneuvering satellite can serve both civil and military purposes, defensive or offensive purposes. It is a dual-use item squared. The International Telecommunication Union (ITU), which regulates access to the radio-frequency spectrum, does cover both military and civilian satellites, but has no standing to enforce its own regulations or directly resolve disputes.

The ever-stricter implementation of "consensus" that governs UN activities has also become a huge obstacle to multilateral diplomacy, so much so that the Conference on Disarmament

has been rendered almost completely irrelevant by its inability to act in any meaningful way for nearly twenty years.

Finally, the diplomatic world has yet to fully embrace the fact that both industry and NGOs have increased power in modern economic and political systems, with space and the cyber realm being primary examples. While the ITU has mechanisms for industry input, and the UN has allowed a modicum of civil-society participation, these mechanisms are inadequate, and only partially embraced by many nations. While the need for reform in the international system is beyond the scope of this paper, it is necessary to point out that these barriers make multilateral diplomacy in space even more complex and difficult.

Technology Next

Obviously, diplomacy must be underpinned by technological capabilities, both for deterrence and for hedging against threat breakout. Under a preventative strategy, technological focus would necessarily be put on understanding the environment and deterrence-by-denial capabilities, as well as cooperative opportunities for mutually beneficial activities, such as cleaning up space debris. Although hedging activities should also be a component of technology development, they should be a secondary priority. Importantly, technologies to execute "deterrence by punishment"—that is, systems aimed at ensuring the price paid by an opponent will be greater than the advantages gained by an attack (the underpinning of "mutually assured destruction" in the nuclear domain)—can, and should, be carefully considered and pursued, but with a transparent intention of "use of last resort." With regard to offensive systems, even more caution is required.

SSA

Improved SSA is a foundational capability for any US space strategy in any and all circumstances, given the rapid changes in the space environment. The national space security community has recognized this repeatedly, although funding has arguably not been commensurate with the rhetoric. Attempts are now being made to rectify the funding situation because of the Russia/China threat scare. According to the Government Accountability Office (GAO), the Obama administration is planning to spend about $6 billion between 2015 and 2020 to beef up SSA capabilities—largely within the Pentagon, but also at contributing agencies NOAA and NASA.[50] Calculating exact spending on SSA activities, however, is not possible due to the way the Defense Department tracks (or, rather, does not track) related spending. According to the GAO report:

- Compiling a budget for all SSA-related efforts is a challenge because many assets that support the SSA mission do not have it as their primary mission.

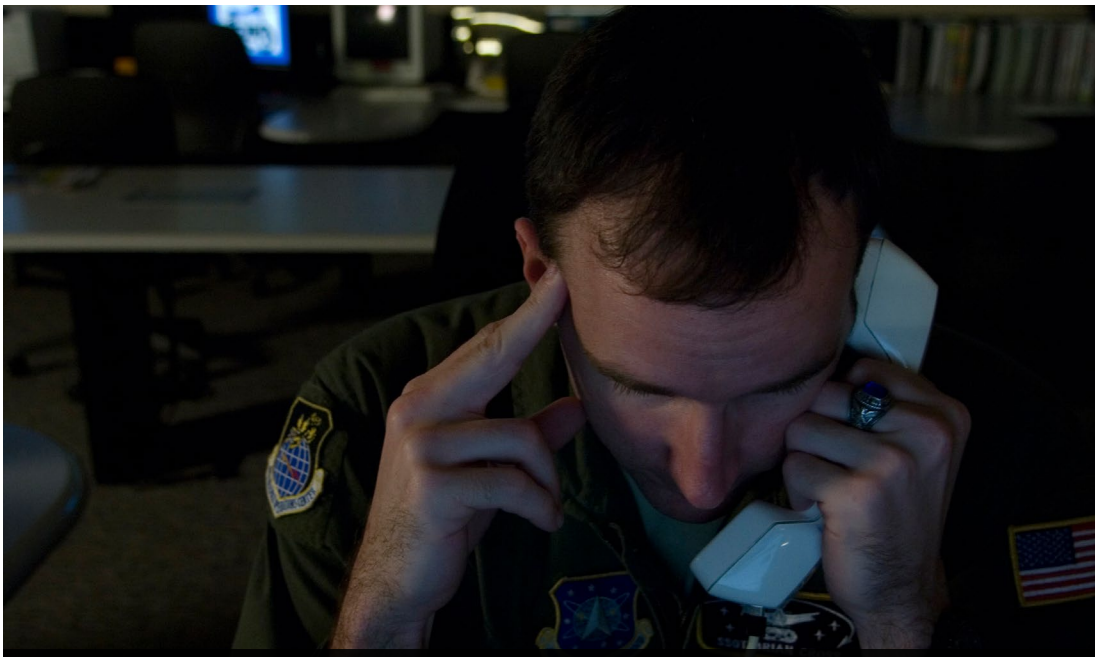
- DOD is not required to and does not track the budgets specific to its SSA efforts for multiple-mission systems, and it does not estimate what percentage would be allocated to SSA.
- For example, some portion of the ballistic missile defense sensors budget, which averages about $538 million per fiscal year over the next few years, supports SSA, but DOD does not track the efforts of multi-mission sensors in a manner that would provide such data. • SSA-related efforts performed using intelligence community sensor systems are also not included in the core SSA budget because those efforts and their budgets are classified.[51]

SSA is also an area ripe for possible leveraging of commercial and foreign capabilities, both to provide resilience and to complicate an adversary's calculations regarding an attack—one of the stated goals of the Obama administration's NSP. However, that potential has yet to be fully exploited, and greater emphasis should be put on doing so.

On June 1, 2015, US Strategic Command (STRATCOM) initiated a six-month pilot program to research how to integrate commercial operators (and their SSA data) into the JSpOC, called the Commercial Integration Cell. The initial effort involves six operators: Intelsat, SES Government Solutions, Inmarsat, Eutelsat, DigitalGlobe, and Iridium Communications. The goal is to assess whether JSpOC operations can be enhanced via integration of industry capabilities and insights, and, if so, how.[52] The pilot program comes after years of lobbying by industry, including through SDA, for closer cooperation and collaboration between commercial operators and the US military on space-object data tracking. One major hurdle has been that the computer systems and models used by JSpOC are antiquated, and incompatible with more up-to-date industry practices. While updates are planned, given the lack of adequate budget resources, this situation is not likely to be rectified anytime soon. This misalignment between ways and means should be addressed as soon as possible by the incoming administration.

Another question is the extent to which US allies will be allowed access to the improved SSA data, including the interference warnings and collision analysis it will provide.[53] The issue with allies is not just technical, but also, and primarily, political. The uncertainty in the private sector about JSpOC-industry collaboration and data sharing is underscored by AGI's COMSpOC. AGI is seeking to tap into the expanded (and unfilled by JSpOC) need for such data in the commercial marketplace, both in the United States and abroad.[54]

Lieutenant General John W. Raymond, Commander of the Joint Functional Component Command for Space, told the House Armed Services Strategic Forces Subcommittee on March 25, 2015, that STRATCOM is working on a new "tiered SSA Sharing Strategy." Raymond stated: "The tenets of this strategy are to share more information in a timelier manner with the broadest range of partners. We aim to promote an interactive, exchange-based relationship with satellite



Missile Warning Sensor Controller from 614th Air and Space Operations Center Staff Sgt. Brian Cross on a call about the Delta II site at Vandenberg Air Force Base on March 4, 2009. The Joint Space Operations Center provides a focal point for the operational employment of worldwide joint space forces, and enables the commander of Joint Functional Component Command Space to integrate space power into global military operations. *Photo credit:* USSTRATCOM/J020.

owners and operators where all parties gain. This open exchange of information also supports U.S. and allied efforts to detect, identify, and attribute actions in space that are contrary to responsible use and the long-term sustainability of the space environment." He further noted that, as of March 2015, there were forty-six SSA-sharing agreements in place with forty-six commercial firms, eight nations, and two intergovernmental organizations, with ten more in the works.[55] (The number of such SSA agreements, as of March 2016, is now at sixty-three.)[56]

The word "tiered" in Raymond's statement is central, as part of the issue for the Defense Department is figuring out what data to share with whom, at what level of specificity and accuracy. There has traditionally been reluctance about "giving away the store," particularly because many allies more closely integrate their civilian and military space operations, with less of a focus on protecting national security secrets. It is hard to underestimate the challenges—for example, simply regarding security clearances for access to US data. Further, some nations are leery of relying too closely on information provided by the US military. For this very reason,

the European Union (EU) in 2009 launched an effort to pursue independent SSA capabilities—an effort that has proceeded in fits and starts, due to internal EU concerns about the sharing of both information and funding. As of early 2015, the nascent program is being funded by fourteen participating EU states, focusing largely on figuring out how to better coordinate European activities, but also looking at how to improve capabilities.[57]According to the European Space Agency (ESA): "To date, Europe's access to information on what is happening in space has been largely dependent on non-European sources. In recent years, for example, data to trigger alerts on potential collisions between European satellites and debris objects have only come through the good will of other spacefaring nations. For this and other reasons, Europe needs an autonomous SSA capability."[58] It remains unclear how the EU SSA system, once established, will interact with that of the United States. This should be a major focus of future US space diplomacy and cooperation, to ensure that the systems are compatible and accessible—in part, to provide mission assurance.

The United States signaled its desire to forge the closest partnership on SSA sharing with Australia, Canada, and the United Kingdom, via a Memorandum of Understanding on Combined Space Operations, signed in September 2014.[59] The details of the MoU, however, are vague.[60] It should be noted that all three countries have assets that could contribute to US efforts, and would not simply benefit from a one-way absorption of US data.

Also, it is not only US allies who require better SSA in order to operate satellites safely and securely. More than seventy countries operate satellites, with 1,381 operating satellites in orbit at the end of 2015.[61] Many of these operators lack sufficient SSA. In the July 2013 report adopted by the UN General Assembly in October 2013, the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities cited the need for improved global access to space data, both for safety purposes and for building trust. The report stated that, beyond a lack of space capacity, "the inability of many States to acquire significant space-based information" is a factor "contributing to the lack of confidence."[62] Russia has proposed to the COPUOS Scientific and Technical Subcommittee that the UN Office of Outer Space Affairs consider the development of an international, open database of on-orbit objects (both operational satellites and debris) to fill this gap.[63] The United States and its allies have rejected the Russian proposal, largely for budgetary reasons, but the United States has been internally mulling over a possible proposition to create an informal international group to discuss the challenges to sharing SSA data and how to overcome them. This would be a promising first step, and a testimony to continued leadership in SSA by the United States, consistent with a national space strategy aimed at reducing risks. Inevitably, some form of open-access space-object database is going to be required, simply to ensure on-orbit safety—particularly in LEO, as the number of so-called Cubesats (very small satellites) rises

dramatically. The United States should take the lead on developing a workable space-traffic management regime underpinned by SSA.

Resiliency, Mission Assurance, Deterrence by Denial

Resiliency in space-force structure, mission assurance, and deterrence by denial are three related principles critical to a proactive prevention strategy for national space security. Resiliency is a subset of providing mission assurance; deterrence by denial is another, but also forces adversaries to reconsider the benefits and likelihood of success of targeting space systems.

The 2011 NSSS identifies resiliency of space operations as a priority. The Department of Defense defines resilience as follows:

> Resilience is the ability of an architecture to support the functions necessary for mission success in spite of hostile action or adverse conditions. An architecture is "more resilient" if it can provide these functions with higher probability, shorter periods of reduced capability, and across a wider range of scenarios, conditions, and threats. Resilience may leverage cross-domain or alternative government, commercial, or international capabilities.[64]

The Pentagon further characterizes resiliency as comprising four elements:

1. Avoidance: countermeasures against potential adversaries, proactive and reactive defensive measures taken to diminish the likelihood and consequence of hostile acts or adverse conditions
2. Robustness: architectural properties and systems design features to enhance survivability and resist functional degradation
3. Reconstitution: plans and operations to replenish lost or diminished functions to an acceptable level for a particular mission, operation, or contingency
4. Recovery: program execution and space support operations to re-establish full operational capability and capacity for the full range of missions, operations, or contingencies[65]

Thus, resiliency is a classic approach to deterrence by denial, and it is clear that the US national space security community recognizes that space-based capabilities cannot constitute a single point of failure for US military operations. Indeed, the need for resiliency within the space forces has been recognized for decades. What has failed to happen, up to now, has been a consistent budgetary plan to support development of resilience capabilities and architectures.

While there has been a renewed emphasis on resiliency in the wake of the Strategic Portfolio Review, the Department of Defense and the Office of the ODNI have yet to fully articulate what a resiliency strategy would entail. However, during the 2014 Strategic Portfolio Review, the Defense Department developed a concept for Assured Space Operations—defined by Loverro as "the notion that space forces needed to be as dependable as the forces that depend on them, regardless of threat."[66] Further, Loverro said in his March 15, 2016, testimony to the House Armed Services Strategic Forces Subcommittee, that, in 2015, the Defense Department had developed the DoD Space Mission Assurance Framework to include "three assurance pathways: reconstitution, defensive operations, and resilience" and is working on "DoD policy that makes it mandatory to include some or all of these types of mission assurance pathways in all new space systems."[67] The Pentagon effort also includes a reexamination of how its space-force structure might be reorganized based on these concepts. "As we've worked through that calculus we arrive at the conclusion that of the three pathways we've outlined—reconstitution, defensive operations, and resilience—resilience is the best path for both understandable [by adversaries] assurance and robust assurance," Loverro said.

While Loverro did not go into detail as to what exactly is being considered under the resiliency pathway, he did mention two elements: working with US commercial industry, and coalitions with allies. As for gaining national space security advantage from the commercial sector, Loverro cited the Air Force's program of Commercial Satcom pathfinders—funded at $121 million in the fiscal year 2017 five-year defense budget plan—to develop new business arrangements with commercial satellite communications providers that provide the Pentagon with new access to comsat capabilities. This will "increase resiliency and to complicate any adversary attack," he said.[68] He also noted the Defense Department's interest in leveraging commercial remote-sensing capabilities.

In the area of allied cooperation, Loverro said: "Our 2014 Portfolio Review highlighted that the strategic pursuit of partnerships with allied nations can simultaneously reduce the need for direct U.S. government investment, increase the complexity of the target set our adversaries must engage, diversify the means for us to support space missions, and create political hurdles for any adversary who might want to try to isolate the United States." He noted US SSA-sharing agreements, and the addition of New Zealand to the Combined Space Operations Initiative, which he characterized as a "nascent effort" to "coordinate our space activities, share insights and knowledge of the space environment, and to plan and exercise our space forces together."[69]

Resiliency now appears to be the central element of the revised Obama approach to national space security strategy. This is a welcome move, and should be supported, and even bolstered, by the incoming administration. The decades-long pitfall of identifying the need (the ways), but failing to put budgetary resources to fulfill the need (means) must continue to be avoided.

Another approach to deterrence by denial, via mission assurance, would be to offload some mission capabilities provided by satellite systems to non-space-based platforms and systems. In recent years, the Defense Department has shown interest in aerostats and airships for intelligence, surveillance, reconnaissance, and, in more recent times, communications. These options should be seriously explored, even if primarily as backup in the worst-case scenarios of loss of critical space assets.

Further, for many years, there has been a debate on whether some large, so-called "exquisite" satellites—primarily spy satellites controlled by the National Reconnaissance Organization (NRO)—could be replaced by constellations of small satellites into systems that would be more difficult to target and degrade—an approach known as distribution. That debate is ongoing.

Tom Webber, Director of the Space and Strategic Systems Directorate of the US Army Space and Missile Defense Command, told a September 2015 symposium in Washington that advances in computers and electronics have made small-satellite constellations more feasible, and thus more advantageous in ensuring resiliency.[71]

Loverro, however, while recognizing the need for a "space-offset strategy," downplayed this option in his 2016 testimony:

> While many advocates have called for the United States to move to small, reconstitute-able satellites as a reaction to these threats, it's far from clear that this strategy could ever serve to offset the cost advantage that these methods employ, nor is it clear that a single, monolithic strategy can ever defeat an advancing and evolving threat. Plus, such a reaction limits the immense advantages the United States garners during lower intensity conflicts from our exquisite space capabilities.[72]

A debate related to distribution is that over "disaggregation," a term of art that refers to separating the strategic missions of a satellite or satellite constellation from the tactical ones. The debate has been particularly thorny with regard to early warning satellite systems, which in recent years have been optimized to perform both strategic missile warning and targeting for missile-defense systems. While the Cold War case for putting strategic space capabilities linked to the nuclear kill chain off limits as targets remains as strong as ever, many other nations (especially Russia and China) view US missile-defense systems as provocative and dangerous to nuclear stability, and thus potentially fair targets in a conflict. It also applies to secure-communications satellites for nuclear forces, as well as other missions. The debate is most obvious with the Space Based Infrared System (SBIRS) missile-warning satellites, and the related Advanced Extremely High Frequency (AEHF) secure-communications satellites. The Pentagon is currently reviewing whether to purchase new satellites of the current design, or to follow another pathway designed to separate out the strategic missions.[73]

Disaggregation can be fitted into two categories of deterrence: deterrence by denial, in that more targets complicates adversary attack; and deterrence by assurance, agreeing (even if tacitly) with potential adversaries to mutually place strategic space systems off limits in a conflict, to avoid nuclear escalation. Thus, this approach would bolster a proactive prevention strategy, and should be supported both by the outgoing Obama administration and the incoming administration, despite concerns about potentially higher costs. One of the boons of the commercial space revolution has been a drop in launch and satellite-manufacturing costs; hopefully, these advances can be harnessed to a disaggregation approach.

Deterrence by denial should, along with diplomacy, be at the front and center of any future US national space security strategy—and all elements should be consistently and proportionally funded.

Loverro also mentioned the need for the United States to improve reconstitution, the ability to rapidly replace satellites lost to malfunction, debris, or hostile acts. Again, this concept has long been recognized by the Air Force, although interest and funding has waxed and waned. The Operationally Responsive Space Office at Kirtland Air Force Base in New Mexico was stood up in 2007 as a joint office involving the Air Force, Army, Navy, Defense Advanced Research Projects Agency (DARPA), National Reconnaissance Office (NRO), Missile Defense Agency (MDA), and NASA. Its aim was to promote new methods of launching and building satellites more rapidly and affordably. Part of this effort was focused on small satellites and constellations, and part on new methods of satellite launch. The Air Force has tried to kill the office several times since then, but has been thwarted by Congress. While the Air Force apparently has re-embraced the office's mission, the funding request for fiscal year 2016 was a mere $6 million.[74] Given the recent developments in the commercial space sector regarding launch costs, a renewed focus on reconstitution would be wise.

Deterrence by denial should, along with diplomacy, be at the front and center of any future US national space security strategy—and all elements should be consistently and proportionally funded. It is indeed the inherent vulnerability of current national security space assets that is at the heart of justified concerns regarding the heavy reliance on those assets by the military. Unfortunately, in the realm of space, the classic approach of "the best defense is a good offense" does not make sense. Further, although not to be dismissed entirely, protection of on-orbit assets is also difficult. That said, there are technical fixes for some vulnerabilities that

deserve future investment. These include: improving cybersecurity, including at ground stations; antijamming and blinding technology; and maneuverability where feasible.

Finally, it is important to remember the "carrots" in a preventative strategy. There is value in US military cooperation on the development of technologies that would benefit all space users. One primary example is active debris removal. Currently, there is no such thing as a working "Space Hoover" to clean up space junk, although a number of studies have been done, or are underway, that show promise. There are also diplomatic and legal hurdles to be overcome before active debris-removal capabilities can get off the ground. A US government-wide effort to lead a multilateral initiative on active debris removal could serve as assurance to potential adversaries that their strategic restraint will be rewarded. The Interagency Space Debris Coordination Committee already has begun to consider active debris removal. Thus, there is already a scientific foundation that could be built upon.[75]

Hedging/Offensive Operations

Even within a preventative strategy, hedging against adversary counterspace capabilities, and preserving the capability to deter by punishment, has a place. Indeed, no US national space policy or strategy approach in history has *not* included hedging as an integral part.

While the United States cannot expect to maintain the wide gap between its national security space capabilities and those of other spacefaring nations that has existed for the past several decades—due to the rapid dissemination of technology, and the determination of some potential adversaries and allies alike to catch up—pursuing a reasonable technical edge is only prudent. First, when technology development is outpacing policy—as is clearly the case regarding space technology in the civil, commercial, and military arenas—there is a real danger of unintended consequences. This is part of the role of a strategic pause, to assess where technology is headed, where it is prudent for research and development to go forward, and where such research and development might actually be counterproductive. Second, the perception of major asymmetries in capabilities between the United States and its potential adversaries can actually backfire, pushing competitor states to redouble efforts to close those gaps. This paper argues that this is what is happening now in the US space relationship with both China and Russia.

Hedging can be conceived as a modular approach: hedging to provide capabilities against offensive counterspace by adversaries; hedging to ensure strategic parity in space capabilities; and hedging to provide offensive capabilities against adversary use of space, if conflict in space becomes unavoidable. Hedging further does not necessarily imply reliance on either ground-based or space-based ASAT systems—traditional means of force, such as targeting ground stations via airpower and jamming, must also be considered, based on analyses of alternatives for achieving any one mission.

When other countries become as capable as the United States of using space assets to project power, do offensive US counterspace weapons and operations make sense, or indeed become a necessity?

The first two "flavors" of hedging (to defeat adversary counterspace capabilities and to provide parity) are obviously applicable in a preventative national security space strategy. As to hedging against counterspace capabilities, the United States has long been pursuing that path. At the same time, there has long been debate within the national security space community, and some confusion, about exactly how to go about this. Hedging against adversary counterspace capabilities does not necessarily equal or require pursuit of US ASAT capabilities, especially based in space. For most counterspace capabilities that are coming into play in the foreseeable future, ASAT strike weapons are of little, if any, advantage. Adversary ground-based ASATs are best targeted on the ground, via airpower or other traditional means. Due to the tyranny of physics and of economics, using US ground- or space-based ASATs to take out these systems make little sense. Space-based counterspace capabilities also may be best directly countered with ground-based jamming, spoofing, or even cyber manipulation—although case-by-case analysis of alternative approaches would be required to make such a determination, given advances in space-based computing, electronics, and maneuverability.

However, the question of the extent to which US NSSS should include an offensive component, as potential adversaries (and others) build up military space capabilities to the level of sophistication that the US now enjoys, is even more complicated. In other words, when other countries become as capable as the United States of using space assets to project power, do offensive US counterspace weapons and operations make sense, or indeed become a necessity? This paper argues that while what might be termed "offensive hedging" can and should be pursued, the manner in which that is done is important. Michael Krepon of Stimson Center argues there is scope for what he calls "inferred deterrence"—that is, pursuit of offensive capabilities "quietly or by indirect methods," without a ramping up to deployment that would create the basis for a space arms race.[76] This is a subtle, but important, distinction. Overt pursuit of ASAT weapons aimed at taking out adversary satellites would not, at this point in time, serve even a strict deterrence goal. Neither Russia nor China (much less any other potential adversary) is as reliant as the United States on space assets for military success on the ground, in the air, and at sea. As the United States has more to lose, threatening other countries' satellites does not do much in the way of deterrence by punishment. This situation will remain

true for at least a decade. An overt, aggressively voiced pursuit of offensive ASATs by the United States at this time is likely to backfire, and instead further drive others to pursue that path. Caution is the watchword here, and at the heart of the concept of "inferred deterrence."

The United States has already demonstrated capabilities that constitute "inferred deterrence," in particular under the US missile-defense program. One example was the 2008 destruction of the malfunctioning NRO satellite, USA 193, by a modified SM-3 missile-defense interceptor launched from an Aegis cruiser. While USA 193 was destroyed at a low altitude (about 240 kilometers), the modifications to the SM-3 were primarily to software, and were achieved in a relatively short period of time. Improvements to the system under the Obama administration's Phased Adaptive Approach missile-defense system for Europe (some based on Operation Burnt Frost technologies) would increase the ASAT potential.[77] In some ways, targeting a satellite with a ground- or sea-based missile-defense interceptor is easier than hitting an incoming ballistic missile; the currently deployed Ground-based Midcourse Defense (GMD) interceptors could reach almost all satellites in LEO.[78] Other programs that have (or had) inherent ASAT capacity include: the Geosynchronous Space Situational Awareness Program (GSSAP), two maneuvering satellites in GEO on orbit since July 2014 and designed to monitor other satellites and debris; and the Experimental Satellite System, microsatellite demonstrations (XSS-10 and XXS-11) that date back to the early 2000s. Indeed, any satellite system developed for rendezvous-and-proximity operations (satellites that move closely around, or dock with, other satellites), whether designed for refueling, observation, or repair, have inherent ASAT capabilities.

Deterrence by punishment and/or offensive systems to counter adversary use of satellites need not be accomplished through direct targeting of the satellites themselves.

Once again, it is important to recognize that deterrence by punishment and/or offensive systems to counter adversary use of satellites need not be accomplished through direct targeting of the satellites themselves. Ground facilities, command-and-control networks, and launch pads can all be targeted by conventional US weaponry. In many cases, an analysis of alternatives will show that using conventional power is less expensive than developing new ASAT systems. Thus, deterrence by inference also comprises the capabilities of US conventional forces.

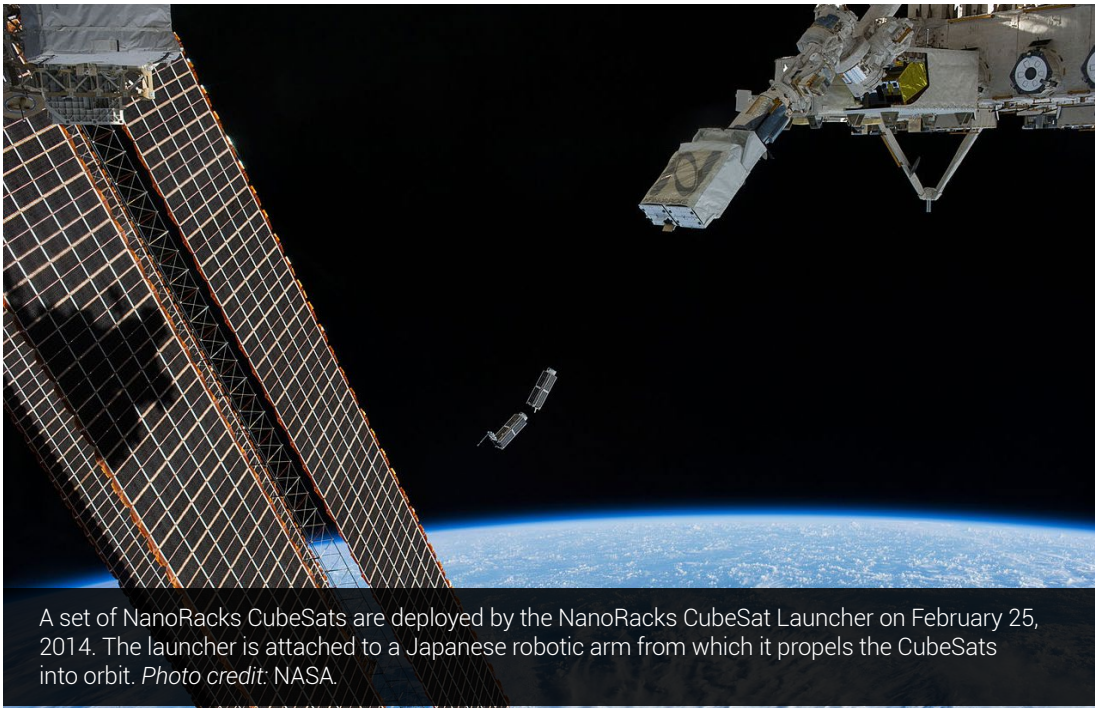
One key technological approach to any type of hedging—including offensive hedging —would be development of temporary and reversible means of disabling or degrading adversary counterspace systems (as opposed to permanent means). Research and development on these capabilities can be done in a manner that is not overly provocative, if adequate transparency about deterrent intent is provided. The United States has, for some time, been working on such capabilities, and has deployed at least one such counterspace system: the Counter Communications System (CCS), essentially a communications jammer on steroids, first deployed in 2004, and for which the Pentagon has budgeted $144 million in fiscal year 2017.[79] Although details of the CCS are classified, it could conceivably be used to jam communications between an ASAT ground station and its payload. Another example would be using lasers to blind optics on adversary systems designed to track or target US satellites. Obviously, these technologies would also have offensive uses against adversary satellites. But again, the nuance comes in how US intent is framed, in both direct communications with potential adversaries and signaling through public diplomacy.

Ongoing efforts to develop rendezvous-and-proximity operations capabilities likewise fall into the category of hedging, even as they provide nonmilitary benefits to civilian and commercial space operators. Maneuvering satellites can serve many different purposes: surveillance; repair; refueling; jamming and lasing; or kinetic-energy destruction of satellites. Again, how research and development of such systems is communicated and fit into a larger US strategy of deterrence is critical to how potential adversaries react.

Structural Reform

At this point, it is necessary to point out that a large part of the problem of fitting together goals, ways, and means in the national security space domain is the organization and structure of the US national security space community, as well as overarching space governance. There is a plethora of organizational actors—including the intelligence community, the Defense Department, NASA, the National Oceanic and Atmospheric Administration (NOAA), the Federal Communications Commission (FCC), the Federal Aviation Administration (FAA), and the State Department—that each have an impact on national space security, but have different priorities and responsibilities. The Department of Defense itself is fractured regarding space responsibilities, and there is disconnect among the military services, which all benefit from space assets. This results in some issues—such as the question of Cubesat governance, and the oversight of any eventual space resource-extraction activities—falling between cracks. Alternatively, for years, competing bureaucratic rules from the Commerce and Defense Departments regarding licensing commercial satellites for export created confusion, havoc, and, at times, gridlock. Systemic neglect, lack of accountability, and overlap also result in inefficiencies and duplication of effort regarding space-systems development, and a broken process for space-asset management. Within the Pentagon, there is a lack of unity of command, responsibility, and accountability. Most importantly, the longstanding disconnect, and, indeed, outright squabbling, between the "black" space world—the NRO, the National Geospatial Intelligence Agency, the Central Intelligence Agency (CIA), the National Security Agency (NSA), etc.—and the "white" space world—the Air Force and other military services—remains a serious issue.

There has been much handwringing about these structural problems for decades. Various solutions have been explored, such as the creation of a national security space "czar," but the question of bureaucratic reform has not yet been wrestled to the ground. Indeed, entire books and studies have been written on the subject of national security space governance. The issue of organizational and structural reform is beyond this paper's scope. But the problem can most easily be seen in the various efforts at reorganization of the Defense Department command structure for space over the past three decades. United States Space Command was created in 1985 as a Unified Combatant Command, in an attempt to harmonize military space usage. USSPACECOM was merged into US Strategic Command in 2002, with responsibilities for space and nuclear missions merged under the Joint Function Component Command for Space and Global Strike. The responsibility for space missions was once again separated out in



A set of NanoRacks CubeSats are deployed by the NanoRacks CubeSat Launcher on February 25, 2014. The launcher is attached to a Japanese robotic arm from which it propels the CubeSats into orbit. *Photo credit:* NASA.

2006, and now resides under the Joint Functional Component Command for Space. Likewise, the National Security Space Office, established in 2004 to harmonize the competing needs of the intelligence community and the military, was disbanded in 2010, after the intelligence community pulled funding for the office. In 2005, the dual hatting of the Director of the NRO and the Undersecretary of the Air Force was ended.

Under the current structure, which the Defense Department put into place in 2015, the Air Force Secretary is the Principal DoD Space Advisor (PDSA), and the director of the PDSA Staff is Deputy Undersecretary of Defense (Space). The PDSA staff serves as the secretariat of the Defense Space Council, which exists to coordinate classified and unclassified space-system needs. In addition, a Joint Interagency Combined Space Operations Center (JICSpOC) was created to bring together the NRO (and other intelligence-community space users), although the exact role and authority of that center remains to be seen. At the same time, the Director of the NRO, Betty Sapp, and the Commander of STRATCOM, Admiral Cecil Haney, inked a memo standing up a Joint Space Tactics and Doctrine Forum to develop joint approaches.[80]

The Obama administration has obviously recognized that there is a problem in US national security space acquisition and asset management. However, it remains to be seen whether the "black" and "white" space communities can overcome their tradition of infighting over both authority and budgetary resources. Further, the problems of integrating civil and commercial space needs with those of the national space security community remain. The next administration will need to assess whether the changes made are working and have gone far enough, or if further reorganization to harmonize US space governance is necessary—and find ways to make changes that result in more than just rearranging deck chairs.

Budget Considerations

Even the most well-thought-out space security strategy will flounder if it is not supported by the means to execute it, both in terms of budgetary resources and attention by leadership. Arguably, the Bush administration failed at implementing its national space strategy because of a failure to budget funds to cover the extremely high costs required to meet what were, essentially, unviable goals of space dominance and control. And yet, Secretary of Defense Ash Carter stated in March 2016 that the Pentagon would spend $22 billion on space in 2017; $2 billion of that money will be slated toward space control.[81] Determining the right amount to allocate to space control, versus multiple other means to achieve goals, must be part of a strategic assessment. The space environment and the technical challenges of space inherently make it an expensive domain in which to operate, as does the desire for autonomous capability. Prudent stewardship of funding is essential to maximize the funding available. Programs intended to bolster US capabilities regarding SSA illustrate the challenges encountered in development of space capabilities.

Knowing what is going on in space is key to avoiding misinterpretations and consequent dangerous escalatory responses, so advances in that area are largely supported throughout the US space security community, as well as at the international level. Indeed, SSA is consistently touted by Pentagon and Air Force leaders as a top priority. Yet budgetary commitment to SSA programs has been inconstant, even under the Obama administration.

For example, the Space Fence is a second-generation program using a network of radar to track objects in LEO. While a longtime priority for the Air Force, it nonetheless has suffered from budget cuts and delays. According to a 2015 Government Accounting Office (GAO) report, the Air Force has already spent some $1.6 billion on the Space Fence program over a period of several years, largely on development of competing designs and prototypes from Lockheed Martin and Raytheon.[82] The Air Force had originally planned to award a contract for Space Fence systems development in July 2012. But, due to internal program reviews and budget reprioritizations, the date was delayed to 2014.[83] The program was cut back and, in April 2014, Lockheed Martin was awarded a $914 million firm-fixed-price contract. Initial operating capability was originally scheduled for 2015, but delays due to budget issues have pushed that to 2019 at the earliest.

Space programs generally, and military space programs in particular, regularly cost more than originally estimated, take longer than promised to develop, and often result in systems that fall

The point is that there is no limit to what *could* be spent on developing space assets; the question is how much *should* be spent relative to gains.

far below original performance goals. These problems have been particularly evident in space programs. Indeed, as long ago as 2005, Senator Wayne Allard (R-CO), then the chairman of the Congressional Space Power Caucus, bitterly complained about the problem, noting that the "continued mismanagement of our space acquisition programs is a far greater threat to our space dominance than any external danger."[84]

According to the 2015 GAO report, "…current annual estimated costs for selected major space system acquisition programs have overrun and are projected to exceed original annual estimates by a cumulative $16.7 billion—186 percent—over fiscal years 2014 through 2019. The cost increases that DOD is dealing with today are partly the result of management and oversight problems…"[85] Cost overruns on space programs are a problem unlikely to abate.

Also on the Air Force must-have list of SSA-related items is a new Space Based Space Surveillance (SBSS) satellite, a LEO-based satellite designed to better track objects in GEO. In 2005, an independent review team found: that the program's baseline was not executable; that the assembly, integration, and test plan were risky; and that the requirements were overstated. The SBSS was restructured in early 2006, considering cost growth and scheduling delays. The restructuring: increased funding and schedule flexibility; streamlined the assembly, integration, and test plan; and relaxed requirements. The launch of the initial SBSS Block 10 satellite was delayed, and costs increased by about $130 million over initial estimates.[86] Congress began cutting funding for the follow-on system in fiscal year 2011, and the Air Force cancelled the program in April 2013. But in Washington, few programs ever really die; by fiscal year, 2015 SBSS was put back in the Air Force budget, toward building SBSS Block 20 satellites.

There are numerous other examples of military and intelligence space systems that have fallen prey to budget overruns, delays, or budget cuts. The point is that there is no limit to what *could* be spent on developing space assets; the question is how much *should* be spent relative to gains. That makes stewardship of government funding imperative—stewardship based on a prudent assessment of need, viability, and consequences. To come full circle, need, viability, and consequences are aspects of ways and means, and can only be assessed based on clear goals. The Obama administration appears to be making progress on aligning goals, ways, and means—particularly in the area of resiliency. However, the incoming administration will need to remain vigilant, both about setting priorities and reining in mission creep, turf wars, and overambitious planning that contribute to cost overruns, schedule delays, and lower

performance standards. It will also need to be cognizant of the need for balanced investment in the elements of a national space security strategy, rather than simply rushing to build new systems for counterspace operations.

One solution toward better budgetary management would be the long-debated (and congressionally promoted) establishment of a Major Force Program (MFP) for Space. A MFP is a budgetary tool that would provide a unified view of space spending by the Defense Department—a step long recommended by experts, but actively avoided by the Air Force in particular, which has long used the lack of transparency regarding space spending as a means of shifting budgetary priorities from space to air assets. The National Defense Authorization Act for 2016, passed by Congress in May 2015, would establish space as the twelfth MFP managed by the Department of Defense. It also calls for a reassessment of the fiscal year 2017-2020 space budget.[87] Both moves should be welcomed and implemented by the incoming administration.

Conclusion

The next US administration will have the time to undertake a thorough review of both National Space Policy and the underlying National Security Space Strategy. While the risks and threats to safety, sustainability, and security in space are indubitably increasing, there are no immediate threats that require either panic or rushed decision-making. Developing a new NSSS for a changing space environment will require consideration of ends, ways, and means in a proactive, rather than reactive, manner—based on a realistic, holistic understanding of the current and future risk and threat environments. Diplomacy and positive deterrence should be valued and supported as ways to achieve a preventative strategy that, first and foremost, seeks to avoid conflict in space—which, for the foreseeable future, would harm US interests more than those of any potential adversary.

It is further inevitable that other nations will continue to seek the national security benefits provided by satellites. The United States cannot expect to prevent them from doing so, by any means. Thus, it is necessary that any US assessment of its own national security in space take into account the security interests of others, and the need for a secure and stable international space environment. It is imperative for US policymakers to understand that "do as I say, and not as I do" is *not* a viable security strategy in space, or in any other domain. While it would be patently silly for the United States to forgo hedging research on technologies and capabilities that would help it win a conflict that included space as a warfighting domain, if it comes to that very bad end, the US national space security community must be careful what it wishes for.

All things considered, a posture of inferred deterrence regarding offensive space activities is most valuable in helping shape a strategic environment where US space assets are best protected. Finally, the United States, above all, must not be driven into a space-arms competition that includes indiscriminate weapons—weapons that could destroy the space environment for the very commercial and civil uses that are so benefiting the country, and the world at large. Norm setting to avoid these worst-case scenarios thus continues to be a critical requirement, and an area in which the United States must show continued leadership. There is no getting around the fact that what any one actor does in space has the potential to affect all, for better or for worse. This means that cooperation among all space actors—military, civilian, and commercial, at both the national and international levels—must be a paramount piece of any nation's space security approach. The United States has the most to gain from a stable and secure space environment, and the most to lose if space becomes a battlefield.

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