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Space and US Deterrence

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What is ViTTa®?

NSI's **Virtual Think Tank (ViTTa®)** provides rapid response to critical information needs by pulsing our global network of subject matter experts (SMEs) to generate a wide range of expert insight. For this SMA Contested Space Operations project, ViTTa was used to address 23 unclassified questions submitted by the Joint Staff and US Air Force project sponsors. The ViTTa team received written and verbal input from over 111 experts from National Security Space, as well as civil, commercial, legal, think tank, and academic communities working space and space policy. Each Space ViTTa report contains two sections: 1) a summary response to the question asked and 2) the full written and/or transcribed interview input received from each expert contributor organized alphabetically. Biographies for all expert contributors have been collated in a companion document.

[1] For access to the complete corpus of interview transcripts and written subject matter expert responses hosted on our NSI SharePoint site, please contact gpopp@nsiteam.com.

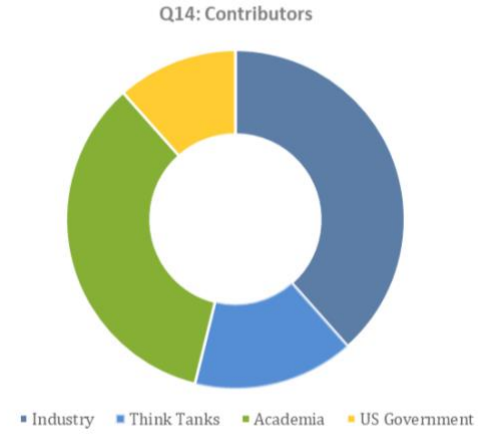
Cover Art: http://www.afgsc.af.mil/News/Article-Display/Article/629485/nuclear-deterrence-the-silent-sentinel/e.jpg

Question of Focus

[Q14] How should space feature in US deterrence strategy? How do space operations, policies, and investments impact multi-domain deterrence? What changes to US deterrence thinking are required to incorporate the space domain? To what extent should space adopt deterrence strategies from other domains? Which is the most critical US national security objective: deterring aggression from space, through space, or in space?

Expert Contributors

Major General (USAF ret.) James Armor[2] (Orbital ATK); **Marc Berkowitz** (Lockheed Martin); **Caelus Partners, LLC**; **Dean Cheng** (Heritage Foundation); **Dr. Damon Coletta and Lieutenant Colonel (USAF ret.) Deron Jackson** (United States Air Force Academy); **Colonel Dr. Timothy Cullen**[3] (School of Advanced Air and Space Studies, Air University); **Dr. Malcolm Davis** (Australian Strategic Policy Institute, Australia); **Faulconer Consulting Group**; **Jonathan D. Fox** (Defense Threat Reduction Agency Global Futures Office); **Dr. Nancy Gallagher** (Center for International and Security Studies at Maryland, University of Maryland); **Gilmour Space Technologies**, Australia; **Harris Corporation, LLC**; **Dr. Henry R. Hertzfeld** (George Washington University); **Theresa Hitchens** (Center for International and Security Studies at Maryland, University of Maryland); **Dr. Moriba Jah** (University of Texas at Austin); **Dr. John Karpiscak III** (United States Army Geospatial Center); **Dr. Martin Lindsey** (United States Pacific Command); **Sergeant First Class Jerritt A. Lynn** (United States Army Civil Affairs); **Dr. Xavier Pasco** (Fondation pour la Recherche Stratégique, France); **Dr. Luca Rossettini** (D-Orbit, Italy); **Dr. Krishna Sampigethaya**[4] (United Technologies Research Center); **Victoria Samson** (Secure World Foundation); **Matthew Schaefer and Jack M. Beard** (University of Nebraska College of Law); **ViaSat, Inc.**; **Dr. Brian Weeden** (Secure World Foundation)

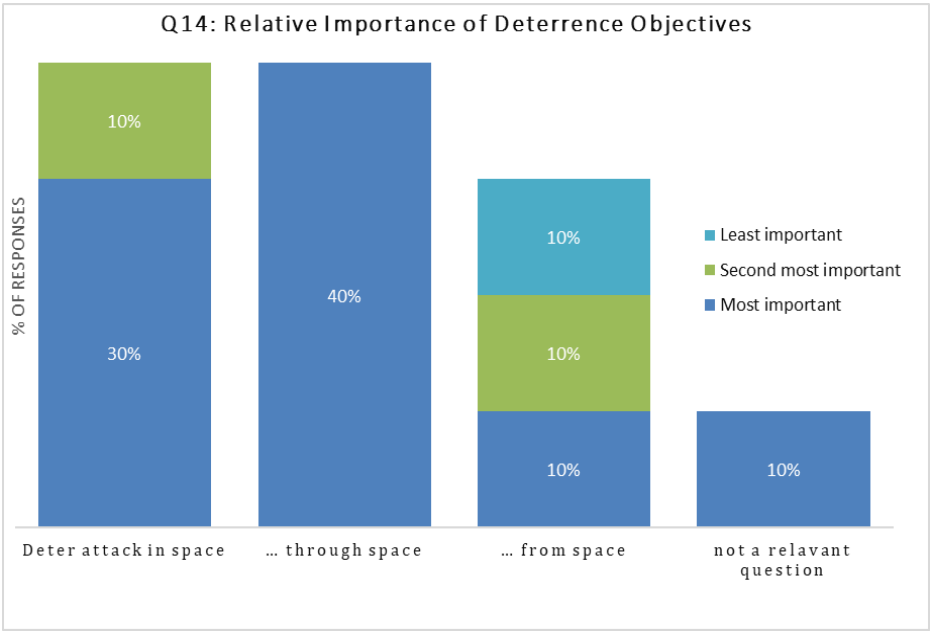


Summary Response

This report summarizes key points from 27 insightful responses contributed by space experts from industry, the US government, academia, think tanks, and space law and policy communities. These also include expert contributions from non-US voices from Australia, France, and Italy. While this summary response presents an overview of the key subject matter expert insights, the points summarized below cannot fully convey the fine detail of the expert input provided, each of which is well worth reading in its entirety.

[2] The subject matter expert's personal views, and not those of his organization, are represented in his contributions to this work.
[3] Ibid.
[4] Ibid.

How Space Features in US Deterrence Strategy (It Is Integral, but…)



Marc Berkowitz of Lockheed Martin and the team from ViaSat, Inc. articulate an underlying presumption that appears in most of the expert contributions to this report. Namely, that strikes against space and cyber assets (whether on orbit or on the ground) will almost certainly feature in the earliest stages of future conflicts. Consequently, there is broad consensus among contributors that space systems should be a "prominent feature" of US deterrence thinking and policy; that they are now integral to the strength of the economy, to US and allied defense in all conflict domains, and are essential facilitators of cross-domain operations. Differences of opinion emerge, however, over what that critical importance implies for US defense postures and policy involving space. Here, two schools of thought emerge regarding whether the exceptionality of the space domain requires a deterrence strategy specifically for space (what we will call 'space deterrence') or whether talking about deterrence of space assets independent of deterrence in all other domains is meaningless (i.e., 'deterrence involving space').

Space Is Unique

The arguments of contributors[5] favoring a space deterrence policy tend to rest on the contention that space is *so* integral to US national security that it demands a distinct space deterrence policy, albeit one that is ultimately integrated with other defense doctrine and policy. The focus for this group is deterring aggression against specific military space capabilities.

Space Is Just Another Domain

However, for the majority of contributors—proponents of the 'deterrence involving space' school of thought— the appropriate question is how to deter aggression in any domain and using any source of national power. This line of reasoning holds that space is so indelibly intertwined in all national security activities that the idea of a separate "space deterrence" is nonsensical. Rather, these contributors—including scholar, government, and commercial views—echo the sentiment of Major General (USAF ret.) James Armor of Orbital ATK that space is "just another medium of national power" and agree with General Hyten's belief that "there's no such thing as war in space; there's just war."[6]

[5] Six expert contributions discussed the need for or the value of a specific space deterrence policy that is ultimately integrated with national security and civil space policy. See Davis and Fox for examples of this line of reasoning.
[6] For similar arguments, see contributions from Berkowitz; Coletta and Jackson; Sampigethaya; ViaSat, Inc.; and B. Weeden.

How Is This Accomplished? (Hegemony Versus Collective Management)

There were also two schools of thought on what contributors considered reasonable and achievable goals regarding defense of space assets. The first group believes that space superiortity or dominance in space is critical to US and ally defense and thus demands a space policy and posture directed toward retaining US military hegemony there. Jonathan Fox of DTRA points out that potential US adversaries are already working to exploit US dependence on space and calls for a space policy based on "anticipatory self-defense," while Sergeant First Class Jerritt Lynn of United States Army Civil Affairs argues that US interests are best served by retaining "hegemonic dominance" in space. Lynn caveats his support for a policy of maintaining US space superiority by reminding the reader that "the image of the US amongst the international community affects US power and legitimacy" and asserts that "the United States must use international space relations to create a narrative that showcases how the US is a steward of an open, secure, and reasonably regulated domain." Lastly, Jack M. Beard from the University of Nebraska College of Law states his argument in terms of the current reality: "The US Air Force has a mission to defend our assets in space and to disable or restrict the other country from operating in space if such actions become necessary in an armed conflict. So, the US Air Force has to have the ability to establish supremacy when it needs to, and it has to be able to control space if that is what is required in order to achieve its mission in an armed conflict."

The alternative view is that achieving space hegemony, dominance, or superiority is not only infeasible, but the act of pursuing such a goal itself is likely to reduce rather than enhance US security. Many of the experts that take this position mirror the argument of French researcher Dr. Xavier Pasco of the Fondation pour la Recherche Stratégique that also represents current reality: "Space remains an environment that cannot be fully controlled." As a result, many of the experts suggest that the US must move toward collective international management, in large part by taking the lead in establishing international security norms for space.[7] Colonel Dr. Timothy Cullen of Air University offers an economic argument regarding the importance of approaching space as a global commons and establishing international norms to manage conflict when it arises. He notes that to date commercial and other activities in space "are financially viable because there remains little need for expensive security measures. It is in US interests for conditions to remain that way."

The Issue of Credibility

Space effects and services go directly to US capabilities to attribute attack and retaliate, and thus to the credibility of deterrent threats. For example, capabilities like space situational awareness support the credibility of threatened retaliatory strikes on Earth. Berkowitz reminds us that "space systems have been integral to nuclear deterrence for years" and more recently are critical components of conventional deterrence as well. Many of the experts argue that space capabilities significantly enhance the credibility of US deterrence in all domains.[8] Dr. Damon Coletta and Lieutenant Colonel (USAF ret.) Deron Jackson (United States Air Force Academy) point out that given the possibility of causing military and potentially economic devestation without necessarily causing loss of life, the response principles and means of escalation control have not yet been well-understood or articulated. As a result, what is required for the credibility of deterrent threats may be different in space than in other domains. Similarly, Fox recommends that the credibility of US deterrence strategy must be shored up with well-articulated response options to a clearly defined series of threats, for example to "national and allied space-based systems, personnel, property, and interests critical to the functioning of core military or civilian societal functions."

[7] Arguments along this line are also made in the inputs from Caelus Partners, LLC and Jah.
[8] For the specifics of these arguments, see Davis, Berkowitz, Karpiscak III, Jah, Lindsey, Lynn, and Samson.

However, the expense of space assets and the US dependence on them may suggest that the credibility of a US threat to take kinetic action in space is difficult to maintain. Cullen argues that "US postures to deter aggression in space with force will be counter-productive and hardly credible … kinetic operations in space risk environmental catastrophe." Other experts argue that deterrent credibility comes from the ability to threaten retaliation in other terrestrial domains. This, in fact, is the US advantage when it comes to deterrence involving space.

How Do Space Operations, Policies, and Investments Impact Multi-Domain Deterrence?

The majority of the experts appear to reject the basic premise of this question. To make this case, a number of experts highlight the historic interdependence between space assets and capabilities to produce military effects in other conflict domains. With respect to multi-domain deterrence, the contributors see space not only as *a* critical enabler but in many cases, *the* critical enabler. While most emphasize additional positives that space capabilities provide to decision makers, like more expansive warning and a wider range of deterrence options, others highlight the added vulnerabilities that relying on space presents (e.g., an additional domain to manage/defend or the greater cost to the US than adversaries of conflict in space).

What Changes to US Deterrence Thinking Are Required?

Although they clearly have different views on other issues, the SME contributors universally point to the prominent place of space within US deterrence and strategic options. Rather than changing how we think about deterrence, Dean Cheng of the Heritage Foundation begins by reminding us that simply changing the way we think will not be enough to forge an effective deterrent including space. Rather, key *conditions* must change—namely the obvious dependence of the US security establishment on space assets. In this context, there are a number of suggested changes to thinking as well. Berkowitz, Coletta, and Jackson assert that the first hurdle is for the national security space community to move beyond the post-Cold War notion that the dissolution of the Soviet Union would ameliorate the space threat. Experts also remark on the urgent need for policy makers to shore up deterrence effectiveness by clarifying for ourselves, our allies, and potential adversaries what the US considers a provocation with regard to space systems. These new bounds of behavior should be followed quickly with demonstrations of US resolve to respond.[9]

Primarily experts classified as academics and policy researchers admonished the defense establishment to rethink what they consider to be the critical components of deterrence as it relates to space or otherwise. Namely, these contributors advise that policy makers pay serious attention to the role and formation of international norms as critical features of US deterrence.[10] Similarly, quite a few experts question the applicability to the space domain of notions of deterrence as punishment, especially where kinetic actions are involved. Rather, as Dr. Nancy Gallagher of the Center for International and Security Studies at Maryland argues, when thinking about deterrence involving space, one should consider the "cooperative dimension" of deterrence, not just deterrence as punishment. Finally, the contributing experts from ViaSat, Inc. make the point that the national security establishment in the US might take a page from the commercial and private sector playbooks with regard to updating thinking about space-related deterrence or strategic thinking. They point out that these space communities should not think

[9] For example, see the contributions from Berkowitz, Coletta and Jackson, Fox, and Lynn.
[10] For discussions of norms, see Coletta and Jackson, Cullen, Davis, Samson, and Sampigethaya.

of space systems such as space situational awareness (SSA); positioning, navigation, and timing (PNT); or communications assets as existing "exclusively in space or the space domain," but consider them to be "complex ecosystems that exist in multiple domains." The ViaSat, Inc. experts add that the least attributable, lowest cost, and most effective attack to a space ecosystem could likely not occur in space, and this needs to be considered in regard to the defense of space ecosystems and their space based assets.

Borrowing From Other Domains

There is no single conflict domain that shares the characteristics of space completely. While a number of the experts reference deterrence concepts from other domains that might be used to inform deterrence strategies involving space, most also echo Fox's caution to avoid "unerring straight-line extrapolation" from other domains to space. Still, as shown in the table below, *insight* may be gleaned from experience and thinking in different domains for specific conditions. For example, deterrence questions about the impact of difficult attribution on the credibility of deterrent threats might be illuminated by submarine or cyber deterrence operations. Space deterrence problems that involve single or limited attacks that can cause large numbers of fatalities may find applicable instruction in nuclear deterrence thinking, while circumstances in which mass effects can be produced without direct loss of life might be informed by literature on cyber deterrence.

Characteristics of the Space Domain	Shared by …				
	Maritime	Nuclear	Air	Cyber	Ground
Attribution a significant issue	submarine operations add difficulty	mobile launchers add difficulty	no	yes	no
Operational environment without physical bounds	no	no	no	yes	no
Many types of actors with significant capabilities	yes	no	yes	yes	yes
Potential for low cost/weapon to effect ratio	no	yes	no	yes	no
National economic infrastructure dependence	yes	no	no	yes	no
Strong commercial sector	yes	no	yes	yes	no
Critical for early-warning of attack in other domains	no	no	no	no	no
Potential for mass destruction or mass effect without loss of life	no	possible exception of EMP attack	no	yes	no

Subject Matter Expert Contributions

Major General (USAF ret.) James B. Armor, Jr.[11]

Staff Vice President, Washington Operations (Orbital ATK)
7 August 2017

WRITTEN RESPONSE

Deterrence *writ large* requires a major National debate right now. Deterrence includes *all* the elements of national power, including space as a conventional domain. Space is *not special* in this regard.

- The only reason to highlight "space" would be because there are *so many misperceptions*, about the special-ness of space, mainly from idealism of the past (and adversaries' cynical exploitation of those feelings)
- Yes, there are some great analogies from other domains, but at the end of the day, space is just another medium of national power that must integrate with all other forms of national power.
- Unique aspects of space are national infrastructure dependence, early warning of crisis/attacks in other mediums, crisis stability, and warfighting capabilities, etc.

Priority would be deterring aggression in space then from space, but must do all simultaneous. ("Through space" is irrelevant – real issue there is ballistic missile defense.)

Marc Berkowitz

Vice President, Space Security (Lockheed Martin)
12 June 2017

WRITTEN RESPONSE

[Q14] How should space feature in US deterrence strategy?

Space should be a prominent feature of US deterrence strategy. Space systems are integral to the overall deterrent posture and capability of the US armed forces. Any nation or subnational group contemplating an action inimical to US interests must be concerned about US space capabilities. Space is the ultimate high ground. It encompasses the land, maritime, and air domains as well as flanks any terrestrial battlefield. Space assets provide US national decision-makers, combatant commanders, and operating forces with unprecedented global situational awareness to identify and respond to threats anywhere in the world. Space systems perform global monitoring, ensure access to denied territory, offer a form of forward presence, and provide indications and warning of hostile intentions and actions. They endure that hostile intentions and actions will be discovered by the US in a timely manner and support the credible threat and application of force in response to aggression. Space forces thus may introduce an element of uncertainty into the minds of potential adversaries regarding whether they can achieve their aims. They are critical to the ability of the US to sustain a force posture that ensures that the costs of the threat or use of force against American interests are unacceptable to potential aggressors and that aggressors are denied the benefits of inimical actions.

[11] The responses here represent the sole views of Major General (USAF ret.) James Armor, and are not intended to represent the position of Orbital ATK.

Space systems have been integral to nuclear deterrence for decades. Since the Cold War, space assets have been oriented to support of the National Command Authorities and nuclear deterrence operations. The national reconnaissance program performs imagery and signals intelligence as well as mapping, charting, and geodesy missions to determine adversary political intentions and military capabilities, support targeting and weaponeering of strategic forces, and formulation of nuclear war plans. Environmental monitoring and weather satellites are employed to support the national reconnaissance and strategic war planning efforts. Defense space missions of course also provide warning and assessment of ballistic missile attack, nuclear detonation detection, positioning, navigation, and timing for weapons delivery, and dissemination of Emergency Action Messages for force generation and execution. In short, space systems remain central to enabling the operational effectiveness of US strategic forces as the ultimate top cover and guarantor of the nation's security.

Over the past few decades, space systems also have become integral to conventional deterrence. Space assets are high technology force multipliers that increase the combat effectiveness of nonnuclear military forces. They are critical for information-based, network-enabled warfare. Space systems collect, generate, and relay information essential for achieving decision superiority. The ability to sense, comprehend, and act first enables the joint force to make informed decisions faster than an adversary. The ability to leverage the global access, speed, persistence, and precision of space capabilities to create kinetic and non-kinetic effects is a foundation of US military doctrine, strategy, and operational style. Space mission capabilities enable formations of smaller, dispersed military forces to maneuver, conduct nonlinear operations, synchronize actions, and mass effects against the adversary.

[Q14] How do space operations, policies, and investments impact multi-domain deterrence?

Space policies, investments, and operations inherently impact multi-domain deterrence for two main reasons. First, as discussed above, space systems are integral to nuclear and conventional deterrence in all terrestrial domains. Second, space systems are comprised of multiple (launch, ground, orbital, up/down/cross link(s), and user) segments that concurrently operate in multiple (land, maritime, air, space, and cyber) domains.

The utility of deterrence with respect to space activities should not be considered in the narrow context of war or peace in the space domain. Despite limited war theories and the notion of creating a space threshold or firebreak to deter or isolate conflict in space, the pertinent issue is war or peace — not war or peace in space. US policy makers and planners must be concerned about deterrence of war as a whole. US policy and strategy must comprehend the adversary in its totality and devise plans of action (i.e., policy) and means-ends relationships (i.e., strategy) that consider deterrence issues holistically. Indeed, reductionist thinking that focuses exclusively on a single domain (e.g., deterrence of aggression against the orbital segment of a space system) will necessarily create blind spots that could be catastrophic for operations in space (e.g., cyber intrusion and takeover of ground-based satellite command and control systems) or other domains because of the failure to understand the interdependencies and relationships between space and terrestrial operations.

Whether or not an adversary can be deterred from fighting in space or for deterrence to function to protect space systems depends on the stakes of the conflict and the adversary's risk calculus. Establishing the necessary conditions for deterrence to work will be dependent upon the specific adversary. Deterrence is a psychological phenomenon in adversary decision-makers' minds. For deterrence to function, the adversary must believe that the threatened consequences (denial or punishment) are proportionate to the interests at stake. The costs of aggression must be seen by the adversary to outweigh its risks. Threats of punishment and/or denial must be credible. Credibility depends upon the political will and military capability to enforce the threatened consequence. Hence, space policies, investments, and operations are expressions of the credibility of US nuclear and conventional deterrents.

[Q14] What changes to US deterrence thinking are required to incorporate the space domain?

US deterrent thinking continues to carry the intellectual baggage of the golden age of arms control and other discredited strategic stability theories from the Cold War that our adversary did not in fact accept (i.e., mutual societal vulnerability as the basis for stability). The US must see prospective adversaries for who they actually are. We must not presume that Russia is the Soviet Union or China is a lesser included case of Russia. We must not engage in wishful thinking or mirror imaging. Instead, US policy makers and national security planners must come to grips with the demands of multi-domain deterrence and warfighting against near-peer or peer adversaries

armed with equivalent or perhaps even better space capabilities who come from a different political culture, history, and geography than America and who think differently than we do.

We must recognize that our adversaries already are conditioning our behavior, managing our perceptions, probing our defenses, and raising the noise floor to conduct "grey zone" operations in "peacetime." The US thus far has done little in response other than to issue a few demarches and demonstrate some of our defensive tactics, techniques, and procedures. We have not demonstrated the resolve to address the increasing prevalence of deliberate interference with space systems over the past few decades despite long-standing national policy that such purposeful interference will be considered an infringement on our sovereign rights.

While the decision to initiate aggression will be made by humans on Earth, the first hostile actions in future contingencies are likely to occur in cyberspace and outer space before the initiation of kinetic strikes that take human life in a terrestrial domain. The precursors to nonnuclear warfare are likely to involve attacks with non-kinetic, reversible effects that are concealed to create ambiguity and to make attribution as difficult as possible. Similarly, we must recognize the need to prepare for attrition in a deep crisis or conflict, a sudden threat surge against space-based strategic forces C4ISR assets during nonnuclear hostilities, and a multi-weapon space control campaign during regional or global conflict.

[Q14] To what extent should space adopt deterrence strategies from other domains, e.g., maritime?

The US national security space community should leverage the empirical experience of military affairs in all domains to learn applicable lessons for deterrence, escalation control, and warfighting involving space operations. In particular, given some of the commonalities between the space and maritime operations environments, the space community should look to the historical record in the maritime domain, particularly subsurface, for appropriate analogies.

Critical lessons that should be applied to US space force structure, posture, and operating practices, among other things, include: importance of classical strategy relying upon both offense and defense as well as their integration for synergistic effect; deterrence by denial and punishment; utility of active and passive countermeasures working in combination to achieve mission survivability, endurance, and operational continuity; applying a mix of passive countermeasures (e.g., signature management, mobility, distribution, diversification) to mitigate or defeat specific threats; value of covert or clandestine capabilities; value of strategic, military, and technical deception; and criticality of intelligence and counterintelligence support — know the adversary (political culture, history, geography), character and personalities of individual decision makers and commanders, strategy, doctrine, war plans, command and control arrangements, etc.

[Q14] Considering return-on-investment in general terms, which is the most critical US national security objective: deterring aggression from space, though space, or in space?

All are critical. Deterrence policy must address deterrence of war as a whole, not just deterrence of war in a particular domain or particular types of hostile acts. Return-on-investment considerations in all of these cases involve the supreme stakes of the nation's survival as a sovereign entity. In terms of deterrence of space-related hostilities, however, deterring aggression through space via the use nuclear-armed intercontinental ballistic missiles and submarine-launched ballistic missiles must remain the top priority given the current and prospective threat environment.

Deterrence of aggression from space might supplant deterring aggression through space in the future, however, if Russia, China, or another nation began developing, testing, or deploying space-to-surface force projection capabilities. Force application from space against terrestrial targets poses unique defense challenges because of unusual attack axes and short flight times and would pose a grave danger.

In the meantime, deterring aggression in space should take precedence over deterring aggression from space because of the strategic significance and value of space assets to the US society, economy, and national security. Loss of political and symbolic space assets, spacecraft critical to the functioning of commerce, finance, and trade, or loss of essential military and intelligence space systems would strip the US of the benefits of the information-age economy and network-enabled warfighting returning us effectively into a 1950s-era economy and military.

Caelus Partners, LLC

Jose Ocasio-Christian
Chief Executive Officer and Anonymous

24 August 2017

WRITTEN RESPONSE

Caelus Partners believes that the only effective deterrence strategy for the US and every other nation is to create a community in which scientific collaboration, nation-state interests, and commercial competition can be coordinated and managed. We have provided our effort to support this concept through a document named the Community in Space™ Campaign Plan, which is working to build the principles, policies, and investments necessary for this collaborative community.

Dean Cheng

Senior Research Fellow
(The Heritage Foundation; Asian Studies Center, Davis Institute for National Security and Foreign Policy)
2 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: Okay. So, let's shift gears a little bit in to the deterrence side of things. How should space feature in US deterrence strategy, and what changes to US deterrence thinking are required to incorporate the rapidly evolving space domain?

D. Cheng: So, the first thing we need to do is to stop thinking about deterrence in space (i.e., how do I deter an adversary from operating against a certain satellite or from developing certain capabilities?). Because: 1) you are not going to stop somebody from developing a capability that they think is necessary and 2) you are not going to stop them from attacking something of yours if it's sufficiently vital to you.

By the way, this goes back to the question, "are other countries going to end up as dependent as we are on space?" Other countries have us as an example—they will not replicate our infrastructure. So, if we are dependent on space, two things happen: 1) we ***invite*** attacks, essentially, against our space systems and the entire space enterprise and 2) we make sure that other people ***don't*** become as dependent on space.

So, what is it that we can do? I would say that the Chinese and the Russians actually have the right idea on this, which is "deterrence through space"—not just "deterrence in space." Space is one of the various instrumentalities available to achieve deterrent objectives. During the Cold War, there was a joke where two Soviet tank commanders sat under the Eiffel Tower, and one turns to the other and says, "Who won the air war?" The point here is, if you successfully "deter" action in space and you lose Taiwan or you lose Poland, is that really a success?

So, we should be thinking about what can we do in space to raise the price of terrestrial aggression, and, conversely, what is it that we are doing on the ground that reduces the vulnerability of our space capabilities? For example, when the Chinese buzz an EP-3 or a P-8 as they have just done yet again in the past couple of weeks, I would say that that would've been a perfect time for us to have done a GSSAP [Geosynchronous Space Situational Awareness Program] close approach towards a high value Chinese satellite system that we know of. The point is: you buzz us, we buzz you—it doesn't have to be terrestrial.

The adversaries, if they are limited in their reliance on the space, then in that case we really aren't going to be able to deter much. But, on the other hand, if they do require space, and as the Chinese seem to more and more identify targets in the Central Pacific, then we want to demonstrate a range of abilities to counter that. By the way, those don't have to be kinetic. For example, passive denial of information can still be useful. If we can demonstrate, as we did during the Cold War, that even with overhead persistent coverage, I can sail a carrier group off of Petropavlovsk (the main Soviet submarine facility at that time), then that is a very powerful deterrent message. How does that touch on space? Well, to some extent because we were able to evade their space capabilities.

So, going back to your last question, the problem there is going to be, "Well, you have ubiquitous persistent overhead coverage, how do you avoid being detected and tracked?" I think it's still possible, but that's a lot of energy in that sense.

Dr. Damon Coletta & Lieutenant Colonel (USAF ret.) Deron Jackson

Dr. Damon Coletta
Professor of Political Science (United States Air Force Academy)

Lieutenant Colonel (USAF ret.) Deron Jackson
Director, Eisenhower Center (United States Air Force Academy)

8 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: Okay, great. That actually brings me to the next question I was hoping to ask you, which has to do with deterrence. How should space feature in US deterrence strategy, and what changes to US deterrence thinking are required to incorporate the rapidly evolving space domain?

D. Jackson: Well, we are the ones that originated the concept of layered deterrence back in 2009 that went into the 2011 National Security Space Strategy. However, their spin on it was slightly different than ours, so Damon and I can provide a slightly different perspective to it. The basic thing we came up with was that the traditional thinking about deterrence in terms of purely rational cost benefit analysis based on threats of retaliation is not adequate or well-matched to the space domain, because even with asymmetrically invested actors, it might not be credible that we would go kinetic, for example. Your last resort for assuring deterrence is not your threat to wipe out everything the other side has, because, again, you may be in an asymmetrical relationship where you don't have as much of a target set for them as they have for you. What you want to demonstrate for credibility—which goes back to thinking from the Cold War—is that whatever they try will not deny you the ability to continue to operate and achieve your objective, presumably a terrestrial objective.

Thus, an adversary is not simply going after space for space's sake. In the same vein, you don't simply want space for space's sake. Ultimately, the benefits that operations in the space domain have are for terrestrial military operations and achievement of objectives. Thus, you want to be able to demonstrate a multiplicity of ways to sustain your military operations. So, that last phase of denial, or the ability to fight through whatever the other side throws at you, is essential to maintain the credibility that you are going to be able to inflict pain on an adversary or deny them their objective (i.e., you're still going to be able to fight). That's what is essential to deterring an adversary far more than threats of retaliation, because it affects their basic calculus which led them to consider messing with your space assets in the first place, thinking they could gain an advantage over you. Deterrence is enhanced if the adversary sees space systems as one part of a

larger suite of capability which will still function to deliver defeat to them even if the space segment is attacked.

So the end result is to sort of set space aside so that other actors are deterred from going after it in the first place, given the many costs of doing so. The initial costs associated with violating the first layer of international law and norms are not likely to dissuade the most aggressive actors. It is more likely, however, that the consequences of entanglement (i.e., dragging other national or commercial actors into the conflict when they may want to keep it limited) may affect an aggressor's calculus in seeking a quick and easy victory by knocking the US off balance. For the few enemies that might be willing to risk both international outrage as well as drawing other actors into the conflict, demonstrating that all their best efforts didn't prevent you from maintaining continuity of operations as they were hoping for, you want to create doubt in their mind that it's worth all that just to lose in the end. Wouldn't it be better if they just kept space off the table?

D. Coletta: So, that report that Deron mentioned was submitted to OSDP, and we also published a copy of it in our small peer reviewed journal titled *Space and Defense*. I have a follow up question for Deron. That work on space deterrence is probably one of our most high-profile pieces over the years, and it was criticized, wasn't it?

D. Jackson: Well, we encouraged criticism in the journal. So, we ran competing views about space deterrence in the same journal where we lofted our solution, because that's the way we work as an academic entity here within the Academy—the idea being that getting that criticism fosters a better understanding of the subject. We're not a policy making organization. We do study policy and theory, so we think it is useful to offer an idea out there and then have other people criticize or critic it. We try to represent one point of view and all the reasonable competing points of view.

I think one of the basic criticisms that I remember from that time was the whole notion of calling out space as a separate area of deterrence, rather than just seeing space as part of the larger continuum of deterrence (i.e., in the general deterrence theory). The idea was that you don't want to say that space alone is an area where you deter operation, rather you want to say that you want to deter a hostile actor from doing something at any level of conflict—which is a harder challenge to meet and also wasn't what we were charged with doing. We were charged with looking at the idea that if you can't really actively defend space satellites and space systems, how could you at best deter using other aspects?

One of the criticisms that I think we took the most flak for was, as Ambassador Harrison used to say, people probably thought we were bedwetting communist sympathizers or fellow travelers because we put norms up there as the first layer of deterrence. The idea there was not that norms were sufficient to deter an adversary, but that as an initial layer, we thought that norms provided a useful feature for the government in seeing who's on board. This goes back to the rules of the road idea—the people that are basically on board with you and basically adhering to standards of behaviors, you don't have to worry about them because they are self-deterred because they want to comply with these steps of international behaviors. So, going through that first layer lets you know who your outliers are, which should get your attention. If there is an actor that is not deterred by normative arrangements for space, then they need to have other pressure put on them, and that's where you start building your alliances—either with the commercial side or with other likeminded part nations or outright allies—because the adversary will be deterred by the fact that now they have to go against not just the United States but a whole constellation of wider players (i.e., if they tread into this area and mess with one or the other space systems, they'll not only have the first layer of international scorn heaped upon them, but the second layer will actually have offended and disrupted people that maybe they needed to partner with on other areas).

That process ought to take care of another layer of bad actors. So, by the time you've got through those first couple of layers, it should be only a small number that are now worried about outright retaliation in kind, in some other domain, or through some sort of horizontal escalation. That ought to deter yet another group, and it's only the, hopefully, single hard case that burns through those first three layers, which you now have to worry about demonstrating your capability to continue to fight no matter what they've thrown at you.

So, these increasingly hard layers that you get through were part of an overall package designed to whittle down competitors or those that want to contest the space domain. And, eventually, the idea is that the last layer takes care of even those if you can demonstrate a willingness to put up a resistance at each layer. So, for example, if someone blows through an international norm and you don't call them out for it, then the lesson they're going to learn is that "hey, this really was nothing." Or, if something happens and you're on your own and you have not entangled them in a wider coalition that shows, "hey, you're not just messing with us. You're messing with the commercial side, our allies, our partners, etc. and it's a much bigger fight," then your deterrence is not going to work there. So, you're already two steps into failure if you let those softer layers be compromised without response. Rather than taking a kind of a soft and squishy, kinder, gentler arrangement for deterrence, we envisioned something that requires a lot of activity and engagement from the very, very beginning so you're sending warning signs as to what you're not willing to tolerate, before you even get the necessary steps of maybe needing to retaliate or activate other alternative systems to ensure you can prevail.

D. Coletta: If I can, I just want to add a different line of inquiry. I helped out on this layered deterrence paper as a research assistant, so I like the paper but I'm also willing to be sympathetic with the criticism, and not so much the criticism that Deron was just talking about with norms being the first layer, but, and I'm going to be flippant here to try to make a point and contrast, I think of the layered deterrence report as 'The Princess and the Pea' version of deterrence where the pea is that satellite and you've got all these mattresses and layers of deterrence, with the top layer being norms.

I think the criticism that the paper didn't take into account space as part of a general deterrence scenario is a legitimate criticism, and I think it takes you to another line of work that's being done on cross-domain deterrence and multi-domain deterrence. From what I what can tell, the Joint Staff, the Services, and the OSD are all interested in this possibility—the idea that you could have operations that are tied to the same conflict of interest that are crossing over domains, and how to try to manage that in a way that would shore up general deterrence (i.e., deterring attacks against your interests in general).

So, there is the Eisenhower Center paper, but there's also this line of research that's coming out by different names (e.g., cross-domain deterrence, multi-domain deterrence). I'm thinking you've probably of already come across some of these folks and efforts, but an example like the Gartzke and Lindsay cross-domain deterrence project at UCSD that is being funded by Minerva (OSD AT&L OSDP) incorporates the space domain, cyber domain, and nuclear domain. Basically, there seems to be a lot of talk currently that I think is really a complimentary line, and not really contradictory line, to what the Eisenhower Center said head to head. So, this is certainly something else to think about when you think about space deterrence—what happens if you're involved in a conflict in the South China Sea, for example, and one of the responses is an attack against a space asset? In this scenario, it is no longer the princesses and the pea—you're no longer trying to protect the pea, you're trying to keep that attack against the space asset as part of a larger conflict from putting the United States in a position where they have to fire off everything at once and approach Armageddon or concede. You're back to this question of managing escalation and escalation dominance.

So, to answer your question, I think there's layered deterrence as a proposal, which, again, is the princesses and the pea situation where you're trying to protect the pea (i.e., protect the

satellites). Additionally, there's this other complementary line that you have to think about where space becomes part of a larger regional conflict with escalatory potential. So, is part of space deterrence being able to manage escalations in multiple domains at once? That's a pretty hard question for most of the bureaucracy to figure out because each element of that bureaucracy is typically responsible for just one piece of that conflict—getting all of them to think on the same page at speed in real time is a difficult problem, which is one of the reasons why I think OSDP and OSD AT&L have been so interested in it.

D. Jackson: This raises the concept of what space contributes to deterrence? That was something we came across in the year we were working on our report, but it was not really relevant from the question that had been queued up to us. But, I think it's very significant when you start thinking cross-domain, because it ties back into the idea of the mattress level where you're trying to protect a particular space asset through these different layers of padding and support. The idea is that space is your vehicle at the earliest stage of a crisis to make the other side aware that you know what they're up to and that they've lost the element of surprise, or your vehicle to share that fact of what they're doing in some level of detail so that you can then build a coalition (at the government level) of those willing to resist that action, assuming that the hostile actor is going to be denying that they're up to anything bad in the first place.

A good example—and analogy for the challenge of dealing with space assets—of this would be if you think about the Cuban missile crisis, at some point, to call out to Cubans and the Soviets, the US presented pictures from surveillance from flights over the island to say, "well, look here Mr. Ambassador, here's what you have on that island, and we're ready to wait until Hell freezes over for your answer to explain why you have these systems on that island." Well, the US has to be capable and willing—capability probably isn't the issue, but willingness probably is—to share that type of evidence at the early stages of a crisis to build up some deterrent effect against an adversary.

This, I think, loops back to your relationship with the commercial side—if we could, by some other means than a US government asset, attribute behavior either in space or on the ground to a country that was about to do something that we wanted to deter them from doing, then that would be advantageous for the US government. Essentially, we could use the space resource to contribute to deterrence without burning sources and methods or capabilities that you might otherwise want to put on hold for anything short of all out nuclear war.

The great challenge in taking deterrence literature and applying it to the space domain is that for all the bad economic, societal, and military impacts that hostile activity in space might have over the long-term, it doesn't affect the terrestrial outcome in the same way that a total nuclear exchange would. So, we had to figure out what was credible for the US to threaten in response to something that could be extremely bad, maybe even economically and militarily devastating, in space that didn't have the corollary physical destruction for society as a whole. That was a big problem, and still remains a problem today.

D. Coletta: It's a problem both in protecting the asset itself and in escalation management. Because you can imagine scenarios—and these kinds of scenarios are being published now (e.g., "The Case for US Nuclear Weapons" by Brad Roberts)—where you could imagine an adversary thinking that an attack in space that causes destruction in space without physical destruction on the ground would be a way for that adversary to signal to the United States their seriousness, the asymmetry of resolve, and perhaps get the United States to back down. Essentially, the attack on a space asset is part of a larger conflict, and makes the management of escalation more difficult.

D. Jackson: We have to consider our willingness to escalate horizontally (i.e., be cross-domain in our respect). If the US were to face a disabling attack on one of its space assets, is it credible to think the US would use kinetic force on the ground as punishment for that action? If the effects were truly confined only to space, or the debilitation of US capability to retaliate—which comes down

to, "well, shame on you for being so reliant on that particular asset or resource—then the burden is then on the US to demonstrate its willingness. It really comes down to willingness, not capability, to respond for that. So, again, you have a relationship where if responding in kind and taking out something of that aggressor state's own constellation isn't there as an option, and our only option is to escalate into another domain (i.e., land, sea, air, or something that's tangible and kinetic), then the credibility just doesn't measure up in a lot of scenarios.

D. Coletta: So, Deron and I are playing off each other here, but if this is something of interest to your SMA effort, then I think academia could help you, because academia is interested in different models of conflicts. For example, in the classic deterrence literature, you have: 1) the chicken game or the competition in risk; 2) the escalation management, crisis management, and escalation dominance games, where you have enough capability so that you can respond to whatever the other side is throwing at you (i.e., rather than concede or end the world, you always have a response at the ready); and 3) the frozen conflicts game, which has received less attention but is something that I think could also be going in current situations like Ukraine, the US relationship with Iran, and potentially with China as well. The frozen conflicts game relates to situations where the adversary is able to break something off of value, and the defender has a heck of a time trying to tie that morsel, if you will, to larger interests in the way that the Berlin Brigade tied little Berlin to larger interests of the West. If you get involved in something like that, where the situation looks more like a war of attrition, then that's where things aren't really escalating, but the adversary is kind of hanging in, hanging in, hanging in until the United States let's go of the morsel—that's the game of attrition.

So, if you get interested in space deterrence as part of multi-domain conflict or multi-domain operations, it's going to be important to know, as you're figuring out policies, what kind of game you're preparing for—because in each of those games, depending on which one of the games is applied, I imagine that you get different policy outcomes. My point is that there might be a nice way to draw from the way in which academia models these scenarios with the way in which you all are modeling the scenarios when you're thinking about policy.

D. Jackson: So, Damon, with respect to the terrestrial example of attrition that you were outlining, would you agree that Crimea and Ukraine is kind of an example of this? In this case, the Russians managed to break off Crimea, there wasn't much the West could do about it, and now Russia continues to grind away in eastern Ukraine. There also seems to be a level of fatigue for the United States, the European Union, and NATO, which has provided Russia with the opportunity to continue on in these efforts. Though, I'm not sure what the space counterpart to that would be, but it is illustrated **…**

D. Coletta: Yes, the potential space counterpart that you mention here would have to be something about a position in space or a new space capability that could be broken off from the expected escalation chain. And that might be a type of play that the US government isn't prepared for, but they could end up losing because the other side would win the war of attrition (i.e., if the adversary can break something off that the other side, the defender, can't easily tie back to larger interests). Because if you can't tie it back, the escalation management never happens because it never becomes credible. So, our concrete examples for this are Crimea or the reefs in the South China Sea, but I think it remains unclear what that might look like in the space domain in particular. Space is involved because you wonder if the game of attrition is multi-domain, because a lot of the times the way in which we respond to Crimea is in other domains—though, I don't think we responded in the space domain in this particular case, but I would say the economic sanctions enacted in this case illustrate the multi-domain approach.

A game of attrition and multi-domain operations are connected, have been connected, and it's certainly feasible that multi-domain operations involving space could eventually get wrapped up in a game of attrition—for example, either some morsel has been broken loose in space itself or space operations are part of imposing very minor costs to stay in and hold on to something else

that is not in space. Another example that just came to mind would be another ASAT test. The Chinese ASAT test caused debris and it caused a lot of protest, but it really didn't cost the Chinese too much. So, you can imagine something like that happening as part of a game of attrition, just to say, "hey, we're not going to let go of the reefs, and here's an example of how we're not going to let go, so you either let go or you're going to have to pay costs in other domains." This might be something that could come back into play—something that's annoying but doesn't lead to major crisis or escalation management. You could see space getting involved in that way.

Interviewer: Okay. Great. Well, thank you both for the robust and insightful response to these questions. I think this is actually a good time to open it up to my colleagues on the line, who I imagine have some additional deterrence-specific questions. So, Lt Gen (ret) Dr. Elder, do you have any further questions for Damon and Deron?

General Elder:[12] Sure, I will jump in with a question. I'm glad to hear you both talk about deterrence, and I'm glad to hear you both recognize that when we talk about deterrence against space behaviors, we're not talking about mutual assure destruction, we're talking about escalation control, crisis management, etc. So, let me ask you about the warfighting component of this. When we talk about making space a warfighting domain, we wouldn't just be saying that it's a warfighting domain for the US—it would be the warfighting domain for our competitors as well. Has your team talked at all about what the implications are of our competitors treating space not only as a place that they contest, but as one that they actually do warfight in, and how that would affect the United States?

D. Jackson: At the time when we were doing this study, which is now coming up on 10 years ago, the temperature of the whole warfighting domain discussion was a lot lower. So, we were trying to deal with it in more of a truly hypothetical situation where hopefully with sufficient engagement at the early end, there would not be any need to escalate all the way up to the warfighting level. Other than at the ASAT level, which was kind of a crude but simple way to organize thinking around, we weren't worried about fleshing out particular warfighting-type breadth. As the intervening 10 years have spun on, I think the level of potential sophistication for warfighting effects has increased in what's discussed publicly—and, again, we're constrained by operating just within the unclassified world, so our ability to speculate is limited by that environment. I think if you really get into concerns about warfighting, and if the adversary is confident that they can get a return on their investment for going that way, then you may need to up your ante in how you want to deter them from breaking the seal on that. This might be done through an intervention at the very earliest level, so that you threaten to escalate and emphasize that whatever goes on will clearly not be constrained to the space environment. Is that connection to general deterrence going to be the essential element here? This, again, was one of the criticisms of the narrowness of our study, based on the narrowness of the question. So, it may be the time to revisit how space is wired in to the overall theaters or domains of warfare, so that an adversary can't see itself as being able to successfully fight and achieve an outcome.

General Elder: I think one of the issues here is that today whenever we talk about warfighting in the US, it is always an away game except for homeland defense. Once we make space a warfighting domain, then we basically set ourselves up to have what I'd call a home game type of situation, and that's one the pieces of this that I'm not sure we've really thought through. We have 3 legs of this thing—we're looking at the deterrence piece, the resiliency piece, and the norms piece. Once you declare something a warfighting domain, then that implies that you accept that in times of crisis, actors would be able to do things that they wouldn't do in peace time to advance their interest. If we don't consider it a warfighting domains, then the norms would be different about

[12] Lt Gen (ret) Dr. Robert Elder (George Mason University).

the types of things that you could do. These are just the kinds of things we've been trying to work our way through. So, if you have any thoughts on this, it would be great to hear them.

D. Jackson: One of the things that comes to mind here is to go back to some of the earlier questions and look at the investment and engagement of the commercial sector. It's a very apt description to say it's a home game for us, but that also makes it a home game for a lot of other people. So, conveying to that hostile actor that, if they pick a fight and decide to engage in warfighting in space, then the limitation is not going to be to the space realm exclusively, nor to the US as a competitor in that, because they're going to be making a home field attack on any number of other players. So, the greater interconnectivity—entanglement as we called it—ought work to our advantage if we can persuasively impose upon that hostile actor to certainty that they're not going to be able to restrict things. Their ability to be discreet and surgical leads them to greater calculation that they can get away with it. Well, if we can muddy that calculation and introduce ambiguity favorably, in this case on our side, that they can't get away with it, I think it would enhance deterrence and dissuade them from trying to go space warfighting.

D. Coletta: Just to add some additional thoughts. First of all, you guys are going to way ahead of us on that issue. I can tell you that what we've seen is that there's a thought out there that it matters whether the weapons are actually operating from space. So, I would think that one of the things that you are thinking about when you think of space as a warfighting domain, is what sort of cost could you impose should another state base weapons in space? Can you maintain space itself weapon free? I'm not sure what the implications of that are, because some of the satellites are going to be vulnerable in either case. My sense of it is that you want to try do that, so if you want to try to keep space weapons free as it has been, then there ought to be plans for what the response will be, and credible communication that would deter others from putting their weapon there. Then you still have the problem of vulnerability to Earth-based weapons. And I don't think that we have gotten very far on that, but we go back to what Deron just said, which is if you go ahead and use those against us, there are going to be consequences in other domains. But, to our knowledge, there's not a very specific policy about that. So, I think it's a real hard problem that's just a set of questions that have come across our desk.

Interviewer: Great. So, does anyone else online have any questions for Deron and Damon?

D. Coletta: Well, let me ask you a question. When you're thinking about space as a warfighting domain, do you use concepts like "offense dominant" or "defense dominant"? At the unclassified level, do you talk about the idea that things are nearly impossible to defend so we have to escalate in some other domain? Is that the line of thinking that you're at, or is it possible to develop new technologies to make satellites either able to run away or ride out attacks? Is that something that's feasible given the limited budget?

D. Jackson: Well, just to add in one other element here, one way to defend satellites would be to suppress enemy systems preemptively. So, if your weak on the defensive side in terms of up-armoring or inserting a whole lot of maneuver without compromising service life, then you would want to go ugly early and suppress what the other side had.

D. Coletta: So, are those talked about as technologically feasible options?

Interviewer: I will defer to Lt Gen (ret) Dr. Elder here on this question.

General Elder: So, you're getting into the crux of the issue here. Realistically, you do have some thoughts that the preemptive approach might be required to be effective, and, by the way, I think that's partially what's driving this line of thinking that we need to start thinking about space as a warfighting domain, and in the way that we would of a conventional type domain. For example, if we thought that someone was posturing to take out our ability to defend ourselves, then we would feel compelled to take some kind of action. I think there's some reasonable to that, but that is still actually a little bit different than the way we would treat a warfighting domain. The

fact that we would take action to defend ourselves is one thing, but once we start talking about preemptively operating that space, that's where it gets a little murky, I think. So, I'm just pointing out what I think could be the issue. The reason we're having these conversations is to try and help us better understand the issues, and one of the things that we're looking at is the implications on the United States of treating space a warfighting domain. So, we're trying to understand all aspects of this, and my earlier question comes from the standpoint of enabling us to start thinking about the preemptive-type activities for defense that work well. If we inadvertently do something that leads an actor to think that we're about to take away something of theirs, how does the escalation control work? We haven't really talked that through, so I don't know if you guys have thought about that.

D. Jackson: This was actually part of the first about 15 years of debate within the nuclear strategy community, when they were trying to grapple with all these ideas that we now come back to look on as being deterrence theory. There is an article by Glen Snyder from the 1960s that contrasts deterrence and defense, and points out a dilemma that as you are building up your force structures, there are some things to help you defend and then there are some things to help you deter, but they're not the same systems, they're not interchangeable.

The dilemma is: at what point do you need to have capabilities that don't have any defensive value (i.e., capabilities that are purely offensive), and then how do you manage that mix, and then also how does your adversary see that as they are building up, and then can this relationship in anyway be construed as being stable? I think for the first at least 15 years, the scholars of that time were trying to wrestle with these problems, just as we now are trying to apply them in space, because there's not a uniform continuum of have options for people. It comes down to, at some point we may need to be preemptive. This was on the table in the early ages of the nuclear confrontation. So, ultimately, this problem is new in this domain, but it's not a new problem—the classic dilemma emerges, and the relationship between states goes through a certain phase.

D. Coletta: On the nuclear side, the way it gets resolved is that you end up moving towards launch on warning and the so-called hair trigger strategy, so it makes the whole thing I guess less stable—you have lower crisis stability. I guess one of the things that you're liable to run in to if you're responsible for treating it as a warfighting domain is, at what point is it worth it? How unstable are you willing to go, and how unstable is the other side willing to go, because they have voice in this too? Just the recognition that if you can't harden satellites, if you can't build the technology to allow them to run away, and if you start moving toward preemption, then you're starting to change the level of stability, and you're probably going to enter a competition in risk taking there. In the nuclear domain, you have agreements to kind of stop that competition—you have moves to reduce crisis stability on both sides, and then recognition that it's probably not a good idea, at least in the nuclear realm (it would probably also not end up being a good idea in the space realm, either). Then, eventually, you come to some kind of verifiable agreement to keep that instability in check. So, that's where that eventually goes.

D. Jackson: So, to come back to Lt Gen (ret) Dr. Elder's example of the home game for space, cities were the early targets and they couldn't be hardened or moved, so they had to come to the grips with that dilemma. Space was essential in providing stability in that area, because it gave you some idea of what the other side's capability was when the early reconnaissance programs came on board. In the domain of attacks on aerial reconnaissance, the space domain was a necessary evolution for awareness of the other actor's capability, deployment patterns, and ultimately warning of launch, so you weren't blind and, therefore, stuck not being able to identify an attack before it was really too late to do much about it. So, maintaining that role for space in space itself, and circling back on the idea of situational awareness and surveillance and maintaining a good picture of what's going on will, like it was during the nuclear era, probably be absolutely essential to maintaining some sort of stable relationship amongst powers in the space context.

D. Coletta: Just to dovetail on that, space was part of moving toward that so called verifiable agreement, and "verifiable" being one of those ambiguous terms, but space was the key element of that. So, if you're going to defend assets in space, treating space as a warfighting environment by reducing crisis stability, then the next step, as long as the adversary also feels the heat, is moving towards some kind of verifiable agreement, not to eliminate instability but to somehow hold it in check. There's only so far that can go before it's against the interests of both sides. I guess, looking back at the nuclear era, that's where we would see that dynamic going over time.

General Elder: Great. Thank you for the insight. I'm glad to hear you talking this way because most people do not have that level of understanding that you have, so I appreciate you speaking with us.

Colonel Dr. Timothy Cullen[13]

Commandant and Dean (School of Advanced Air and Space Studies, Air University, Maxwell Air Force Base)
15 August 2017

WRITTEN RESPONSE

Operations in and from space should supplement land, sea, air, and other deterrent actions. They should not supplant them nor should US deterrent postures completely rely upon space operations or support. A deterrent capability from a domain that is also a global commons is inadequate on its own and is highly vulnerable to surprise, not unlike how the naval undersea leg of the US Nuclear Triad could never deter near-peer adversaries on its own. The most credible and secure form of deterrence originates from the domain completely under control of the defender—sovereign territory, airspace, and territorial waters. Deterrence activity from space to protect space assets is ludicrous as well as overly expensive. There are no people in space to protect. There is no sovereign territory in space to defend. Yes, there are machines in space to safeguard, which represent a large US investment, facilitate a significant percentage of the US economy, and enable the US government to conduct military operations around the globe and dominate its adversaries, but the US government and military should provide incentives to ensure the economy and security of the US are not wholly dependent on numerous yet eternally vulnerable autonomous robots in orbit around the globe.

US postures to deter aggression in space with force will be counterproductive and hardly credible, if at all. The US has the most to defend and lose in space due to a potential space conflict, which would risk not a single life in the domain. Kinetic operations in space risk environmental catastrophe, yet even in worst case scenarios where the space domain is rendered completely unusable due to space debris, governments and societies would adapt and economies would rebound. No civilians will have died and the effects of the conflict would be effectively invisible for a vast majority of the public. Yes, profit margins in the commercial sector will suffer in the short term and international markets will decline temporarily, but farmers will again learn how to drive their tractors in straight lines without GPS navigation and gas stations will relearn how to charge their customers for their services without timing information from space. Regardless, enterprises in space are financially viable because there remains little need for expensive security measures in and from the domain. It is in US interests for conditions to remain that way.

[13] The views expressed in Colonel Dr. Timothy Cullen's answer to this question do not reflect the official policy or position of the United States Air Force, Department of Defense, or United States Government.

Dr. Malcolm Davis

Senior Analyst – Defence Strategy and Capability (Australian Strategic Policy Institute)

21 August 2017

WRITTEN RESPONSE

Key Findings

1) Space is becoming both contested and congested. The development of adversary 'counter-space capabilities' (kinetic and 'soft-kill' ASATs) threatens US Space Assurance.
2) Although adversaries would have to consider the implications of US retaliation in the event of ASAT use, they are under less constraint in terms of introducing operational space weapons capabilities than the US and its allies in western liberal democratic states.
3) Commercial space, and 'Space 2.0' open up both risks and opportunities. Space 2.0 technologies in particular make it easier to exploit space for military purposes in innovative new ways, but also see broader access to Space for a wider range of state and non-state actors including those who are unfriendly to the US.
4) A key transformation to watch is the development of reusable launch capabilities – reusable rockets, airborne launch, and on the horizon, aerospace planes – which could dramatically lower cost, improve responsiveness and boost cost efficiencies in accessing and exploiting space. These potentially represent disruptive innovation that could fundamentally transform military space operations.
5) The US needs to formulate an effective deterrence policy for space to dissuade adversary use of counter-space capabilities. This should be based around a combination of strengthened resilience, and rapid reconstitution of capabilities, the use where appropriate of terrestrial and 'near space' capabilities to fill gaps, and perhaps most controversially, the ability to undertake deterrence by punishment against an opponent's satellites using non-kinetic 'soft kill' ASAT capabilities.
6) The loss of space capabilities – a 'day without space' – would force the US and its allies back to an older, less precise and more costly form of warfare. We would not be able to fight a 'western way of war' which emphasizes, speed, precision effect and gaining and sustaining a knowledge edge over an opponent. Instead, the playing field would be levelled to an extent where an adversary could better exploit asymmetric capabilities more effectively.

Space capabilities are essential to maintain effective deterrence for US forces, including to ensure credible nuclear deterrence against a range of adversaries. Space-based systems for missile early warning, launch detection, and also tracking, play an important role in providing warning time for missile launch events, and ensuring the US is able to retaliate were the worst to happen. Communication and data relay satellites provide the rapid communications and connectivity essential in ensuring effective nuclear deterrence, whilst GPS means that US nuclear forces have far greater effectiveness in holding at risk targets. All of this contributes towards an effective deterrence posture. This is relevant not only in nuclear deterrence, but also non-nuclear deterrence, and without access to space capabilities, the risks posed by threats from states would be considerably magnified. The space support element of deterrence is therefore a vital component for US deterrence credibility.

In the same way that space supports nuclear and non-nuclear deterrence on Earth, there is a requirement for reinforcing deterrence in space against counter-space threats. We must deter not only aggression from space (i.e. attacks by space strike weapons against terrestrial targets), but through space (through missile defence) and in space (to dissuade and deter the use of ASATs). That means that the US has to develop and articulate a space deterrence strategy that is credible and dissuades an opponent from using space weapon capabilities against it, or its allies.

Under the Obama Administration, there was a degree of strategic restraint[14] that was self-imposed whereby the US refrained from active deployment of counter-space capabilities (i.e. its own ASATs) to threaten an opponent's

[14] http://www.heritage.org/space-policy/report/obamas-national-space-policy-subordinating-national-security-arms-control#_ftn1

satellites and enable 'deterrence through punishment'. Instead, the US relied[15] on strengthening international legal norms against space weaponisation, pursuing Confidence Building Measures, and supporting where appropriate arms control measures. These approaches were backed up by Space Situational Awareness (SSA)[16] to detect and monitor space activities by other powers. (National Space Policy, June 28th, 2010, 'National Security Space Guidelines', p. 13-14) There was emphasis on pursuing strengthened resilience and the option for rapid reconstitution of space capabilities, and also developing capabilities, plans and options for defense and defeat capabilities. 'Space Control' – both defensive and offensive ASATs – was held back as an option, but not deployed operationally, though the US demonstrated such a capability in Operation Burnt Frost in 2008.[17] The overall objective of US space policy under Obama was to dissuade rather than explicitly deter.

The Obama approach of dissuasion has failed to prevent development and testing of adversary ASAT capabilities that can be employed offensively against US and allied satellites. The Trump Administration's policy on space deterrence and space control is unclear at best, and absent at worst, with current debate focusing on whether or not to proceed with creation[18] of a Space Corps. Discussions about organisational and bureaucratic structures are important, but slow the process for responding to growing adversary counter-space threats. It is vital to protect critical US space capabilities especially given the prospects of deniable non-kinetic threats such as cyber-attacks against satellites. Given the emerging threat environment, greater emphasis should be placed on strengthening resilience and developing a rapid reconstitution capability for space systems as a first step in strengthening 'deterrence by denial' in space.

The implications of commercial space – particularly innovation in commercial space launch (see above) and the potential offered by low-cost small satellites, 'microsats' and 'CubeSats' which can be mass produced (potentially using 3D printing)[19] when brought together in an Operationally Responsive Space (ORS) capability – may go some way to mitigating risks posed by adversary counter-space capabilities, and deterring threats. The US needs to fully embrace Space 2.0 technologies and paradigms, which emphasize the value of the 'small, many and cheap' over the 'large, few and expensive' in space systems. The ability to rapidly launch swarms of networked CubeSats and Microsatellites, along with Small Satellites, and exploit responsive reusable launch systems, may go some way to providing a greater degree of assurance in Space. Collaboration with key allies – for example, Australia, Japan, and those in NATO – to work together in developing space reconstitution capabilities, and launch services – should be an essential step.[20]

The US will also need to confront and make a clear policy choice on developing its own counter-space capabilities. The credibility of space deterrence by denial (through greater resilience and rapid reconstitution) can be matched by space deterrence through the implicit threat of punishment, in which the US reserves the right to strike at an opponent's space capabilities in the event of an attack by adversary ASATs. In this regard it is important that the US should *not* emphasize 'kinetic kill' ASAT capabilities which create debris that makes space more congested. It should consider developing 'soft kill' capabilities such as jamming, electronic warfare in Space, and potentially cyberwarfare capabilities against satellites. Passive disruption, temporary disabling, and the importance of reversible effects must be preferred tactics over physical destruction.

In summary, deterrence against threats from Space, through Space and in Space, must be based around a combination of enhanced dissuasion and 'deterrence by denial' (through greater resilience and rapid reconstitution), that undermine the effectiveness of adversary counter-space capabilities, together with an implicit threat of 'deterrence through punishment' that would see adversary space capabilities also held at risk in the event of an offensive ASAT campaign.

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[15] https://www.aspistrategist.org.au/space-security-obama/
[16] https://www.spacefoundation.org/what-we-do/government-and-policy/intro-space-activities
[17] http://edition.cnn.com/2008/TECH/space/02/20/satellite.shootdown/
[18] http://aviationweek.com/defense/trump-administration-fights-creation-space-corps
[19] http://www.esa.int/Our_Activities/Space_Engineering_Technology/3D_printing_CubeSat_bodies_for_cheaper_faster_missions
[20] ASPI is currently undertaking a major project on Space 2.0 capabilities in collaboration with MITRE Corporation with a focus on this specific issue of how Australia can develop its own sovereign space capabilities using low cost satellites and launch systems.

Faulconer Consulting Group

Walt Faulconer
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Mike Bowker
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15 August 2017

WRITTEN RESPONSE

Broad question, requires war gaming, scenarios, and assessing/developing fundamental approaches. These answers likely don't exist; however, we need to get the answers. Recommend a follow-on study.

Jonathan D. Fox

Strategic Foresight Practitioner and Forecaster (Defense Threat Reduction Agency Global Futures Office)
21 July 2017

WRITTEN RESPONSE

Space operational and doctrinal considerations must assume a preeminent and critical role in current and evolving US strategic deterrence policy. This is an unavoidable truism due to (1) the location of critical strategic military (particularly C4ISR) and foundational civilian infrastructure assets in space, and (2) the open determination by multiple adversary military doctrine that the space domain will be the subject of concerted asymmetrical force efforts to neutralize US strategic superiority in any future geopolitically significant conflict. The United States is militarily and economically dependent upon unfettered access to and navigation of both near and outer space, and this dependency cannot be mitigated or replaced to any substantial degree with similarly achievable operational results for the forecastable future. Accordingly, free and unfettered access to this domain by the United States for the full spectrum of lawful and allowable purposes must be a fundamental and foundational principle of our national security policy.

Our freedom of navigation as a space-faring nation cannot be restrained or restricted. Any such interference must be publicly declared as presenting an unacceptable threat to our national security. Either the potential or actual interference with that right should be met with the publicly stated determination to be resisted and overcome with the strongest possible military response. We must be prepared to reinforce that stated determination with demonstrable and globally credible military force if necessary. The principle of freedom of celestial navigation must be non-negotiable. Likewise, the generation of hostile force from, in or to space must be dissuaded, deterred and (if deterrence should fail) punished.

Space operations and multi-domain deterrence impacts? Space operations and associated doctrine have a fundamental impact on joint multi-domain strategic power projection and deterrence paradigms. Space operations introduce another dimension to strategic deterrence capabilities while simultaneously introducing an entirely new sub-set of force projection and C4ISR vulnerabilities. Increased reliance on space-based platforms has introduced a quantum leap in benefit but at the penalty of increased systemic vulnerabilities, increased systemic complexity and increased cost. Continued effective integration of the space domain into the overall strategic deterrence construct will require a conscientious investment approach that will incorporate proactive cost control

mechanisms. The alternative is to lessen both military and societal reliance upon space-based systems, something neither necessarily feasible nor desired.

Necessary changes to US deterrence thinking required to incorporate the space domain? Taking into account (1) the substantial and growing reliance upon space-based systems both in the military and civilian sectors, (2) the stated determination of our adversaries to hold these systems at risk, and (3) the costs incurred if (2) becomes an operational weaponized reality, there are some self-evident adjustments to current US deterrence doctrine that should be considered. As part of a credible strategic deterrence that takes into account this expanded operational dimension, we need to openly commit to the doctrine of anticipatory self-defense when confronted with either (1) an observable and articulable threat to national and allied space-based systems, personnel, property and interests critical to the functioning of core military or civilian societal functions or (2) the reasonable likelihood of an occurrence or effect generated in, to or from space that presents a reasonably perceived and measurable risk to the national security, safety and effective societal functioning of the United States, allies or the global community (irrespective of where that effect may be manifested). Open adoption of a standard of pre-emptive action would send a clear and reinforcing message to adversaries who have become reliant on the lagging US national commitment to both deterrence policy and overall international legal norms demonstrated over the last decade. It would not be time bound; the requirement of an imminent immediate threat as a prerequisite for the exercise of this fundamental right attendant to sovereignty has proven increasingly inapplicable in an era of failing proliferation regimes and technology development pathways that can require years for fruition. An evidentiary standard requiring objective articulable proof of both capability and intention (*animus belligerandi*) to make war at a particular point in time not necessarily imminent could be highly defensible in light of past state practice. This proposed doctrine would be governed and restrained by the principles of military necessity, proportionality and the accumulated juridical standards of the Laws of War and associated state practice as reflected in statute and regulation.

Once the standard of deterrence reflects the realities of the evolving threat, there will remain the question of the means. In this regard, the growing complexity and extent of the space operations and deterrence missions eventually have to raise issues as to the most appropriate performer. Can the Air Force adequately perform both the terrestrial air and space power missions as they evolve over the long-term horizon of the coming decades? Is there a logical bifurcation extant within the service that can accommodate the two cohabiting together, or does one function inevitably prosper at the cost of the other? There are serious arguments and historical antecedents supporting both organizational models. But what cannot be disputed is that the future prospect of a separate military space service is gaining ground and can no longer be dismissed as a pulp fantasy. Establishment of a separate and distinct independent space service comprised of military, civilian and scientific components may prove unavoidable as the nature of this theatre's interrelationship with our national security expands and matures.

The applicability of other domain deterrence strategies and standards? The evolved standards of international Maritime Law (particularly those portions of the *1958 Geneva Convention on the High Seas* and the *1982 United Nations Convention on the Law of the Sea* that reflect practices of those states demonstrating a commitment to global order) may apply in analogous circumstances (of which many can be found), and those accumulated rules may provide a general conceptual framework governing the development of future strategies as long as unerring straight-line extrapolation is avoided. Likewise, the evolved body of law governing *jus ad bellum* (international legal precepts governing the justifiability of a state's resort to military force, particularly as analyzed in the 2015 United States Department of Defense *Law of War Manual*) also applies valuable legal and ethical guidance in this regard. Once you get beyond these, the ultimate default position has to be that space operations and associated deterrence strategies, as with all issues in international law where there is no centralized rule-making and adjudicating authority, are ultimately decided on the cold equations of state self-interest. We should not underestimate the ability and opportunity to write, and impose, our own rules should the need arise.

An investment-return driven definition of the space deterrence mission objective? It is a false dichotomy to define the strategic deterrence aspects of military space operations doctrine as a "zero-sum game". An "either/or" choice too narrowly restricts the spectrum of adversarial threats to be deterred, and artificially constraints the flexibility required of an effective strategic deterrence. The mission definition has to focus on the threat to be deterred. The broadest flexibility of capability and response needs to be promoted and preserved within the

"from, to and in" calculus. Accordingly, this mission should be defined as "The deterrence of overt or covert aggression intended against, and designed to interfere with, the free navigation or operation of US and allied space-faring systems or supporting, navigational and networking means (whether governmental or privately owned, irrespective of location); or force or effect generated in space designed to impact terrestrial territory, objects or systems under the jurisdiction or control of the US and allies; or interference with critical technologies and systems necessary for the orderly function of civil society, government and national security irrespective of location; resulting from the employment of space-based or earth-borne weaponry effects, instrumentalities or forces."

Dr. Nancy Gallagher

Director (Center for International and Security Studies at Maryland)
Research Professor (University of Maryland School of Public Policy)
10 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: So, you mentioned deterrence, and that segues nicely to the next question I was hoping to talk to you about. I'm wondering, how does space feature in US deterrence strategy currently? Given the rapidly evolving space domain, does US deterrence strategy need to evolve as well? If so, what changes to US deterrence thinking are required to cope with and incorporate a rapidly changing space domain in which more and more actors are getting involved in and technologies are becoming increasingly accessible?

N. Gallagher: Well, you're asking this question as if it's a new question in terms of thinking about the connection between space and deterrence—this isn't something that we're only now getting around to doing. I find that really interesting because from the very beginnings of how we were thinking about the rules for space security, the basic understanding that we worked out in the Outer Space Treaty and bilaterally with the Soviet Union was that military uses of space that serve the purpose of stabilizing deterrence were considered peaceful, and those that didn't were considered hostile or not protected.

So, I think that we've always thought of space in the context of deterrence, and obviously a lot of our early warning sensors, a lot of our arms control verification capabilities, a lot of the communication that we would use for crisis management or the information that we've use for crisis management, etc. are all things that are very, very central to how we practiced deterrence over the decades, both nuclear and conventional, and are space-based. What really started changing in the 1970s was that we started thinking about the utility of space more and more for war fighting purposes as well as for deterrence. This shifted our thinking from thinking about how we do what we're doing in space to maximize deterrence stability on Earth, to thinking about whether our objective in space is to deter attacks on space assets or to gain some sort of advantage that we think we would gain by in effect being willing to initiate attacks on other countries' space assets.

The Russians and the Chinese have been very clear for a very long time that you really can't talk about nuclear deterrence and nuclear arms control without also talking about space, both space-based missile defense but also other space assets that in effect support our conventional and nuclear capabilities. The United States has frequently tried to keep them more separate than I think they really are, but if you just think in practical terms, they are highly interconnected.

Interviewer: So, it sounds like you're pointing to the need to sort of think about this from a multi-domain perspective with respect to deterrence rather than just solely deterrence in the space domain on its own?

N. Gallagher: No, I think we have thought about it from a multi-domain perspective all along, and you definitely have to think about how what you do in one domain is going to affect both the stability of deterrence, and the likelihood of use of force in the other domains, and whether you can have positive spill-over effects from cooperative moves as well. Ultimately, it depends a lot about how you think about deterrence. If you are thinking about deterrence in basically retaliatory terms or if you're thinking about deterrence in what some people call deterrence by denial (other people call this a damage limitation approach to deterrence), I think it's very hard to make a good argument for retaliatory deterrence in space, and a number of people have pointed this out and argue that therefore we should practice some form of deterrence by denial or damage limitation in space. I think that the problems of that are logic are also extensive and haven't been thought about very carefully. I don't think the alternative though is to in effect say, "Well, we just should go for straight war fighting posture in space as opposed to deterrence because deterrence is too difficult to do." Instead, I think it calls for thinking about the shortcomings of any of these strategies and making sure that whatever you're doing includes a substantial attention to the cooperative dimensions. Some people have called for this cooperative dimension to be part of your deterrence strategy, while other people have looked at it as a compliment that increases deterrence stability. But, ultimately, neither a war fighting approach or either of the forms of deterrence is going to work on their own. They don't work very well on Earth, and they particularly don't work well in space.

Gilmour Space Technologies

Adam Gilmour
Chief Executive Officer

James Gilmour
Director

13 July 2017

WRITTEN RESPONSE

Ability to redeploy tactical satellites combined with the ability to knock out adversary satellites would seem like a good deterrent.

Harris Corporation, LLC

Brigadier General (USAF ret.) Thomas F. Gould
Vice President, Business Development, Air Force Programs

Colonel (USAF Ret.) Jennifer L. Moore
Senior Manager, Strategy and Business Development Space Superiority

Gil Klinger
Vice President; Senior Executive Account Manager for National Security Future Architectures

15 August 2017

WRITTEN RESPONSE

Simply stated it should be an integral part of any US deterrence strategy. Unfortunately, the USG has no meaningful space deterrence strategy at this time; and what little it does have sends mixed signal to any potential adversaries. A declaratory deterrence policy for space must be developed and integrated into the broader U.S.

strategic/deterrence policy, and must complement the deterrent policies of the other domains and where possible, leverage existing deterrence policies. Any additional discussions on this matter should be in person.

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: This is very interesting point that I have to encounter, and it is interesting how it's getting higher. Those were all the questions I had, but before I open up the floor for other questions, I just want to see if there was anything you and Jennifer would like to reemphasize here or any point you'd like to extend on or a tertiary point you'd want to make?

T. Gould: So, two points. One, from a deterrence policy, if we're going to make it a world-fighting domain, we have to have a well thought out…and I'm sure we're working through it right now…but a well thought out deterrent policy. That deterrent policy then needs to be communicated through the appropriate diplomatic channels; and integrated at the strategic level with our other deterrent policies spanning the rest of the domains. The second thing is, now that we are calling it a war-fighting domain, we need to take the gloves off and treat it like a war-fighting domain.

Jen might be able to talk to this better, but we are too, stove-piped with our space programs…there is very little synergy across the enterprise. The reason we're so effective in the other domains is because we've been able to leverage numerous capabilities from other mission areas in support of the joint fight. In space, for whatever reason, we compartmentalized everything. To be truly effective in any domain requires all of our capabilities within that domain to understand each other's mission areas and to leverage them in support of their own missions. Until we can do that, we take on more risk and we will not be as effective as we could be going forward.

From a war-fighting domain perspective, if it's a war-fighting domain, then let's set out the requirements for operating in that war-fighting domain. We know what the principles of war are, have a basic understanding of our CONOPS in space; and the mission areas required to support it. The mission areas are very similar to the other domains. We need to embrace these concepts; articulate the requirements; and ask for industry's help to move out towards meeting those requirements. Jen, anything to add to that?

J. Moore: The one thing I would say is you take a big leap by stating space is now war-fighting domain without necessarily, I think, considering the cost of preparing the people to fight in that domain. We seem to think we can create very high-tech space systems and that the value from those systems is intrinsic in the technology, when in fact a lot comes from the people who operate them. I think right alongside pushing for a new technology and new capabilities in space, we have to build up the infrastructure and capabilities for the operators who will actually be responsible for bringing the capabilities to bare. We haven't done that traditionally. Those are the first things that generally they cut from programs, a lot of times in the last minute add or consideration. I would say that that's a very different approach in the air community. There's a great focus on preparation of the pilot. It's another point that I think we have to take into account.

T. Gould: Yeah that is a good observation and to Jen's point, there's a whole organized training equipped aspect of operating in a domain that's a war fighting domain versus operating in a domain that's a support domain to the other domains. Jen is actually leading an effort to operationalize the training for operators in space. In many ways, it mirrors what we did in the air domain or have been doing in the air domain.

Dr. Henry R. Hertzfeld

Research Professor of Space Policy and International Affairs (George Washington University)
17 July 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: Okay. So, building off of that, how should space feature in US deterrence strategy? How do space operations, policies and investments impact multi-domain deterrence? What changes to US deterrence thinking are required to incorporate the space domain? To what extent should space adopt deterrence strategies from other domains, like maritime? Considering return-on-investment in general terms, which is the most critical US national security objective: deterring aggression from space, though space or in space?

H. Hertzfeld: That's so broad. All of the above. Of course, everything acts together. Space is probably, at least historically, is not the best place to actually engage in some sort of activity because getting there is expensive. It takes a lot of planning and timing, unless you have things up there. Even then, maneuvering, particularly certain maneuvers, are very difficult to do. It's an environment that we understand a lot better than we did 30 or 40 years ago, but we still don't understand everything up there the way we do understand things terrestrially much better. What's being threatened is really part of the question. If it's an asset on Earth, then perhaps some deterrence that's terrestrial that might have to be fired towards space. I don't know. It might be the best thing to do, but if somebody is actually trying to do something in space then… there are number of ways of reacting. One is to try to do something else aggressive in space to deter it. The other is, of course, diplomacy, which is probably the best thing to do first anyway. But if you can't, then also, what about resilience? Space may be the best way to do certain types of things like global communications, point to multi point, but should we put money into developing alternative methods that may involve high altitude or even terrestrial that can be more expensive in space and satellite, but can it provide the same services if we lose some of our capabilities in space? I don't think we've been willing… I know there have been proposals, and there has been money spent, but how resilient are we from temporary or even longer-term loss if we lost some of the capabilities to communicate, to travel, transportation, and other things terrestrially. Everything is very deeply intertwined. If somebody is trying to be aggressive in space, usually, somewhere on Earth is the origin of that aggression, and you'd use traditional means, terrestrial means, to clear it out, or deter it first, it'd be a lot more efficient.

Theresa Hitchens

Senior Research Scholar (Center for International and Security Studies at Maryland)
19 July 2017

WRITTEN RESPONSE

Entire books been written about this and no one has a good answer. Ultimately, space needs to be thought of as part of holistic approach to deterrence. I don't think there is such a thing as "space deterrence" by itself, at least in near and medium-term due to asymmetries. And we must be very careful of imposing other domain thinking on space as it is fundamentally different due to laws of physics etc. However, if there is a model the maritime domain is closer than nuclear or air; I worry about the attempts to jam space thinking into those latter two paradigms. Deterring aggression through and in space are most important. From space is sort of silly talk; no one is really seriously considering bombarding Earth from space, at least not yet – because the cost/benefit ratio is simply not there. Costs are too high, technology not there – and the strategic instability caused by such systems would be enormous and counterproductive. It is important also to remember that deterrence comes in several "flavors" and

deterrence by punishment is only one method. Military thinkers tend to forget that "assurance" of allies and "reassurance" of potential adversaries also are forms of deterrence (sometimes called "positive deterrence"), and also are important. Indeed, the 2006 Department of Defense (DoD) document "Deterrence Operations Joint Operating Concept" states that "[deterrence operations] convince adversaries not to take actions that threaten US vital interests by means of decisive influence over their decision-making. Decisive influence is achieved by credibly threatening to deny benefits and/or impose costs, **while encouraging restraint by convincing the actor that restraint will result in an acceptable outcome.** I can recommend the following studies on space deterrence:

- *Anti-satellite Weapons, Deterrence, and Sino-American Space Relations*, Stimson Center, https://www.stimson.org/content/anti-satellite-weapons-deterrence-and-sino-american-space-relations
- *Extended Deterrence and Allied Assurance: Key Concepts and Current Challenges for U.S. Policy,* INSS, http://www.usafa.edu/app/uploads/OCP69.pdf
- *Space and Deterrence*, Eisenhower Center for Space and Defense

Dr. Moriba Jah

Associate Professor (University of Texas at Austin)
3 October 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: Okay. So, I want to transition to the deterrence question that we have been asked. How should space feature in US deterrence strategy? And, given some of the evolution we have seen occur with respect to the space domain as more and more actors are getting involved and increasingly gaining access more and more technologies, what sort of changes to US deterrence thinking changes do you think are needed or required to incorporate this rapidly evolving space domain?

M. Jah: Well, I think that when it comes to human based activity, 24/7 Earth imagery is a big deterrent because now you can get more persistent monitoring of things that are happening on Earth globally. So, when it comes to maybe treaty compliance, monitoring against treaties or agreements, and that sort of stuff, it's increasingly hard for countries to hide their activities from the international community when they have people looking down all the time 24/7. There are critical space services and capabilities that we've become increasingly reliant upon—like position, navigation, and timing systems, and that sort of stuff. So, by having some sort of international activity that makes that transparent, where people can share data and that sort of stuff, I think that will serve as a huge deterrent for people doing weird things in space.

Interviewer: Do you think there are lessons that can be learned from deterrence strategies and efforts in other domains? I'm thinking here to the maritime domain, and maybe in particular the case of the South China Sea, which is an area where there's not exactly clearly drawn boundaries or lines and the actors involved are increasingly contesting various sorts of land, and in some cases even pushing the limits to contest things that might not even really be considered land. So, do you see a situation like that of the South China Sea as maybe being one that the space domain might encounter in the future?

M. Jah: Well, for the maritime deterrence domain, if bad things happen on the seas, it doesn't necessarily mean that it will result in some sort of nuclear war cataclysm or whatever. The nuclear deterrent domain, I think, is probably most relevant towards space for being able to provide lessons learned into how people should look at deterrence in the space domain. People are talking about armed conflicts in space, and, well, the best one is the one that can be avoided for sure. I think the case that needs to be made is that space is a global commons, and we need to provide the knowledge and perception that if anybody acts irresponsibly in space, then that

commons is ruined for everyone, including the people who conducted the harmful activity. So, I think the space domain has an easier case to make in terms of deterrence than other domains.

Dr. John Karpiscak III

Physical Scientist (United States Army Geospatial Center)
19 July 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: Given all of this rapidly developing technology, plus the increasing number of actors that are getting involved in the space domain, how should space feature in US deterrence strategy? And what kind of changes to US deterrence strategy might be needed to account for a rapidly evolving space domain?

J. Karpiscak III: That is probably the most important question on your list. I think you can look at this a couple different ways. Overall, I think there are 3 key factors: preemption, integration of thought, and monopolization.

By preemption I mean getting people to work with us and to expose the fact that we can see things in country 'X' and elicit a worldwide response prior to any escalation. We can do that via continual monitoring of certain areas and sharing the data. This is not just from a military weapon standpoint (i.e., monitoring for new missiles new launch complexes) but also to reveal things like the extent of resource depletion in a country that might be going to war with another country. From space, we can monitor all sorts of resources to identify indicators and warnings of resource depletion—for example, we can monitor many important factors regarding water, minerals, and forests. Resource depletion has always been a historical reason of going to war, for one reason or another, so the more we can share or understand the extent of those resources and how they're being depleted, the better the likelihood that would be able to intervene, step in and address an issue before it escalates into a war between two countries. I think this is probably the biggest thing that we can do—something in the form of preemption.

Another important factor is the integration of space-thought, especially for the active military or even as a reserve officer, to avoid classic two-dimensional thinking and instead develop an integrated approach to space-utilization in whatever you do rather than making space some kind of an afterthought. With respect to the third factor, monopolization, the way to maintain multi-domain deterrence is simply to be the best at it and have everybody come to you. To do so, you have to make space access more affordable to people and provide more incentive to partner with the US; its allied countries and organizations. But we also have to understand that the big caveat here is: regardless of what you do, you'll never ever be able to prevent a bad actor from getting access to space—you only may be able to limit their direct access for a time or reduce their access through the use of proxies. Like I said earlier, the "impossibility of gun control," example is probably the best corollary to this situation. I think with the rate of technological change coupled with other things like additive manufacturing, the game has changed permanently with regards to launch and access to space.

But along those lines too, I would think that still the most important need that we have at this point is probably detection and warning. Not limited to ICBM launch detection or spikes in EM transmissions prior to the start of aggressive actions, but also with regard to space debris and the occasional asteroid impact. I like looking at the things like the Chelyabinsk meteorite. How did that get through? Well, it was too small for survey telescopes and it "came out of the sun." Nobody found it. But this kind of thing is going to happen again. So, detection and warning really needs to be rolled in to our overall space strategy.

Dr. Martin Lindsey

Aerospace Engineer (United States Pacific Command)
7 July 2017

INTERVIEW TRANSCRIPT EXCERPT

W. Aviles: Hi, I have a question. You mentioned kinetic conflict in space and how it's indiscriminate and affects everyone. So, I'm wondering, is there a more targeted method of either deterrence or aggression that is concerning to space faring nations?

M. Lindsey: That's a great question. We could speculate on all kinds of different ways that space could be used short of non-kinetic actions. So, I guess to speculate a little bit, one edge of that spectrum could be economic coercion. Let's say you are a country and you rely on another country to host the ground stations that you get your economic data off of satellites from. If they're unhappy with you, maybe they cut off your access to your data. So, from the military perspective, that is kind of on the low end of a conflict. From there, you could move up into something like overt cyber activity (e.g., hijacking satellites or denying the country use) and electronic warfare approaches (e.g., jamming satellites). Some of this has already been shown to happen in the news from time to time. So, there's a wide range of how the space domain could get brought into conflict or could trigger broader conflict short of kinetic action in space.

With respect to deterrence, I think one of the best things to do with respect to deterrence is to really embrace the resilience principles that we have laid out in the last couple of years. For example, the principle of not becoming reliant on single centers of gravity in space or building these huge monolithic space architectures that basically just become the equivalent of the battleships on [Pearl Harbor's] Battleship Row before World War 2—they just become the targets that somebody can focus their energy on taking out.

So, resiliency can relate to things like 1) the disaggregation of larger constellations, 2) the diversification of constellations both in terms of the numbers of satellites you're using and the sources of those satellites, and 3) the increased reliance on sharing between countries, which kind of comes back to where I started with the Response to Space Capabilities Research, Development, Test, and Evaluation MOU partnership between 10 countries to do R&D and develop satellites that we can all contribute to. So, with that kind of partnership, suddenly an adversary would not be facing just a threat of a US constellation of capabilities, it would be facing the threat of the 10 nation constellation of capabilities, and that really has a deterrent value all of its own—as opposed to taking on one country, you have to take on the world. So, I think that those are sort of the key ways short of a kinetic conflict that you would see space either deterring or participating in a conflict.

W. Aviles: Okay. Just one more question. So, you talked a bit about how cooperation is a lot more common than competition, especially in the commercial sector, but how does this compare with proliferation? How much of this cooperation is primarily in the commercial sector, and is it more of a liability in terms of proliferation or is it a net positive for the US and other allies?

M. Lindsey: To me, proliferation means that the spread of technologies, and it also has the connotation of the spread of technology that you want to control somehow so that people that shouldn't have their hands on those technologies don't get their hands on those technologies. I think what you're going to find is, just like in the cyber world and the electronics technology world writ large, that the same thing is going to happen in space. The cost of a cube satellite now is down under $100,000, which means that there's not a country in the world that can't conceivably fly their own satellites. The only big capital barrier to getting into space that remains is launch itself—actually getting the satellite into orbit—but that barrier is coming down too.

So, that's going to be the final barrier to counter proliferation: As commercial companies increasingly are providing that space launch service at lower and lower prices, everybody that wants to, will be able to, put things into space to do meaningful missions, whether that's ISR missions or communications missions or, in the case of nefarious actors, space control and counter-space missions. That proliferation is already happening, and in my mind it's inevitable. I don't see how you control it at this point—other than the way we try to control other technologies (i.e., just having a great global ISR of who's doing what and calling out the bad actors as we see them).

Sergeant First Class Jerritt A. Lynn

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7 August 2017

WRITTEN RESPONSE

ABSTRACT

The proliferation of space activities amongst state and private commercial enterprises is changing the contemporary political and security environment. This calls for United States policy-makers to recognize the domain of space as being integral to U.S. national security, international diplomacy, and the U.S. commercial sector. U.S. policy-makers must work to create a new U.S. Space Strategy that addresses the potential consequences and benefits of additional actors being involved in the space sector, whether it be conducting unilateral space activities or utilizing cheap space launch capabilities to create international partnerships. Through the examination of historical precedent, as well as the contemporary political and security environment, realistic strategic goals and policy recommendations are identified that allow the United States to remain the world's leading nation in space. These goals and recommendations promote U.S. national security objectives, empower a thriving commercial sector, and safeguard the domain of space for the international community.

Key Points

Policy-makers must identify and articulate strategic goals within realistic time horizons that the federal and private space sector can work in tandem to achieving to maintain U.S. hegemony in space. Further research needs to be conducted to better understand the positive and negative effects from the proliferation of space activities and increased number of actors in space. Policy-makers need to recognize that their time horizons are infinitely shorter than those of an organization or sector whose job it is to conduct activities in an environment with zero room for error. Therefore, mechanisms should be put in place by Congress to prevent the election-cycle turnover of the space sectors operational goals. Space is currently an asymmetrically advantaged capability within the U.S.'s arsenal to project power in each of the DIME categories. This is in jeopardy as states such as China use their various facets of national power towards space activities. There must be continued research to understand the potential implications to U.S. national security of an ever-increasing reliance on the commercial and private space sector to conduct space activities.

How should space feature in US deterrence strategy?

The implications of the Soviet Union space program for U.S. national security proved to be the catalyst that provoked the U.S. to accelerate its ability to conduct space activities. Fear of Soviet advances in education, science, and technology created a competitive drive in the U.S. that ultimately lead to an American being the first human to step foot on the moon. The competition between the Soviets and the U.S. slowly fell away through the 1970's and 1980's as the Soviets went into economic and political decline. This decay led to a lack of anxiety on the part of the U.S. and a reduction in a competitive drive. The diminished threat meant a reduced budget for NASA and a lowered interest in U.S. space activities. Over time this has contributed to a loss of strategic vision and a lack of

vision in utilizing the space sector as an instrument of national power and as an integral piece to US deterrence strategy.

If the lack of existential threat was not enough to diminish relevance, public relations nightmares created even more skepticism within the U.S. In 1979, the U.S.'s first space station Skylab, fell from orbit and crashed landed into the Indian ocean and upon Australia (Hanes 2012). Although it had been successful as a scientific research station in space, its unexpected accident led to criticism and mockery of NASA. January 28th, 1986, the Challenger Space Shuttle exploded seventy-three seconds after launch, killing all seven individuals on board (NASA 2013). In 1990, the U.S. launched the $1.5 billion Hubble Space Telescope into space and it was immediately in need of repairs, as the lens was misshaped during construction. It was another three years before a space mission was able to fix the telescope and make it serviceable. Despite the impediments, the loss of life and mechanical setbacks were not entirely indicative of the entire U.S. space program. NASA had several successes, such as the Voyager satellite and numerous space shuttle missions that permitted scientific research. Overall though, the successes often paled in comparison to the headline-grabbing mistakes.

Unfortunately, the greatest setback for NASA and the space sector has been the U.S. space program's lack of strategic focus since the moon landing. That is because the U.S. stopped utilizing its space program as a means of national power. The negative public relations events through the latter part of the 20th century further reduced the perception of NASA's abilities and, therefore, their importance as a contributor to strategic ends. Despite the decades-long scenario of unfocused hegemony in space, the current proliferation of space activities amongst states and the emergence of other capable actors is creating new security concerns and opportunities such as anti-satellite weapons (ASAT) and offensive/defensive space based weapons that cannot be addressed by disorganized policies. In addition to the security concerns produced by additional state actors in space, there are the less tangible effects generated in the realms of national prestige and diplomacy that must also be recognized.

Though some in the U.S. advocate for unitary action without regard to international opinion, the image of the U.S. amongst the international community affects U.S. power and legitimacy, as they are relational in nature. Consequently, the image of the U.S. abroad and international opinion are relevant to U.S. power projection. This was illustrated during the Cold War when foreign diplomats warned that states would side with the winner, regardless of ideology (Department of State 1991). The reemergence of space as an integral aspect of national power should ignite a fire within U.S. Government officials to create policies and to generate a strategy that utilizes NASA and the space community as an instrument that supports U.S. diplomatic, informational, military, and economic interests. It should be noted that space activities or policy do not exist in a vacuum and that the utilization of space as an instrument of national power will have relational effects, potentially positive and negative upon other national instruments of power. The important aspect to recognize is where space activities fit into the discussion as the proliferation of space activities increases.

The United States can increase the deterrence value of its military space capabilities by improving upon tactical launch capability. Currently, the U.S. can only successfully launch from planned positions, such as Cape Canaveral or seaports. The U.S. can use commercial capability or sounding rockets, but they would require re-engineering for a hasty LEO launch for military application. Unfortunately, U.S. adversities have demonstrated this capability with specialized space and launch brigade sized elements operating Transporter Erector Launchers (TELs) (Cain 2017). Additionally, the U.S. military could improve upon stratified augmentation of small satellites and high-altitude platforms. As noted previously, states such as China and India are developing anti-satellite (ASAT) weapons capable of engaging and destroying key infrastructure in space. Therefore, it would benefit the United States to have an augmented stratified concept that allows for a more reliable capability that is more difficult for U.S. adversaries to affect.

The U.S. relies primarily on large satellites which are vulnerable to kinetic direct-assent (ASAT) weapons. To achieve a more robust and assured capability, the U.S. should develop a system in which large satellites are placed in High Elliptical Orbit (HEO), Geo-Stationary Orbit (GEO), and Low Earth Orbit (LEO). Small satellites could also be placed in LEO for specific military missions and could provide specific uses, such as imagery or limited communications and would be cheaper to produce. Additionally, the U.S. currently has no high-altitude programs of record in its inventory, which could, in theory, provide some of the same capabilities as satellites and provide augmented, stratification to its existing capabilities (Cain 2017).

However, improvements to U.S military space-assets is only one aspect of the whole-of-government approach. The United States Government must continue supporting Transparency and Confidence Building Measures (TCBM). In the past decade, the United States has shown a preference for non-legally binding TCMBs, which is in line with the U.S.'s disposition towards legally binding international agreements (i.e. refusal to sign Kyoto Protocol because of its legally binding nature) (Bodansky 2015). This is a policy that should continue, so as to prevent the United States from being restricted militarily or economically through international institutions. Nevertheless, just as was the case during the space race with the Soviet Union and the remainder of the Cold War, the United States must use international space relations to create a narrative that showcases how the U.S. is a steward of an open, secure, and reasonably regulated domain. For this to be successful, international space policies put forth or agreed to by the United States must be in line with domestic objectives in the military, civil, and commercial space sectors. It is then incumbent on the United States to create an overarching strategy that aligns these interests so that it may assist in the creation of acceptable international norms. If these domains and their policies are not aligned, they will ultimately undermine each other.

While politicians work abroad to create policies that benefit the United States, at home we must bridge the gap concerning the lack of basic space knowledge amongst policy-makers, military leaders, and scientists. The last U.S. moon landing was more than forty-four years ago, and since then U.S. space programs have been out of touch with many policy-makers and military commanders. The space programs of the 90's were high risk with a minimal reward for politicians and military leaders who tended to be less concerned with how their systems operated, caring that they just work properly. A newer generation who has less experience with the space failures of the nineties and is more technologically savvy may be less risk adverse and receptive to space activities. However, the only way to capitalize on this is for policy-makers and military leadership to become educated on U.S. space activities and their connection to their specific interests. The space sector's leadership needs to educate policy-makers and military leaders because it is not a process born through Immaculate Conception. Hence, this policy recommendation is aimed more at the space sector (e.g. NASA, the private sector, lobbyists) to take a more proactive approach in educating the decision makers about the ins and outs of U.S. space activities and their role in enabling the life-systems of the modern United States.

The U.S. has been struggling with its role in the world and the dominant position it has traditionally held in almost every arena for more than half a century and is now asking if it should actively try to maintain a hegemonic dominance. This question pertains just as much to the realm of space as it does with any other aspect of national power. While there is no consensus as to whether the world is better off with the U.S. as the dominant state, it is difficult to argue that the U.S. has not benefitted from establishing the de facto institutions and norms that the international system operates within. Based upon that it is in the best interest of the U.S. to retain a hegemonic dominance to maintain the status quo. Thus far, in regards to space activities, it allowed for an open and secure environment that all actors have benefitted. That being said, technological advances and individual state interests are creating competition against U.S. dominance, which in turn has the potential to instigate conflict and lessens deterrence.

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Dr. Xavier Pasco

Director (Fondation pour la Recherche Stratégique Paris)

31 August 2017

WRITTEN RESPONSE

[Q14] How should space feature in US deterrence strategy?

The use of space is a prominent element in the global U.S. national security posture and it largely contributes to its strategic defense. Consequently, it appears natural that space retains a key role in the U.S. deterrence strategy. Besides, space remains an environment that cannot be fully controlled by one country and the efficiency of national space systems depends on a safe collective management of this environment. This puts space in a peculiar situation in which key national assets will depend more and more on well-managed international rules. For this reason, from a conceptual standpoint, space can appear as a relatively "weak" element of any global deterrence strategy, even if part and parcel of it. It is nowadays difficult to consider making space a more nationally controlled environment. The increase in the number of actors accessing space must be considered as a given fact and any deterrence strategy will both have to consider it and use this trend as an opportunity for reinforcing its efficiency.

[Q14] How do space operations, policies and investments impact multi-domain deterrence?

Space operations policies and investments have a multi-domain deterrence impact as it retains a key role in how information chains are formed and perform. Whether at the level of data collection, transmission or dissemination, the use of space systems have had (and will have) deep transformational effects of many elements of the technical architectures involved in the global information chains as well as on the infrastructures in charge of their use and on the professional/working cultures and habits of the personnel working for the dedicated defense institutions.

It must be noted that this transformational effect will rise sharply in the years to come as space originated data will be combined more and more massively with other types of data, putting space at the center of highly reactive global information systems. In other terms, space data will not be identified per se anymore and any evolution of the space system will have a direct and immediate effect on the production and on the maintenance of informational fluxes that will feed the multi-domain deterrence.

[Q14] To what extent should space adopt deterrence strategies from other domains, e.g., maritime?

Space, as it is the rule for other domains such as in the maritime domain, can enhance deterrence strategies by relying on a coherent body of internationally recognized rules that provide a solid basis for implementing national protection policies. It is because such international regulations exist that States can act nationally to protect their interests. Given the fact that more and more governments and private actors will populate space with very diverse objects and activities, it is key that such regulations can be thought about in advance and shared between countries so these activities can develop without harming national security policies. In this respect, the maritime domain offers a good example of a collective management of a global resource. For example, one can think to the "Long Range Identification and Tracking procedures" (LRIT) adopted by the IMO years ago to provide a similar scheme for space collective monitoring and data exchange regarding potentially suspect activities.

Dr. Luca Rossettini[21]

CEO and Founder (D-Orbit)
16 August 2017

WRITTEN RESPONSE

This is a set of quite articulate questions. Space is definitely an asset for US deterrence strategy. The wide possibilities offered by Earth Observation, IoT, M2M and telecommunication applications from the incoming satellite constellations, able to cover the entire globe and provide data in real time is indeed invaluable for anticipating potential national security problems. Dedicated agreements with existing or incoming constellations, maybe accommodating dedicated payload to be used (hid) within a purely commercial constellation, may ensure dedicated services, benefit from the whole and extensive coverage of the constellation and dramatically reduce the budget needed.

Most of the deterrence strategy inputs today required could be retrieved faster and cheaper from space. Substituting those riskiest and most expensive activities today performed "on ground" with data procured from space will enhance our national internal performance. On the other hand, satellites are also particularly vulnerable: they can be hacked, can be hit, can become defunct and can wind up in unwanted territories at the end of their missions.

A set of measures can be easily transferred from other domains to space, for example to make sure satellites are more resilient to hacking, can rapidly avoid collision and can be disposed at the end of their mission along a predefined and controlled trajectory. Regarding the return on investment, US national security entities should start focusing on deterring aggression in space:

- Hacked satellite could easily become a weapon in space against security satellites or used as kinetic bomb on its way to the ground. Cyber security should be one of the highest priorities.
- Collisions in space generated by intentional use of weapons or other space objects could not only destroy precious assets and expose our national security, but also aggravate the space debris situation in orbit, generating at least economic damages with heavy impacts on the US internal economy. Government satellites should adopt collision avoidance strategies, by means of dedicated anti-collision systems, capable of being operated independently from the satellite in way to be functional even if the satellite is damaged or hacked. This also should be one the highest priorities.
- Building a defense infrastructure from space menaces takes more time and money and is definitely less effective without the previous measures already being activated. Medium priority.
- Eventually, intelligence in space should be implemented in order to evaluate which space asset could become a threat.

[21] Dr. Luca Rossettini's response reflects the point of view of a small to medium firm operating across the space domain, focused on the new commercial approach to space as its main driver, but taking account of considerations related to our business with the more consolidated "standard" space industry practices.

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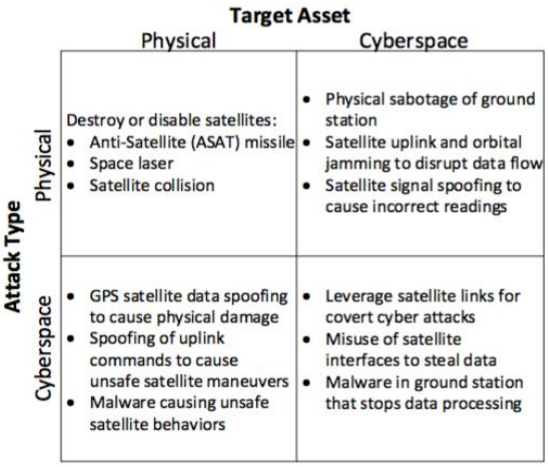
8 September 2017

WRITTEN RESPONSE

Space in US Deterrence Strategy

How should space feature in US deterrence strategy? US dependency on the space domain has grown to a significant level in the last few decades. Our military increasingly relies on the 24/7 availability of satellites for mission, war, crisis intervention, and nuclear deterrence strategies and capabilities. Space system-based capabilities, e.g., the Global Positioning System (GPS), are being embedded in US critical infrastructures and economic fabric, such as in aerospace and energy. Most recently, hundreds of US NewSpace users, such as SpaceX and Blue Horizon, are investing massive private funds in infrastructure for commercial space applications, such as tourism, interplanetary travel, and asteroid mining. Deterrence of aggression on our nation's space assets, thus, is critically and strategically important for the military, national security, and economy.

Figure 1: Threat surface for space domain deterrence and defense. Attack examples are



Space Domain Threat Surface for Deterrence

Counter-space and space-based cyberattack aggression by nation-states has escalated in the last decade. For example, China has tested Anti-Satellite (ASAT) weapons since 2007 and Russian intelligence services have shown satellite-based cyberattack capabilities since 2013. US space deterrence strategy is needed to address this growing attack surface. An essential step is to understand and assess threats from aggression via cyber and physical attacks on space assets. In Figure 1, a cyber-physical system framework is proposed here to help map the different threats to space domain from physical domains—air, land, and sea—and cyberspace.

Attack Type

Cyberspace Physical

Space domain threats will evolve and present dynamic risks in the future. Commercial small- satellites (e.g., Cubesats) and NewSpace user vehicles are manufactured via open-source technologies and an uncontrolled global supply chain. These platforms offer feasible attack vectors for space domain threats and overcomplicate the space attack attribution problem due to their inherent shared, open system environment. For example, malware on a commercial satellite platform—introduced in the supply chain and triggered in orbit—can potentially help launch cyberattacks on other space platforms, force physical collisions with space assets, or attack conventional and cyberspace domain assets from space.

Threat consequences in the space domain can be long-term and catastrophic. Orbital debris from counter-space attacks (e.g., ASAT) or access-denial attacks (e.g., laser weapons) can create debris- filled dangerous orbits for an unreasonable period of time. Sabotage or disruption attacks (e.g., uplink jamming, C2 spoofing, embedded system malware, ground station destruction) on space systems for missions in space, cyberspace, and conventional domains can potentially degrade US warfighting or nuclear deterrence capabilities; even indirectly endanger population or promote huge economic losses. How can threat actors in space domain be deterred?

[22] Any opinions, findings, conclusions, or recommendations in this material are those of the author, and should not be interpreted as of the United Technologies Research Center.

Deterrence of Aggression on Space Assets

Physical threats to space systems (shown in Figure 1), e.g., ASAT, laser, and forced satellite collisions, are likely not priority for most threat actors since the resulting impact, e.g., debris-filled orbits, is mutually shared by all actors and violate international norms for space. Conventional deterrence strategy, including punitive measures, can help stop these threats. Nevertheless, adopting a balanced deterrence-defense approach is a more comprehensive means of combating these threats, e.g., to deter weak actors with no strategic space interests. Active defense capabilities—such as interceptor satellites that collect orbital debris—can be a candidate to balance deterrence.

A more serious concern for US deterrence is the emerging cyberattacks and cyber-physical attacks that may sabotage or disrupt space systems and their operations—particularly if they deny warfighting and nuclear deterrence capabilities. These attacks are not always easy to attribute and less understood in terms of their impacts on conventional domains and implications for deterrence.

Is an offensive approach based space deterrence strategy the way forward? Benefits are unclear. Reasons include high costs and risks associated with space weapons deployment, lack of robust space-based weapons that can stop large-scale attacks, and international taboo about space weaponization. Moreover, an offensive approach in conventional domains is challenging. Unlike nuclear weapons, a space weapon, e.g., mobile ASAT launcher, does not directly cause catastrophic damage and mass casualties. Direct damage may be limited to an unmanned satellite in orbit. Space weapons can also be mobile on the ground and in populated cities or sensitive geolocations. Can an offensive conventional strike on an ASAT, causing human loss and territorial damage, be an acceptable threat of retaliation against an ASAT attack on a satellite? Based on space weapon's dependency on cyberspace, cyber-offensive approaches may prove more promising here.

Is a defensive approach based space deterrence strategy better? This approach can offer better cost-benefit ratio for US space deterrence. Strategy enabled requirements include establishment of: an international environment with space governance, globally acceptable norms of behavior and punitive measures; US space policy; robust new space systems; security-enhanced space traffic management (STM) and space situational awareness (SSA) that detect objects, but also track them to infer object behaviors; and, a distributed space system architecture leveraging US allied nations space systems to ensure attack-resilient operations. These make aggressors perceive that attacking space assets is a high-cost, low-gain risk, changing aggressor's decision calculus.

Furthermore, robustness and resilience considerations for space assets must be investigated towards long-term space deterrence-defense strategy. This includes: adding security considerations for new satellite and space vehicle designs; developing space system architectures that account for data link security and mixed-criticality infrastructure composed of legacy and new systems; assured satellite constellation configurations; and, alternative air- and ground-based capabilities for critical space functions. In addition, US reliance on ground stations around the globe for space operations must be considered, such as investigating alternate architectures and infrastructures that eliminate this land-based system weakness of space domain.

Impact of Space on Multi-Domain Deterrence

How do space operations, policies and investments impact multi-domain deterrence (MDD)? Space deterrence is interdependent on deterrence in air, land, sea, and cyberspace domains. Deterring aggression—from space, in space, or through space—on US space assets and their operations is extremely vital for successful deterrence in air, land, sea, and cyberspace domains due to the underlying dependency of warfare and nuclear deterrence capabilities on space. But, on the other hand, success of US deterrence in space domain is dependent on the ability to deter attacks from air, land, sea, and cyberspace domains. MDD strategy is critical to account for the interdependency between conventional, cyberspace, and space domains. This strategy should ensure that the cost-benefit ratio presented to space domain aggressors is high enough that they are highly discouraged from targeting space assets as well as exploiting space system vulnerabilities to target other domains. To enable this strategy, we need to introduce multi-domain pronged threat of retaliation against aggression in a domain as well as build defense capabilities spanning multiple domains. For example, retaliation against space aggression needs to be carefully coupled with retaliatory actions in conventional and cyberspace domains. System architecture and operations should enhance space systems with support from air, land, and sea domains for continued military operations in space capability denied scenarios.

In developing a balanced MDD-defense approach, differences in technological capabilities and operations in different domains should be considered. For example, the unpredictability, seamless reachability, and agility of air and space domain platforms offer a significant advantage over land and sea domains for deterring the use of land-based and sea-based weapons by nation states. Furthermore, unifying properties of different domains must also be considered in the MDD-defense strategy, e.g., air and space operate in a vertical dimension, provide freedom of movement, and share some theoretical foundations across aerodynamic and astrodynamics disciplines.

Incorporating Space Domain into US Deterrence Strategy

What changes to US deterrence thinking are required to incorporate the space domain? To what extent should space adopt deterrence strategies from other domains? Space deterrence strategy should make space domain threat actors perceive that they will suffer unacceptable costs if they attack US space assets or its space-supporting infrastructure. Threat actors should also perceive that they have a very low likelihood of succeeding in their space domain attacks. One cost factor is the expense of accessing space and another cost factor is the retaliation by the US in multiple domains. The likelihood of attack success can be controlled by balancing with deterrence a good defense strategy in space domain that, for example, makes it significantly difficult for aggressors to identify the weakest links in the space system infrastructure and architecture, and proactively detects attacks and minimizes the magnitude of attack impact. Space domain, however, presents unique challenges to traditional US deterrence thinking. Unlike nuclear weapons, space domain weapons that target space assets and their supporting systems on the ground do not cause catastrophic impacts and casualties at a massive scale. Furthermore, space systems are mostly unmanned and an aggressor's strike on an unmanned satellite may not equate to a strike on aggressors' air, land, and sea assets risk.

Space shares some common features and with cyberspace domain. For example, both present a non-geographic threat that can impact anywhere in the world. Threat of retaliation in cyberspace for a strike on the space domain is a worthy consideration. But, it should be noted that for an aggressor the two domains differ in terms of the ease of attack and attack consequences. Aggressors must invest much more to access space than to access cyberspace. Vulnerable cyber advances embedded in critical infrastructures may result in far more catastrophic impacts than in space domain. Hence, cyberspace deterrence and space domain deterrence are not the same.

Space shares the most commonality with the air domain. Both these domains are unified by their operational environment properties, e.g., both operate freely at an elevation from Earth's surface. Military systems more tightly integrate air and space domains for national security capabilities. For example, military unmanned aerial vehicles (UAVs) use satellites for navigation, timing, and communications, to render surveillance, reconnaissance, and indication and warning capabilities. Furthermore, as described above, due to the interdependencies between deterrence in different domains, the US military should not consider space deterrence, conventional domain deterrence, nuclear deterrence, and cyberspace deterrence as stove-piped strategies. A multi-domain deterrence strategy is needed to provide a holistic view of these interdependent domains.

Deterring Aggression Through and In Space: Most-Critical US National Security Objectives

Considering return-on-investment in general terms, which is the most critical US national security objective: deterring aggression from space, through space, or in space? With the emerging escalation in space threat surface, aggression through space, e.g., cyber-physical attack on a military warfare or nuclear deterrence capability through a vulnerable satellite platform, and aggression in space, e.g., physical attack by an ASAT on satellite, must be addressed as high priority US national security objectives. Aggression from space, e.g., enemy state military satellites conducting surveillance or reconnaissance on conventional domains, presents risks that can be managed with norms, policies, and countermeasures to acceptable levels.

US should invest in modernizing infrastructure for Space Situational Awareness (SSA) and Space Traffic Management (STM) capabilities to monitor for emerging physical and cyber-physical threats in space. One desired capability is to not just detect space objects, but track them and infer their behavior in space. Further, due to the dependency of conventional and cyberspace domains on the space domain, we need monitoring, control, and decision making capabilities in these former domains to detect and counter aggression through and in space domain. Furthermore, protecting these conventional domain capabilities themselves from space threats, e.g.,

securing space vehicle traffic situation awareness data communicated to air traffic control during launch, is necessary.

Other beneficial space deterrence-defense research directions for national security include: investigation of robust and resilient system designs, especially for commercial space platforms; passive space defenses, e.g., satellite data link security; active space defenses, e.g., intercept satellites that collect debris; alternative conventional domain capabilities for critical space-system functions, e.g., high-altitude platform based positioning; and distributed space system architecture that leverages allied nations space infrastructure.

Victoria Samson

Washington Office Director (Secure World Foundation)
22 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: Okay. Great. That's really helpful. I think we should move on to the next question I was hoping to ask you, which has to do with the deterrence. So, I'm wondering, from your perspective, how do you think space should feature in US deterrence strategy, and what sort of changes to US deterrence thinking are required to incorporate this rapidly evolving space domain?

V. Samson: That's a tough question because I don't think there's one easy answer or solution. But, space has always been part of the US deterrence strategy because basically we require our national technical means or satellites to be able to determine whether a nuclear attack is on the horizon, and those exquisite satellites are the billion-dollar satellites where if something happens to them, it's pretty much game over for the other side. So, I think space has always been part of our deterrence strategy. Though, looking at how we deter attacks on our space capabilities, there might be a different way of looking at deterrence and space. There's been a lot of discussion about resiliency, and that sort of thing, which I think is all very helpful. I think we need to re-look at, how do you make sure that the core mission could be continued? And that might mean diversifying your assets, or putting up capabilities amongst different satellites by having a quick, rapid response when satellites are launched. If an adversary has the ability to launch satellites pretty quickly, then that requires having a better launch vehicle strategy because, currently, we don't have the ability to launch things very quickly.

So, I think there are all sorts of ways to go about doing it. At the Secure World Foundation, we are pretty big on international cooperation and norms, and I think that cooperation actually is very helpful. I think there are some things that could be done by the commercial sector in the United States. There are capabilities and national security interests that can be strengthened by having specific, clear norms about what is and isn't acceptable with respect to activities in orbit (e.g., not approaching another country's satellite without their okay—there's a certain amount of distance that is acceptable but anything beyond that is considered unacceptable and at which point you better have a good explanation).

I think cooperation and norms are helpful because right now we kind of have a few norms that everyone totally agrees upon and we sort of think about, but it's not really spelled out whether the international community has officially agreed to something. I don't know if you have heard about the European Union's Code of Conduct that they tried to put together a few years ago. I would describe it as a pretty vanilla document—it's pretty basic, it's stuff that the United States does anyway—but I think it would've been very helpful. Basically, the idea was that the Europeans put this together, and then they sort of just shopped it around and tried to get people to sign on to it. And I think it would've been very helpful just because it is something you could point to as something the international community has discussed and agreed to. Obviously, it's

not going to stop someone with bad intent, but intent is very difficult to signal anyways, and one of the ways you can signal good intent is by agreeing to these international norms. But, unfortunately, the Europeans failed in the formation of this. It was one of the first foreign affair activities the European Union did once they got defense as one of the capabilities that they could actually promote, but they went about it the wrong way and they ruffled a lot of feathers. They built into some of the colonial concerns of the G77. So, the Code of Conduct effort isn't dead, but it's just kind of not going anywhere. But I do think it was good to have the discussion because I think it shows that the international community is interested in norms and non-legally binding agreements, which I think is very important because treaties are so hard to get through these days, particularly for space issues—I think you're dooming yourself to actually accomplish anything if you say that you need a treaty on an issue.

So, I think norms are very helpful, and I think having international discussions on the specifics about norms can be led by the United States government and/or United States military, and should also include the commercial sector, can be very helpful as part of the deterrence strategy. And, again, I think using friends and family allies when appropriate can be helpful as well.

Interviewer: Do you think that there are lessons to be learned from maybe some deterrence efforts in some of the other domains? For instance, the maritime domain and maybe an environment like the South China Sea, which is an increasingly contested area. Do you think there are any lessons learned from deterrence efforts in other domains that could maybe be applied to deterrence efforts in the space domain?

V. Samson: Well, I'm not an expert on maritime deterrence, so I'm not so sure about that specific example. But, in general, I think there are numerous relevant military manuals (e.g., the San Remo Manual, which deals with the maritime domain, and more specifically laws of the sea and laws of armed conflict for the maritime domain; the Tallinn Manual, which deals with the same issues and ideas but for the cyber domain; etc.). So, I think having something like one of these manuals for the space domain would be very helpful, and that could probably be where you could look at the lessons learned from other domains and then think about how applicable they might be to the space domain—experience in these other domains has helped to spell out and basically write a manual essentially explaining how you go to war, which is not saying that you want to go to war, but explaining the idea that you want to describe, which in this case is how the laws of armed conflict apply to the space domain.

There is currently a Manual on International Law Applicable to Military Uses of Outer Space (MILAMOS) effort to kind of provide that sort of capability for outer space, but this effort is in its early stages. They just started meeting last year, and they've got a way to go. But I think something like this MILAMOS effort indicates that there is recognition that the other domains found it necessary to spell this out, so we should probably spell this out for the space domain as well.

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16 August 2017

INTERVIEW TRANSCRIPT EXCERPT

AAC:[23] Hi everybody, I have a question I'd like to present. So, this is a very interesting conversation, but I want to approach it from a slightly different perspective—one of deterrence and deterrent credibility, and the ability to apply deterrence concepts in space. So, from your perspective, I think, it does make sense to take a leadership role in developing these kinds of principles and setting precedents or not setting precedents because it is one other way to basically establish a cost for violating a principle that the rest of the world may have agreed to, right? So, for example, agreeing to passive defense, and agreeing to passive defense only in space. In this example, if you can get the Chinese to agree, then that puts them in the position of being the aggressor if anything is ever done in space. At the same time, if they don't agree, and the rest of the world does agree, then there is an international cost, and an economic cost in some cases, for them. So, first, I'm wondering what you think about this? And, second, what are your thoughts on the effects of precedent setting, as in the US publicly stating that space is a warfighting domain—certainly not international law, but setting a precedent.

J. Beard: Well, on that last point, we're a free country, we have an open press, our military officers write and argue amongst each other on national public issues, we have military law journals, all of our regulations are open to the public, etc. This, however, is not true for Russia and China. The US Air Force has a mission to defend our assets in space and to disable or restrict the other country from operating in space if such actions become necessary in an armed conflict. So, the US Air Force has to have the ability to establish supremacy when it needs to, and it has to be able to control space if that is what is required in order to achieve its mission in an armed conflict. The US Air Force just has to do this. So, Air Force regulations talk about offensive space control, and, yes, that offends countries. And generally saying that space is a warfighting domain, offends countries. The reality is, though, that there is no way for the Air Force to plan on protecting the United States without publicly discussing something like, "if there is a war, these are assets that we need to protect and we need to prevent access to from other countries." So, whatever precedents it establishes, or however you want to describe it, and despite the Air Force turning down its rhetoric a little bit, ultimately the Air Force needs to talk about being the master of space or dominating space. That might offend countries, but, at the end of the day, we have to have programs, objectives, and activities that might offend others who are looking for a peaceful use of space. But, you can always tone down the rhetoric, of course.

So, to your first question about setting up norms so that countries who don't participate can be labeled an outsider. Let's just say, for example, that we're talking about a non-aggression pact for space—no country can take the first aggressive move, they can only take defensive moves in response. So, there are a lot of reasons why you might want to have such an initial position. And, in fact, David Koplow (Georgetown) talks about how maybe we can have at least a no first strike or a no first use of any satellite weapons, and there are precedents for that in world history. For example, with biological weapons: yes you can keep on building them, yes you can be prepared

[23] Dr. Allison Astorino-Courtois (NSI).

to use them, and yes you can have defensive capabilities, but let's at least first agree to not do first strike with these weapons. So, there's something to be said to that. The only problem is if China or Russia doesn't join, and the United States signs up along with some random other countries, then that's great, but if the other side hasn't joined that no first strike proposal or agreement or whatever, it's kind of hard to label them as a violator of it when they can simply say they're not going to join. This then does put you in an awkward position because, as I indicated, you can't distinguish defensive from offensive weapons in space, so when the United States starts building things that have a first strike capability, and people start to question why you are putting things with first strike capability in space, then the Chinese will be sitting on the sidelines, laughing. Some of these proposals just don't work out as well as you'd like to.

Again, there could be limited international agreement to try to get the Chinese to sign up to doing no first strike or first use of these weapons against certain targets in space. Maybe you could limit this to GPS satellites, or something specific, but you'd also have to define what an attack is. Does it include a cyber action that somehow discombobulates or dazzles or otherwise messes up the orbit of one of these satellites? I mean, you have to be very precise about what a first strike is, and that's harder than you might think once you start to get into the details of the ways you can temporarily disable satellites. Though, in theory, a very narrow one like "no first use things" would be something to present to the other side, and if you can get the major players to agree to it, it probably would represent a positive step, if you could define the terms.

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15 August 2017

WRITTEN RESPONSE

Space is another element of strategic deterrence and should be considered in any deterrence considerations. Policies should be established to project a layered, integrated strategy which creates a deterrent posture responsive to cross-domain threats. Actions should not be derived from activities in a single-domain but rather the impact across multiple domains. For instance, aggressions in space or against a space ecosystem could be a threat to nuclear deterrence posture and should be addressed from a strategic perspective in consideration of second and third-order effects. The National Security Council could be a viable forum to address the nature of deterrence in a global commons in which military, commercial and private entities operate in the same domain.

Commercial and private sector companies think of any intentional or unintentional threat to their space ecosystems in much the same way as the government and the Department of Defense. Their concern is that any threat realized could impose negative impact on service delivery, revenues, and business continuity. The difference in how these threats are considered may be in the assessment of a various threats, their likelihood of occurrence, and their severity of effect. For example, from a Satcom perspective, ViaSat considers weather as a highly frequent

adversary. Weather effects at ground stations or gateways can occur frequently and in the past would have caused outages. To deter this adversary, commercial or private sector systems have replicated or augmented ground stations or gateways to enable continuity operations by purposefully routing services around weather effects, fiber outages, power outages, etc. While these capabilities were built to deal with weather threats they are also capable of providing mitigation of any number of other more intentional threats.

The commercial or private sector view is that private sector systems, including SSA, EO, PNT, and Satcom, do not exist exclusively in Space or the Space domain; instead, they are complex ecosystems that exist in multiple domains. They exist in the subterranean domain with fiber and power, the terrestrial domain with teleports and gateways, the space domain with satellites and debris, the cyber domain with cloud computing and user devices, and finally the land, sea, air, and space domains with platforms and end-users. Today's private sector ecosystems are able to create exponential performance increases by considering systems holistically, allowing simultaneous trades and optimizations across ground, space, cyber, and management domains. Treating the space network as a single ecosystem entity allows considers threats and threat deterrence against all domains of the space ecosystem.

Dr. Brian Weeden

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31 July 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: Okay. Great. Thank you so much for running through all of those questions with me. So, we always conclude with a general question: Is there anything I haven't asked you that I should have, or is there anything you would like to highlight as a concluding remark?

B. Weeden: Well, this a huge topic and we just kind of just scratched the surface of it today. The only other thing I would say is that I think you guys are looking at deterrence as a big part of your effort, and again I would suggest going back and looking at what's been done over the last 10 years on space deterrence. I sent the SMA team several studies and articles and briefings that have been done. I am aware of various studies on space deterrence that date back to at least 2008, if not a little before that, that involved a lot of really smart people. So, definitely don't try and reinvent the wheel here. Go back and figure out what's already been done and then build off that. Additionally, as I have highlighted today, don't just look at the space world. One of my frustrations with being a space guy is that too often I think the space world does a lot of navel-gazing and assumes that it is unique and that no one has ever come across the stuff that the space world has come across, but, by-and-large, most of the problems we are having in the space domain have already been dealt with in other domains or fields. It's not a matter of cut-and-pasting the solutions from other domains, but you can almost always learn something and draw from at least part of that solution to apply to what we're doing in the space domain.