December | 2017

Motivations and Costs to Contest Uses of Space

A Virtual Think Tank (ViTTa)® Report

Produced in support of the Strategic Multilayer Assessment (SMA) Office (Joint Staff, J39)

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Author

Dr. John A. Stevenson

Please direct inquiries to Dr. John A. Stevenson at **jstevenson@nsiteam.com**

ViTTa® Project Team

Dr. Allison Astorino-Courtois
Executive VP

Weston Aviles
Analyst

Dr. Belinda Bragg
Principal Research Scientist

Sarah Canna
Principal Analyst

Dr. Larry Kuznar
Chief Cultural Sciences Officer

Dr. Sabrina Pagano
Principal Research Scientist

Nicole Peterson
Associate Analyst

George Popp
Senior Analyst

Dr. John A. Stevenson
Principal Research Scientist

Interview Team[1]

Weston Aviles
Analyst

Sarah Canna
Principal Analyst

Nicole Peterson
Associate Analyst

George Popp
Senior Analyst

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: https://www.army.mil/article/152664/future_army_nanosatellites_to_empower_soldiers

Question of Focus

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Expert Contributors

Brett Alexander (Blue Origin); **Major General (USAF ret.) James Armor**[2] (Orbital ATK); **Dr. Gawdat Bahgat** (National Defense University's Near East South Asia Center for Strategic Study); **Marc Berkowitz** (Lockheed Martin); **Brett Biddington** (Biddington Research Pty Ltd, Australia); **Caelus Partners, LLC**; **Dr. Damon Coletta and Lieutenant Colonel (ret.) Deron Jackson** (USAFA); **Colonel Timothy Cullen, Ph.D.**[3] (School of Advanced Air and Space Studies, Air University); **Dr. Malcolm Davis** (The Australian Strategic Policy Institute, Australia); **Faulconer Consulting Group**; **Dr. Namrata Goswami** (Wikistrat and the Auburn University Futures Lab); **Harris Corporation**; **Theresa Hitchens** (Center for International and Security Studies at Maryland); **Christopher Johnson** (Secure World Foundation); **Dr. Martin Lindsey** (US Pacific Command); **Sergeant First Class Jerritt A. Lynn**[4] (United States Army Civil Affairs); **Colonel David Miller** (United States Air Force); **Dr. Deganit Paikowsky** (Tel Aviv University); **Dr. Edythe Weeks** (Webster University and Washington University, St. Louis); **ViaSat, Inc.**

Summary Response

Subject matter experts generally agreed that there were multiple motive pathways for nation-states to contest use of space. These pathways were:

1. the vulnerabilities and sensitivities that come from increasing cross-domain dependence on space systems;
2. the national pursuit of space programs as a form of (major power) prestige and status; and
3. the yet unresolved rules about how to project national sovereignty into space.

Experts also agreed that there are very high costs associated with acting on any of these motives, although they disagreed on whether high costs increased or decreased the likelihood of conflict.

Motivations to Contest the Use of Space

Experts proffered three baskets of motives for why an actor would contest space: space domain dependence, the prestige of space capabilities, and the lack of alternative dispute resolution mechanisms.

[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.

The Vulnerability of Terrestrial Components from Space Domain Dependence

Dr. Malcolm Davis of the Australian Strategic Policy Institute observes that "space systems are vital to the functioning of the US economy and society." In addition to the economic importance, Dr. Davis notes that space systems also are the bedrock of a "Western way of war," which "exploits precision, high operational tempo, and joint military operations."

The ViaSat, Inc. team concluded simply that "the most easily identifiable motive of nation-state and non-state actors against space ecosystems…is to disrupt military command and control." In other words, the centrality of space systems to the United States' economic and military operations makes those systems an attractive target for adversaries of the United States seeking to gain terrestrial advantages. Colonel Timothy Cullen[5] of Air University warns that adversaries would target space systems "to punish the US and its allies economically, to demonstrate the vulnerability of US and allied space weapons or communications systems, to simply test the effectiveness of unfriendly actions, or a combination of all the above." Targeting assets in the space domain is one of the most cost-effective ways to reduce US military and informational advantages, according to Dr. Namrata Goswami of Wikistrat and the Auburn University Futures Lab. Dr. Goswami notes, "During conflicts, space based assets like military satellites could be taken down by an adversary to deny precision guidance to missile systems, jam early warning for incoming missiles, and deny data and information on enemy positions. Non-state actors with access to space based capabilities could utilize it to deny access to data like jamming GPS, and reconnaissance."

Major General (USAF ret.) James Armor[6] highlights that "extremists" who are not dependent on space would risk targeting assets in space to harm terrestrial components that are dependent on space systems. Rather than "unsung nations" looking for prestige, the main risks of conflict in space stem from the "unplugged actors" looking to level the playing field. Theresa Hitchens, of the Center for International and Security Studies at Maryland, buttresses this view that disconnected extremists—which she refers to as "outliers"—are the likely sources of contestations in space: "I don't see any motivation for anyone, with North Korea being an outlier because who knows what their motivations are, in actually harming space as an environment because there's too much social and economic and military benefit coming from space for anyone to really want to contemplate ruining space for everybody else."

The Prestige of Space Capabilities

Dr. Deganit Paikowsky of Tel Aviv University proposes that "space capability became (and still is) an important mark of great powers." Space capability, therefore, is a marker of status and influence in world politics. It provides tangible and intangible benefits; as such, it is also a source of prestige. Sergeant First Class Jerritt Lynn,[7] United States Army Civil Affairs, observes: "International prestige was a factor during the space race, and it continues to be one as other states are pushing their way into the international spotlight." Similar prestige motives animate China's national space program, according to Lynn: "China just recently finished construction on the Five-hundred-meter Aperture Spherical Telescope (FAST) in Pingtung. This is currently the world's largest radio telescope…As the international scientific community uses this platform, it will garner international prestige, grant the opportunity to

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

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

[7] The views expressed in Sergeant First Class Jerritt Lynn's answer to this question do not reflect the official policy or position of the United States Army, Department of Defense, or US Government.

conduct cutting-edge research, and aid in China becoming a global leader in the space and science community."

Prestige motives, however, are not necessarily identical to the motives to contest other countries' use of the domain in which prestige is pursued. In the space domain, these motives for great power status are part and parcel of the motives to contest, experts argue, because of the dual-use nature of space systems. Dr. Gawdat Bahgat, of National Defense University's Near East South Asia Center for Strategic Study, notes that this dual-use is the source of space programs' prestige: "A space program consists of satellites and communications infrastructure—it has many civilian uses. This is why space programs are still prestigious." The dual-use nature of space systems means that any pursuit of advantages in the space domain has major cross-domain implications for the relative strength of various instruments of national power.

Prestige motives can play out regionally or globally. Dr. Martin Lindsey of US Pacific Command characterized regional factors as being the chief drivers of the dynamics of national space program development in the Asia-Pacific: "There are various space races going on in the Asia Pacific region—the big ones being between China and India, and then to a lesser degree between China and Japan, and these are more tied up in nationalism and global prestige." The interplay of the pursuit of prestige and the cross-domain effects of increased space capability leads Brett Biddington of Biddington Research Pty, Ltd to lament: "I would say that I think that war is already on in space—it's just not declared...The profound issue here is, of course, that almost everything we do in space is dual-use or can be badged as being dual-use."

Pursuit of Sovereignty Claims in the Context of Unclear/Unsettled Rules

Our experts generally agreed that only certain actors would have the means and the motive to contest the use of space. That current set is generally the "Big Three" space-faring nations—the United States, Russia, and China—although Dr. Bahgat also included India as a major space-faring nation.

Dr. Goswami posits that the "lack of international regulatory framework that could adjudicate and establish ownership, a dispute may break out during peace time." Dr. Bahgat provided the most succinct summary of the four potential goals that might lead space-faring nations to contest countries' use of space:

1. Achieve space domain capability and advantage vis-à-vis adversaries by investing in research and development.
2. Stake territorial claims in outer space once humanity cracks the code of mining precious metals on the lunar surface and beyond.
3. Support growing commercialization of space activities and an emerging lucrative market for space based activities.
4. Build military capacity based on space based assets to sustain the trade links and establish superiority on earth.

Of these four goals, the latter three relate to how the lack of rules about how to articulate sovereignty in space also can lead these (generally sovereignty-obsessed) space-faring nations to contest the use of space.

Costs Associated with Contesting Use of Space

Of the subject matters experts who explicitly advanced a view of the costs of contestation, all were in agreement that contested space operations are very expensive and have hard to anticipate second- and third-order effects. The subject matter experts from ViaSat, Inc. suggested that contesting the use of space could occur in any domain, since the space ecosystems exist in multiple domains, and the means would likely be the least attributable, most detrimental, lowest cost approach considering all the ecosystem domains.

In general, contributors to this response suggested three distinct reasons why contested uses of space, in space, would be (potentially prohibitively) expensive:

1. The novelty of space contestation, according to Christopher Johnson of the Secure World Foundation, means that: "Interfering with or hacking a space object would be a new, unique, ground-breaking activity and would therefore be a nefariously prestigious accomplishment unto itself."
2. Dominance in space is fleeting given the technological potential of industrialized countries, making a thorough cost-benefit assessment unreliable. Colonel Cullen observes that "dominance in space may not be possible against aggressive and industrialized nations, regardless. It is difficult to express how expensive the net cost of the development and large-scale employment of even 'low cost' access to space will be or how unforgiving, harsh, and costly the space environment is to conduct operations, and the space industry has little incentive to state their net estimates either."
3. The domestic politics of the militarization of space, especially in societies with stark inequalities in income and wealth, is a tricky set of optics for national elites to manage, as Dr. Goswami discerns: "The desire to create space domain advantage would require budgetary allocations, thereby taking away limited resources … from their poverty alleviation programs. This could create a backlash in society thereby raising questions about the feasibility of such outer-space motivations."

In conclusion, the costs associated with contesting other countries' use of space, in space, is extremely high, while the cost to contest a space ecosystem in its ground or cyber domains could be much less. Although many experts thought that the costs to a country's own space assets make contestation in space too risky for most space-faring nations, they did agree that the same nations possessed multiple motives that could lead them to *consider* it. In addition, if a nation state or non-state actor "considered" contestation, they may also consider targeting the space ecosystem in a non-space domain.

The motives to do so stem from: the vulnerabilities and sensitivities that come from increasing cross-domain dependence on space systems; the national pursuit of space programs as a form of (major power) prestige and status in the context of dual-use space capability; and the yet unresolved rules about how to establish sovereignty space in an environment with increasing demands for stable commercial and/or national property rights *in* space.

Subject Matter Expert Contributions

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

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

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

- Space is normalized part of Western civilization and is thus a target. To the extent that it is celebrated in the West, it is even more of a target. To the extent that the West does not understand the vulnerabilities of dependence on space systems, they become the ultimate target
- Extremist want his attacks to have the biggest public impact for the fewest effort
- Nation-state actors are looking for leverage over West and we are dependent on space

Dr. Gawdat Bahgat

Professor of National Security Affairs (National Defense University's Near East South Asia Center for Strategic Study)
7 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q3]** Okay. So, sort of transitioning a little to another one of our questions. You spoke about how Iranian pride is driving some of its activity and interest in the space domain. The second question I was hoping to ask you is about the motivations of nation-state and non-state actors to contest the use of space, so please feel free to address this question with Iran and the Middle East in mind. So, what are the motivations of nation states and non-state actors to contest the use of space in times of peace, instability, and conflict, and what are the political, military, environmental, and social costs associated with acting on those motivations?

G. Bahgat: **[Q3]** So, as I mentioned, I have been working on weapons of mass destruction for a very long time. At one point, nuclear weapons were considered very prestigious and countries were trying to make the bomb so they can join elite countries. But, eventually, nuclear weapons lost this attraction, but this is different from space programs because space programs are not only for military use. A space program consists of satellites and communications infrastructure—it has many civilian uses. This is why space programs are is still prestigious.

[Q3] The only two countries with space programs in the Middle East are Iran and Israel. It also happens that these two countries are more scientifically developed than the rest of the Middle

Eastern countries. There is a lot of pride and prestige that comes with developing a space program.

[Q3] In Israel, the program is funded mainly by the United States. We contribute a lot of money to developing Israel's space program. Iran does not have these same financial resources. Iran had planned to send human beings to space, but they cancelled this program because of lack of funding. So, these are some of the recent developments about Iran's space program. Probably even with all the pride involved, one of the big challenges for Iran is to secure funding for the space program. With the current oil prices, Iran does not have much available funding, so they are trying to balance the pride they want to get by developing this program with the shortage of funding they have.

Interviewer: **[Q3]** Do any other Middle Eastern countries, beyond Iran and Israel, have interest in or are working towards further development of their space program?

G. Bahgat: **[Q3]** For most Middle Eastern countries, there are two main requirements: money and the scientific infrastructure. The Gulf States—Saudi Arabia, UAE, Qatar, Kuwait—have the money, but they do not have the technical infrastructure (e.g., scientists). Countries with more human resources and better technical infrastructure—like Egypt, Jordan, and Lebanon—do not have the required financial resources. So, this is why the only two Middle Eastern countries—based on open source information—with space programs are Israel and Iran. Even with respect to Turkey, I have not read anything that Turkey has developed a space program, and to the best of my knowledge, Turkey still today does not have a space program and does not have plans to develop one.

Marc Berkowitz

Vice President, Space Security (Lockheed Martin)
25 August 2017

WRITTEN RESPONSE

[Q3a] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict?

Nation-states and non-state actors are motivated to conduct space operations for prestige, influence, prosperity, power, and security. Nation-states and non-state actors are motivated to contest the use of space in peace, crisis, and conflict to: undermine political will, societal cohesion, and morale; harm economic vitality; counter intelligence capabilities; and reduce the operational effectiveness of military forces.

[Q3b] What are the political, military, environmental, or social costs associated with acting on those motivations?

The potential political costs are: international opprobrium, diminished prestige and influence, domestic unrest, and reduced decision-making flexibility. The potential military costs are: military responses (including vertical or horizontal escalatory responses) that inflict punishment or deny benefit, and collateral damage or (unintended secondary or tertiary) effects that constrain future operations or create fratricide. The potential environmental risks (depending on the nature of the weapons effect, the target, and its location) include generating debris or other collateral effects that could create fratricide as well as reducing or precluding the ability to conduct space operations temporarily or for millennia.

Brett Biddington

Principal (Biddington Research Pty, Ltd)
9 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q3]** Okay. That's very interesting. And I think that segues nicely in to the first that I was hoping to ask you, which has to do with how other actors conceive of space operations for both military and commercial purposes. So, how does Australia conceive of space operations for both military and commercial purposes?

B. Biddington: **[Q3]** Again, all of the questions that you're asking are things I've been battling with for a decade, so they're good questions. Firstly, I would say that I think that war is already on in space—it's just not declared. I was at the space symposium in Colorado Springs in April and went to the AGI stand and of course got the briefing about the Russian satellite that cozied up against a NRO asset, and this was all presented at the unclassified level. Equally, the Chinese satellite that cozied up against an Optus commercial satellite, which is an Australian communication satellite.

[Q3] However, this is just not well-known. What's happening in space is not in the public consciousness. There's a little bit, of course, about debris, which has been popularized by films like Gravity, but this is still a very arcane and private conversation among, relatively speaking, a very small group of people (i.e., policy makers, lawyers, technicians, and engineers). This is just not really something that the rest of the world has coherence and understanding about. So, that's the first point I'll make.

[Q3] The second point is about space operations from the Australian perspective. Australia is a tiny nation when it comes to investing in space. Australia has, I believe, the 14th largest economy in the world, but it is not investing much in space in GDP terms—Australia is about just under 2%, I think, of global GDP. Australia doesn't invest anything like that proportion of its treasure in space activities, so it underperforms against that very crude measure. But then, because of Australia's alliance relationship with the United States, it effectively had, if not a free ride, then one that's been very good value from a tax payer's perspective. But, if I lift that up a little bit, the entire world benefits from GPS, which, of course, is now a global utility courtesy of the US tax payer. So, Australia has to balance, I suppose, just how much it really should be investing as a small or medium power.

[Q3] The Australian paradox is that we have two numbers that matter: a big number and a small number.

[Q3] The big number is that Australia is responsible, one way or another, for about 15% of the Earth's surface. That's our national territory, plus the oceans that we have search and rescue responsibility for, and plus Antarctica, of which Australia claims about two-thirds of the continent. To give you a picture of what that means, and this is where Mercator's projection doesn't help us, but think of the map you have in your minds of Australia. The piece of Antarctica that Australia claims is the same size as the Australian continent but minus the state of Queensland. In summary, 15% of the Earth's surface. And, of course, Earth observation satellites and communication satellites are very helpful in regulating, governing, and understanding what's going on.

[Q3] The small number is Australia's population—about 25 million people trying to run a continent the size of the continental United States. Sure, Australia doesn't have all of the infill cities like the US does, but it gives you a sense of the paradox of having a massive global responsibility being met from a tax base of about the size of New York state. So, ask yourself the question, "How would you all do that in your country?" And the answer is, of course, "with a lot of difficulty." Therefore, Australia has had to make some very big decisions about where it places its investments, and space has just not been one of those. And a big reason for this is because of Australia's alliance relationships.

[Q3] Moving to the operations point. If space goes to hell in a hand basket, there's very little that Australia can do about it other than, of course, helping the United States, and the West more generally, and maybe the global community because, ultimately, all of us stand to lose if we muck up the space environment more than we already have—it affects China and Russia just as much as it affects the United States in terms of satellites. So, Australia has to think really hard, I think, because of its strategic geography about how it can contribute to, and I hesitate to use the word the "order of space," but at least to the regulation of space to ensure that's it's there for all to use.

Interviewer: **[Q3]** So, you started off by saying that "war is already on in space—it's just not declared." That's an interesting statement, and one that I would think would be somewhat controversial, right?

B. Biddington: **[Q3]** Yes, that is a controversial statement. Of course, the euphemism we use is proximity operations. And, of course, we do proximity operations every time we supply the Space Station. The profound issue here is, of course, that almost everything we do in space is dual use or can be badged as being dual use. And, I have no doubt at all—and I have no insight into the classified world—that there are nations, particularly the US, Russia, and China, that are essentially testing each others' boundaries. They're not yet blowing things up, because that's to nobody's interest, but, certainly, there's very intense competition within the space environment, I would suggest, simply on the basis of the examples I gave to you.

[Q3] The big three nations (the US, Russia, China) are really trying to understand very, very carefully what each of the others is doing, with a view to be able to shut these things down very, very quickly in the event of conflict. Of course, this is where you get the relationship, then, between space operations and cyber operations.

Interviewer: **[Q3]** Okay. You talked a little bit this Australian paradox and some of the issues that Australia encounters with determining where it invests its money, so, I'm wondering, what do you sort of see as Australia's key ambition and interests with respect to space domain, and what sort of action has the country has taken in pursuit of those ambition and its interest?

B. Biddington: **[Q3]** The first point to make is that Australia is a very low and flat country with large areas of land that are mostly empty of people. This means that there are large areas of the landscape where radio frequency interference is minimal, and that's why, for example, we do a lot of testing of really interesting electronic warfare capabilities out of the Woomera test range, which is five times bigger than China Lake just to give you some perspective.

[Q3] Since World War II, Australia has made a couple of big bets in research nationally. One has been in immunology, and the other has been in astronomy, and especially in radio astronomy and radio astrophysics. Australia has used its landscape here, of course, because being quiet electronically makes Australia a great place for radio telescopes. So, Australia does that very well. Australia came out of World War II with a lot of radar research, and then out of

Australia's radio astronomy capabilities, came WiFI, which was an invention 15-20 years ago but that's where it came from.

[Q3] Australia continues to invest, in particular, in radio astronomy and radio astrophysics at the research level and the operational level.

[Q3] Moving to the operations side of things. Australia, again, because of its geography, hosts important ground stations for the United States, the European Space Agency, and others. And I think that that will continue. Whilst it certainly is the case that it is now technically possible to simply have constellations of satellites talk to each other, so you don't necessarily need ground stations in other countries, I think that prudence and redundancy and resilience for networks will give some of these ground station long lives. And, of course, for the very deep space missions, like those that the NASA station near Canberra, Australia helps to manage you still need three ground stations spread around the world to ensure that the probe is always in view of one of them. Because of this, Australia will continue to support ground stations.

[Q3] An interesting question for Australia and the United States is whether or not we will start to support ground stations from Russia and China. Russia and China are certainly asking if they can put ground station on Australian territory. So far, I think we have said "no," although there is a commercial Swedish organization, that has a ground station in Western Australia, and there is certainly a Chinese commercial lease running through that ground station. So, already, because of the way the world works, we are supporting Chinese space activities through a third party commercial arrangement.

[Q3] If I turn to space regulation and space control, there are now facilities at Northwest Cape, which is at the western extremity of the Australian continent. There is currently a space radar, a C-Band radar, that has been brought from Antigua downrange from Cape Canaveral (Cape Kennedy) to Northwest Cape. There will also soon be an operational space telescopes that is being relocated to Northwest Cape as well. So, Australia is starting to build some ground-based space surveillance capability, and I think Australia will continue to do that. There is also a cooperative research center, which is a joining together of universities and companies and other research organizations based in Canberra, that is looking at how we can improve space situational awareness, tracking, and prediction, particularly of space debris. This will then need to be fed in to a national and, ultimately, an allied and even international system so that we can make sense of it for the whole world.

[Q3] These are the sorts of things that I think Australia will do.

[Q3] In terms of its own space activities, Australia has no government-owned Earth observation satellites at the moment. The only satellites with an Australian flag on the side that are registered with the United Nations, are communications satellites, which are from the Optus company and also from the National Broadband Network company, which is a government-owned business enterprise. In the current Australian defense white paper and investment plan, there is a $3-4 billion project for space-based remote sensing—now, just what translates to, who knows? It could be a combination of commercial leases to buy data that somebody else has already got, but, almost certainly, I think there will be some Australian capability as well—in other words, Australia will start to run its own Earth observation satellites.

Interviewer: **[Q3]** Okay. So, what does the Australian commercial space industry look like in comparison to maybe some other countries' commercial space industries?

B. Biddington: **[Q3]** The Australian commercial space sector is fragmented. There is no center of gravity of companies that self-identify as being space companies. What there are, are some companies that run satellites as part of their telecommunications business, and they see themselves as telecommunication suppliers who happen to use satellites for part of their business. On the Earth observation side, we have a number of companies that sell or re-sell data that come from satellites owned by foreign entities, but they don't identify themselves as space companies, they identify themselves as data companies. Part of the challenge that we have in Australia is to say to these organizations, "Look, you do need to start to at least think a little bit about the dependencies that the bread and butter that you put on your tables has on secure and assured access to space and to satellite services. And you need to invest in thinking about how to help government, and how to help yourselves, ensure that we make the near space environment as safe and secure as possible."

[Q3] This brings us back to the question of, "So what should a small to medium power do that is realistic and helpful, without falling into the trap of over-stating our capabilities and our sense of importance and influence in these matters?"

Interviewer: **[Q3]** Sure. So, what is the relationship like between the Australian government and Australia's commercial space entities? Are there any key noticeable hurdles in the relationship that we should be aware of?

B. Biddington: **[Q3]** Civil and commercial space in Australia is the responsibility of the Commonwealth Department of Industry, Innovation, and Science, and responsibility is buried in the department at the level of middle-ranking bureaucrats. There is no space agency in Australia. There is no central sort of coordination office. There's no identifiable leader in government of Australian space activities at a level that is recognized both nationally and globally (i.e., you cannot simply say, "This is the person who looks after space in Australia"). The responsibility for space in Australia been dissipated and spread around many departments over many years.

[Q3] Now, in part, that's because, at the national strategy level, the big questions of space have been answered by Australia's alliance relationships. Australia hasn't really had to think about space issues too hard because people in the UK or, since the 1960s, the US, have really looked after the big questions for Australia. And, as I said before, if space goes to hell in a hand basket, there's not much that Australia can do to mitigate that other than potentially provide its real estate to help the United States. This has made Australia massively dependent on its allies here, particularly the US—I mean, $1 of every $2 spent in the world on space is spent by the US, so the mere fact of the size of this US investment is a good reason to stick closely to the United States. It just makes good sense economically and strategically.

[Q3] Australia has civil and commercial space buried, from a policy perspective, in the middle of a relatively small government department, which does not wield huge influence and whose minister is not a member of the National Security Committee of Cabinet. The default position of the Australia government for a long time has been, "how little can we invest," not "how much can we invest."

[Q3] With that said, of course, technology is changing this world rapidly, and small startups in Australia and elsewhere are starting to say, "Well, guess what? We can now afford satellites. We can launch satellites. We can make money in a way that previously we could not," so government is having to react to that. Australia even has a company that I think has a 50/50 chance of setting up a successful launch business in northern Australia, looking specifically at equatorial launches into lower Earth orbits in the first instance, which is of course something of great interest from a security perspective to Australia.

Interviewer: **[Q3]** Okay. So, to transition into the next question I was hoping to ask, what are the motivations of nation-state and non-state actors to contest the use of space in times of peace, instability, and conflict?

B. Biddington: **[Q3]** My view on this is very old-fashioned. I see space still as the preserve of nation states. And that's because launch is so difficult, and, therefore, relatively easy to regulate by the nation state. Unlike the internet, where nation-states have basically lost control, this is not the case with respect to space. It's very, very difficult to launch anything in space, and that allows governments to maintain close rein on what gets launched and by whom within their own jurisdictions. That, to me, plus the advantages that satellites give nation states, I think implies that space is the high ground of peace and war. And I think that it will remain ever thus.

[Q3] What that means is that despite the record pace of civil and commercial entrants into the domain and increasingly complicated landscape that is emerging, ultimately governments will be in the position to call the shots and prevent launches if they're not perceived to be in their national interests. This means that small and medium powers that don't launch themselves will be dependent on others to launch for them, and, of course, that means that those dependencies will lead to vulnerabilities.

[Q3] I really see the future in space as one that's run by nation states acting in their own interests, and because of what satellites can and can't do, they will make a very important contribution to national security. To me, the question is how you build sufficient consensus, especially between the big three space actors (the United States, Russia, and China), and sufficient trust and understanding so that everyone actually works to keep the space environment accessible to all, rather than completely trashing it—as we have started to do in the lower Earth orbits. As such, how we begin to clean space up, to me, is where this challenge immediately comes to the fore. As much as I applaud the people who say, "Let's go chase the debris and catch it," the engineers and the technologists who are running these conversations simply struggle with the concept that your garbage truck is my space weapon—they either ignore or seem reluctant to acknowledge the policy consequences of what they are saying. So, my plea is for a lot more people to start thinking about space policy and the issues around policy and law than is the case at present.

Caelus Partners, LLC

Jose Ocasio-Christian
Chief Executive Officer

24 August 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Caelus Partners chooses not to answer this question in detail at this time. However, consider the previous discussion points provided for general guidelines to our thinking on this question.

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

United States Air Force Academy

Damon Coletta; Professor of Political Science
Deron Jackson; Director, Eisenhower Center

8 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q3]** Okay, great. So, let's move on to some of the more national security-focused questions that I sent over to you guys. I'm hoping to run through these questions with you and then open the conversation up for more discussions with some of my other colleagues, so please forgive me if I'm jumping around a little bit. Let's just start with the first one from the list that I sent you, which is: Does substantial investment and heavier commitment by both government and commercial interests provide an avenue of approach for space security and disincentive for kinetic military action?

D. Jackson: **[Q3]** Well, I think it *can*. Whether we can deterministically say it does happen, depends on the actors and the contested relationship. There are two categories of disincentives. First, there is the value of current and future investment and the times involved replenishing space assets if they were lost. Second, there are, the environmental conditions (debris) would make it even more challenging to reconstitute if you went kinetic. Most established and some emerging space-faring states share these concerns, so if you are looking at this with respect to certain global regimes, there may be shared constraints that apply to some actors but maybe not all. As we watch other players around the world, like North Korea, start to demonstrate greater missile capability, who are not as equally "invested" in terms of current on-orbit assets or shared concern for the longer-term viability of the orbital environment, then they are in a position to cause trouble in the space domain disproportionate to their size. Thus, very th fact that you do have considerable investment by some players gives them a certain shared interest in avoiding kinetic conflict provides the incentive to do the exact opposite amongst other emerging actors.

D. Coletta: **[Q3]** Again, what I'm hearing from Deron is consistent with what I've seen. Ultimately, it depends. Thinking about this in terms of political science, one of the variables it depends on is the asymmetry of investment.

[Q3] Another variable that I've heard that might matter is the existence of common rules of the road. We are aware of efforts, some of which involve DoD and others not necessarily involving DOD but maybe just industry, are trying to come up with rules of the road. The idea is that if there were a rough consensus on such rules of the road, that commercial investment would actually be a positive for deterrence. Even if you had, say, asymmetric skin in the game, having rules of the road that were generally agreed upon would help strengthen the relationship between commercial investment and successful deterrence.

Interviewer: **[Q3]** Okay. So, could you maybe provide or play out a scenario with a specific actor that you might have in mind and a specific type of investment that you might have in mind, which you think might be a good example of a scenario in which increased investment and commitment provides an avenue for increased space security?

D. Coletta: **[Q3]** I don't have a historical scenario, but let me just give you a preliminary answer. If we approached this question, what we would do is we would say, well, have there been situations

where a foreign satellite, maybe a military satellite, has maneuvered in a way that wasn't expected or has maneuvered close to a non-military satellite in low Earth orbit? That can be seen as a threat to space security, and it could be seen as a bad precedent, so we would want to know if this scenario is the type of situation where rules of the road would help reduce the ambiguity of these types of incidents or reduce the sort of testing of the waters through satellite maneuvers—let's say, reduce this testing of the waters that generally leads to less space security.

[Q3] Then, we would scour the unclassified sources for situations that fit this scenario and make arguments about what sort of rules, whether those rules are being worked on right now or not, would make this type of insecurity less of an issue.

[Q3] Overall, though, we'd start out with a scenario, a hypothetical scenario, and then we'd see if there's anything in the unclassified record that backs that up. But, unusual satellite maneuvers would be a place to start.

[Q3] I'm sorry that doesn't answer your question about investment. I'm thinking more in terms of where rules of the road could come in, but, obviously, in this scenario there was an initial investment from the commercial sector to put the satellite up there in the first place. As you get more satellites in orbit, and that's certainly expected to increase, so it seems like this sort of scenario would be more likely.

D. Jackson: **[Q3]** Let me make up a scenario on the fly. For your purposes, if we take a state that's just going to be an operator, so we don't presume launching space capabilities. There is a proliferation of states that can be operators, so the chosen state would need to conform to a rules of the road type of approach. Let's take Nigeria for example. If Nigeria contracts with somebody, then they are now a space faring state because they got a satellite in orbit. Then, going back to the idea of contesting regimes or contesting international institutions, the challenge there is to have a set of rules or relationships (e.g., an agreement to share some level of situational awareness data), so that they then have a habit of cooperating with American oriented favored systems, rather than responding to, say, another big country (e.g., China) that would maybe want to set up its own set of rules that are maybe more lax or generous or in some way more favorable to the Chinese interests.

[Q3] So, what they are contesting is: *Who do you work with? What norms and what traditions get established that suggest what the international community's preferred options are for doing maneuvers and the like? Who do you know and who do you trust?* So, as you are theorizing about a country—whatever one it might be—that is trying to build towards that greater level of investment, they can be doing it under a certain set of rules. So, it is crucial to understand who writes those rules, who maintains them, and who sustains them with some level of coordination or information sharing? Is it going to be the United States, or is the contest going to be something less kinetic but more political so that another center of power, Beijing for example, sets those rules and helps to enforce those rules, which may or may not be more permissive of dangerous maneuvers or kinetic activity.

D. Coletta: **[Q3]** There's another scenario that could be interesting—that is, the idea of as investment increases, perhaps the chance of collision increases. We've heard a lot about the concern of collision forensics. If something were to happen and a satellite were to go out of operation, how long would it take US authorities to figure out what happened (i.e., if it was an attack, or if it was an accident)?

[Q3] As investment goes up, the chances for that kind of problem probably increase. Then, to bring in that second variable, could a more elaborate crash protocol—and I gather, for

insurance reasons, there are already some protocols out there in terms of what's supposed to happen after a collision—that could assist multiple countries in their forensics were in place, would that improve space security from what it otherwise would be if these collisions just simply became more frequent under the current arrangement? This is a scenario that relates to increased investments and the importance of let's call it a collision protocol.

Gen. Elder[8]: **[Q3]** 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.

[Q3] 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: **[Q3]** 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 and 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.

[Q3] 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.

[Q3] 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.

Gen. Elder: **[Q3]** 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.

[Q3] We have three 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

[8] Lieutenant General (ret.) Dr. Robert Elder

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 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: **[Q3]** 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.

[Q3] So, the greater interconnectivity—entanglement as we called it—ought work to our advantage if we can persuasively impose upon that hostile actor the certainty that they're not going to be able to restrict things we need. Their ability to be discreet and surgical may lead them to calculate 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 discreetly, I think it would enhance deterrence and dissuade them from trying to their hand at space warfighting.

D. Coletta: **[Q3]** 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.

[Q3] 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.

Gen. Elder: **[Q3]** 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.

[Q3] 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: **[Q3]** 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, nor are they necessarily interchangeable.

[Q3] The dilemma is that in order to deter an adversary, at some point do you may need to have broad range of capabilities. Some systems don't have any defensive value, but are just purely offensive to threaten retaliation. Others may be needed to protect your own forces. How do you manage that mix, setting priorities for limited resources? While you're doing that, how does your adversary see your moves as they are building up? Can this relationship in any way be construed as being stable? I think for the first at least 15 years of the nuclear era, the scholars of that time were trying to wrestle with these problems, just as we now are trying to apply them in space. There's not a uniform continuum of options for people to choose from between deterrence on one end and defense, or warfighting, on the other end. It comes down to the fact that at some point we may need to be preemptive, and thus the tools you need to do that will be different from what you relied on for defense (self-protection) or certain layers of the deterrence framework. Preemption was on the table in the early ages of the nuclear confrontation. So, ultimately, this problem may be new in this domain, but it's not a new problem for us overall. The classic dilemma emerges of how to manage the relationship between states as it goes through a certain phase in history.

D. Coletta: **[Q3]** 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?

[Q3] 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: **[Q3]** 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.

[Q3] Space was essential in providing stability in that era, because it gave you some idea of what the other side's capability was when the early reconnaissance programs came on board. As surface-to-air missiles were deployed by the Soviet Union, enabling 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. This was important 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. Maintaining that role with regard to space requires circling back on the idea of situational awareness and surveillance and maintaining a good picture of what's going on. This 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: **[Q3]** 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.

Colonel Timothy Cullen, PhD[9]

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

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Whether it be in times of peace, instability, or conflict, state and non-state actors contest US and its allies' use of space to degrade or deny their ability to observe unfriendly behavior or coordinate allied activities, to punish the US and its allies economically, to demonstrate the vulnerability of US and allied space weapons or communications systems, to simply test the effectiveness of unfriendly actions, or a combination of all the above. The US and its allies should expose aggressive and belligerent actions threatening allied assets in the space domain to impose political and social costs of the actions and to educate the public and the international community on the environmental, economic, and societal costs of the behavior. Militarily, the US and its allies must continue to develop redundant tactical, operational, and strategic approaches where the continuous access and control of space is not essential to the successful employment of lethal and decisive force. Fortunately, redundant approaches will be much more economical and effective in the long term than the development of the robust space infrastructure and weapon-system architectures that would be necessary to assure access and control of space against a near-peer adversary in times of lethal conflict. Dominance in space may not be possible against aggressive and industrialized nations, regardless. It is difficult to express how expensive the net cost of the development and large-scale employment of even "low cost" access to space will be or how unforgiving, harsh, and costly the space environment is to conduct operations, and the space industry has little incentive to state their net estimates either. It is in the interest of the US government to incentivize commercial investment in launch an orbital systems, but due to the incredible cost, risk, and efficacy of the approach, the US military should not underwrite these investments completely by attempting to physically dominate the domain with force.

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

Dr. Malcolm Davis

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

21 August 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

The United States approach to warfighting is based around exploiting precision effect, speed of engagement, and most importantly, gaining and maintaining a 'knowledge edge' over all potential opponents to fight wars in a manner that minimises cost and risk to deliver rapid decisive outcomes and ensure military superiority. Space is crucial in enabling this 'Western Way of War' that exploits precision, high operational tempo, and joint military operations within US forces and highlights coalition interoperability with allies. Space capabilities provide the information backplane to US military power to enable this western way of war, and represents a key foundation for US military superiority over potential adversaries.

More broadly, space systems are vital to the functioning of the US economy and society. There are obvious civilian applications for satellite communications, using satellites based in Geosynchronous Orbit (GEO) and also in Low Earth Orbit (LEO). Effective monitoring of global weather cannot be easily done without access to meteorological satellites in orbit. There is a rapid growth in the market for remote sensing and Earth monitoring to aid everything from agriculture through to city planning, and to monitor the effects of climate change. The development of the US Global Positioning System (GPS) satellite network, and other Global Navigation Satellite Systems (GNSS) has enabled the rapid growth of globalisation in interdependent economies through inter-linked stock markets, the rapid growth of the Internet, and makes possible a future 'Internet of Things', as well as being vital to support transportation networks.

Now, imagine a day without Space. Imagine an adversary being able to threaten or take away US space access, either by attacking satellites directly with ASAT weapons, or through jamming or spoofing the data between the satellites and the terrestrial ground segment, or attacking the ground segment directly, including satellite control facilities as well as launch sites in the US and elsewhere. In losing access to Space, the US would rapidly lose the advantages and benefits it gains from Space, both in terms of being able to wage war decisively, quickly and with a high degree of confidence in outcome, whilst the US economic and social foundations would fall apart. Such an attack would strike at the very heart of US global power and influence, and erode that power rapidly (in the space of hours or days). In attacking US space systems in what has been referred to as a 'Space Pearl Harbour,' a peer adversary like China or Russia would level the playing field in military, economic and technological terms. This may then enable that them to bring asymmetric advantage to bear and exploit mass (in regions like East Asia or the European Near Abroad). They could then more effectively employ a suite of 'anti-access and area denial' capabilities against US and allied forces that suddenly had been left 'deaf, dumb and blind', and in doing so, gain the operational and tactical initiative early in a conflict. The result could be heavy US and allied losses in the opening phase of any future major power conflict, particularly for forward-deployed forces, and conversely, rapid advances by the adversary to achieve military and strategic objectives. The outcome would then be a political 'fait accompli' for the US and its allies that would be costly to challenge.

Certainly this scenario of a 'Space Pearl Harbour' is well known in the context of a clash with a peer competitor, such as China or Russia, with the concept dating back to the Rumsfeld Space Commission report[10] in 2001, but changes in the nature of space capabilities means there is a proliferation of counter-space capabilities and growing potential risk. In 2017, the commercialisation of Space and the growth of 'Space 2.0' technology and the broader

[10] https://fas.org/spp/military/commission/report.htm

paradigm for its use, is seeing access to space democratise, which means that a broader range of potential state and non-state actors can access space more easily, and at lower cost. Two developments bear watching in this regard. More states, and also commercial companies, are developing low-cost space launch capabilities designed to launch small satellite (up to 500kg), micro-satellite (up to 100kg) or 'CubeSat' type (below 100kg) payloads at relatively low cost and in an increasingly responsive manner. At the same time, the proliferation of ballistic missile capabilities is occurring at a steady pace, with North Korea and Iran being key proliferators in this regard. If an adversary can develop its own ballistic missile systems, it can also launch payloads into Space, including potentially direct-ascent or co-orbital ASATs that could then threaten US and allied satellite systems. Miniaturisation of satellites epitomised by CubeSat technologies, together with low-cost 3D printing technologies, means that an adversary could manufacture a suite of ASAT capabilities for ready use prior to, or at the outset of a conflict. Non-state adversaries might be able to purchase or build low-cost GPS jamming or spoofing systems that can interfere with GPS signals to deflect GPS-guided munitions, or interfere with aircraft or ship navigation. Future development of cyberwarfare capability for both states and non-state adversaries will see increasing threat of using cyberattack[11] against the ground segment, or directly against the satellites themselves. This could see data manipulation to provide false or misleading information, monitoring of communications traffic, spoofing of signals, and even seizing control of a satellite network and denying it to US forces.

Obviously there are potential costs in launching attacks against US and allied space capabilities. There is an environmental risk if kinetic-kill ASATs were employed that physically destroyed their target, with China's January 2007 ASAT test[12] leaving a cloud[13] of debris that over time threatened other spacecraft in other orbits. The potential for a 'Kessler Effect' scenario[14] emerging from an ASAT campaign of rapid expansion of cascading collisions that produce ever more space debris generating additional collisions (popularised in the 2014 film 'Gravity')[15] must be a real concern, and suggests one reason why China and Russia are both pursuing 'soft kill' options such as jamming, electronic attack and cyber-attack against satellites. If ASATs are to have operational utility they must be usable. The US may also respond asymmetrically to any ASAT campaign, regarding such an attack as a strategic strike,[16] particularly if US missile early warning satellites (SBIRS and DSP) are hit. The risk of escalation[17] would be on the minds of Chinese and Russian planners. Furthermore, any ASAT campaign, unless tightly controlled, could see threats emerge to civilian space systems (particularly those used by the US military to supplement bandwidth of military satellite systems) that could have serious effects on US and allied economies. This may be an intent for the adversary such as North Korea. However, the world is globalised and based on interdependent economic systems. China and Russia would need to consider the risk of economic 'blowback' against their own financial systems before launching an ASAT campaign in a conflict.

There would be understandable political and social costs in decisively violating a perceived (rightly or wrongly) 'norm,'[18] which suggests Space is a global commons open to the use of all. Once violated, such a norm could not be easily restored – in the same way that first use of nuclear weapons in anger since Nagasaki in 1945 would undo a key norm against non-use of such weapons. There would be an obvious political blow-back against the side which initiates space warfare using ASATs. However, for authoritarian regimes, this may not matter greatly, particularly if they have initiated warfare in the first place, and given they are not accountable to checks and balances in their political system, or indeed, to their people. For non-state actors such as extremist groups, there would be even less concern over the political, economic or societal consequences of first use of space weapons. This is one issue where western liberal democracies, who are accountable to their people and must fight wars in a manner that acknowledges their value systems that are based on known legal and ethical constraints, are at a relative disadvantage to authoritarian states or extremist non-state actors.

[11] https://www.chathamhouse.org/publication/space-final-frontier-cybersecurity
[12] https://swfound.org/media/9550/chinese_asat_fact_sheet_updated_2012.pdf
[13] https://www.space.com/3415-china-anti-satellite-test-worrisome-debris-cloud-circles-earth.html
[14] http://www.esa.int/Our_Activities/Space_Engineering_Technology/The_Kessler_Effect_and_how_to_stop_it
[15] https://www.youtube.com/watch?v=OiTiKOy59o4
[16] http://allthingsnuclear.org/gkulacki/the-united-states-china-and-anti-satellite-weapons
[17] http://ndupress.ndu.edu/Portals/68/Documents/stratforum/SF-272.pdf
[18] https://www.scientificamerican.com/article/war-in-space-may-be-closer-than-ever/

Faulconer Consulting Group

Walt Faulconer
President

Mike Bowker
Associate

Mark Bitterman
Associate

Dan Dumbacher
Associate

15 August 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Excellent question, requires research effort to address fully, and likely continuing assessment as the geopolitical environment evolves. This would take some study, but could be compiled as a follow-on study task to add this data to the taxonomy data base mentioned before. Example:

Nation State Motivations

	PEACE	INSTABILITY	CONFLICT
Political	Prestige, respect, negotiation leverage, influence. Better "seat at the table". Black mail the U.S.	Optics of power. Build sympathy and form alliances.	Alliances, create an advantage. Negotiate a better outcome.
Military	Optics of power for leverage and influence	Temporary denial of U.S. advantage	Eliminate U.S. advantage
Environmental		Potential increase in space debris and EMI.	Increased space debris. Deny some orbits to all
Social Costs	Can provide distraction to other issues.	Economic embargos	Loss of infrastructure

Dr. Namrata Goswami

Senior Analyst (Wikistrat); Subject Matter Expert (Auburn University Futures Lab)
15 August 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Nation states, like the U.S, Russia, China, and India (major space-faring nations), have four goals that could result in contested use of space.

1. Achieve space domain capability and advantage vis-à-vis adversaries by investing in research and development.
2. Stake territorial claims in outer space once humanity cracks the code of mining precious metals on the lunar surface and beyond.
3. Support growing commercialization of space activities and an emerging lucrative market for space based activities.
4. Build military capacity based on space based assets to sustain the trade links and establish superiority on earth.

In times of peace, contested use of space could occur if two countries discover precious minerals on an asteroid or on the lunar surface. Given the lack of international regulatory framework that could adjudicate and establish ownership, a dispute may break out during peace times.
During conflicts, space based assets like military satellites could be taken down by an adversary to deny precision guidance to missile systems, jam early warning for incoming missiles, and deny data and information on enemy positions. Non-state actors with access to space based capabilities could utilize it to deny access to data like jamming GPS, and reconnaissance.

Potential political costs of acting on motivations to create an advantage in space or engage in conflict could result in regime change especially in democracies like the U.S. or India, or create a domino-effect where the space based conflict would trickle down to earth resulting in several jumps in the escalation ladder in a nuclearized world. Such a conflict would have direct negative costs, politically and socially.

The desire to create space domain advantage would require budgetary allocations, thereby taking away limited resources, especially in countries like China and India, away from their poverty alleviation programs. This could create a backlash in society thereby raising questions about the feasibility of such outer-space motivations. For instance, there was intense debate in India as to whether its MARS orbiter expense was legitimate or necessary, given the elevated levels of poverty in the country. Several leading Chinese academics also argue that China's increasing space expenditure is not judicious given the country's need to develop in other areas. The environmental impact of a conflict in space would be detrimental, creating 'space debris', further enhanced in impact due to the lack of any mechanism to clear it out.

Harris Corporation

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

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Any U.S. adversary with a capability to do so is highly likely, if not certain, to attack U.S. space capabilities or its ability to utilize space services. As mentioned above, any state or non-state adversary clearly recognizes the asymmetric advantage US space capabilities bring to U.S. forces supporting military and intelligence operations. Most U.S. adversaries are equally aware that the high and ever-increasing level of dependence on space by U.S. military forces is also a unique asymmetric vulnerability. Since U.S. space capabilities were designed to support a war effort from space versus fight one in space; and because the cost to disrupt space operations (via electronic, cyber and kinetic attacks) is far lower than the cost to achieve space superiority against the U.S. there is a very strong incentive for state and non-state aggressors alike to attack US space capabilities in crisis or wartime.

Because "attacks" on space capabilities need not be kinetic, directed at an orbiting satellite, or result in human casualties or collateral damage, some adversaries also may view attacks on U.S. space capabilities as lower risk/higher reward options, believing there is a lower probability that these actions would result in a U.S. military response.

Existing U.S. declaratory policy about attacks against space systems are ambiguous. As a result, we are sending mixed/conflicting messages regarding potential U.S. responses to an attack on our strategic and/or dual use (strategic/tactical applications) space assets. This ambiguity undermines the credibility of U.S. deterrence in space.

Some adversaries may believe that attacking U.S. space capabilities could deter the U.S. from entering a conflict for fear of even greater losses to its space capabilities. Others believe that the difficulty in attributing the source of some attacks, e.g., cyber, jamming, etc., poses significant challenges and could greatly delay or paralyze the USG's national security decision making process.

To effectively deter adversaries from targeting our space assets, it will be essential for the USG to establish a declaratory policy at a strategic level, tied to an overall national strategy, with classified/unclassified messaging that states how we would react to an adversary's attack. Our dependence on space and late-to-need investments in the protection or resiliency of these capabilities present a significant challenge going forward

Theresa Hitchens

Senior Research Scholar (Center for International and Security Studies at Maryland [CISSM], the University of Maryland)
19 July 2017 (Written Submission)
30 June 2017 (Interview)

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Again, this is practically a research paper by itself as motivations vary state to state. Russia and China have motivations for counterspace vice US because of force asymmetries. One might assume Iran/NK would have counterspace aspirations re USA if they ever got their space act together, for political deterrence if nothing else. Israel and India have shown interest in counterspace capabilities – because they feel threatened/want to keep up with the Joneses. UK, Australia likely to be integrated in any US counterspace operations. I don't see any state having motivations simply to "mess up space." As for NSAs I personally don't think besides hacking websites they have much motivation to "contest" the use of space, either vice an individual nation or in general (i.e. debris/EMP to harm environment.) It's too hard, doesn't really help them in their goals.

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q3]** Okay. One other question. Are any of these of these countries that we listed collaborating and/or cooperating with each other to advance their interests in the space realm? And, on the other end of the spectrum, are any of these countries sort of openly hostile towards each other with respect to their space interests and activity?

T. Hitchens: **[Q3]** Well of course the Europeans all work with each other and are all pretty well aware of each other's interests and activities. In Europe, you've got the European Space Agency, and even in the military realm—although they are little more secretively—the Europeans are working together on various aspects of various satellite programs (e.g., Galileo), various ground systems, etc.

[Q3] The Chinese are very interested in satellite cooperation. They see their satellite capabilities as a form of soft power, and therefore they are doing a lot of marketing in places like Africa and Latin America, and helping other countries own and operate their first satellite or their first satellite systems primarily in the Earth observation arena. The Chinese are very interested in market—they have a capitalist-hybrid communist economy, so they have a lot of interest in playing a bigger role in the world market. China is also working very hard to develop cooperation with the Europeans in space.

[Q3] The Russians, I don't know. The Russians are just in such a bad space right now across the geopolitical spectrum, so they are kind of currently not really cooperating with anybody other than a little bit of cooperation with India and China overall.

[Q3] Putting North Korea, which is an outlier problem set here, to this side, I don't think there's actually hostility in space that I'm aware of between these countries. I mean, indeed, I would say at least based off of my interactions internationally, there is a lot of concern amongst other countries, who are not Russia, China, and the United States, about growing

hostility between China, Russia, and the United States because they see those geopolitical hostilities and the potential risks involved in risks of conflict as being detrimental to their own ambitions in space.

Interviewer: **[Q3]** So, Theresa, we always ask this question at the end of our interviews: Is there anything that I haven't asked you that I should have, or is there any final point you would like to conclude with?

T. Hitchens: **[Q3]** Okay, interesting. I have a lot of thoughts on some of the other questions from your full list of questions. I wanted to just briefly address Q3 from your list of questions because I think the framing of this question is really important.

[Q3] So, what are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

[Q3] I mean, again, this is a state-by-state question—you have to look at each state individually, different states have different motivations, and that's going to be pretty clear. There are some countries that have motivations for counter-space operations against the United States, and maybe there's more. That's not a surprise. Then maybe India and Israel have shown an interest in counter-space capabilities because they feel threatened by their neighbors and in some ways just want to keep up in general.

[Q3] I want to address the issue of the non-state actors. I personally don't see non-state actors having any interest in messing with space, so to speak. I just don't see it. I don't think non-state actors have any motivation to do so, I don't think they would want to spend the money, and I don't think it helps them achieve their goals. I think this would be kind of silly.

[Q3] I actually think this question is kind of a moot question. I don't see any motivations there for non-state actors to contest space.

[Q3] I also see no motivations, perhaps with the exception of North Korea who is an outlier, on the part of any other states to mess up space in general. In other words, they might not contest the use of space in a conflict, particularly in a conflict with the United States. But I don't see them having motivation to do something stupid like launching an EMP. This is because of the fact these countries are investing money in improving their use of space, so there's nothing in it for them, at least in peace time. In times of conflict, they have motivations and they might have motivation even to do things like creating space debris or creating space weapons if they feel as though they are losing a war. They might have motivations to do that because they have those capabilities.

[Q3] Indeed, with the United States under Trump, this also might not actually be off limits for the US if we were in a conflict. We've said that we don't wish to use space debris creating weapons, that we have no desire to see those kinds of weapons deployed and developed, and that we have no intention of producing those kinds of weapons, but we've never outlined in any doctrinal paper or any policy papers that we need to have instituted that self-imposed ban on these kinds of technologies—we've not done that.

[Q3] So, all I'm saying is that I don't see any motivation for anyone, with North Korea being an outlier because who knows what their motivations are, in actually harming space as an environment because there's too much social and economic and military benefit coming from space for anyone to really want to contemplate ruining space for everybody else. I think it's really important that this understanding underlies this question about motivations to contest space.

Christopher Johnson

Space Law Advisor (Secure World Foundation)
11 September 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

This question is outside the scope of my expertise so I could not offer an answer with overwhelming confidence in its accuracy. I would hazard a guess that actors might contest the use of space at various times due to a mix of various contributing characteristics that such actions encompass. Interfering with or hacking a space object would be a new, unique, ground-breaking activity and would therefore be a nefariously prestigious accomplish unto itself. Secondly, interfering with space activities offers disproportionately large effects compared to the time and resources required. Thirdly, as attribution would be difficult, the lure of anonymity is also an attractive aspect.

Regarding the political/military/environmental/social costs of acting on these motivations, they set a precedence and open the domain to these types of actions.

Dr. Martin Lindsey

Aerospace Engineer (USPACOM)
7 July 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q3]** Okay. So, you mentioned some collaboration efforts between European countries, the US, Canada, and Australia, but, beyond some of that collaboration, are any of these big countries working together bilaterally in close collaboration when it comes to the space domain? And, on the other hand, do the space interests and space-related actions of any of these countries openly conflict with those of any other countries?

M. Lindsey: **[Q3]** I would argue that there's a lot more cooperation going on in the space domain than competition. I don't know how you want to define "conflict," but there's really not any kind of overt or even covert conflict that I'm aware of right now in space—though, there is competition. But, overall, I think there's a lot more cooperation going on in space. Again, a lot of that is done multilaterally on the commercial side or bilaterally.

[Q3] Some examples of multilateral cooperation would be the US has a Five Eyes relationship, right? That relationship spills over into cooperation on technology development, and space technology development, between the five countries in that partnership.

[Q3] In Asia, the Asian nature is to be more bilateral than multilateral across the board in everything. So, a lot of the relationships in Asia are bilateral in nature—so, you see a lot of times where countries will go to Japan or go to China, or increasingly they're going to India or European countries, to get their first exposure to development in space. So, you see like, for example, the Chinese will fly country X's satellite for very low prices, and in return they'll work out some agreement maybe for ground station access in that country. There are some

multilateral space institutions in the Asia Pacific. These are mostly on the civil side of the house or the civil/commercial side. I'm not really aware of, other than the Five Eyes partnership, any real national security-related relationships between countries in the region—though, with the one exception being that USSTRATCOM is working a series of a space situational awareness agreements throughout the world, and these are bilateral agreements with countries that include several countries in the Asia Pacific (e.g., Australia, Japan, Korea).

Interviewer: **[Q3]** Okay. So, from a longer-term perspective with respect to some of these countries' space interests and where they see themselves going, while you think things seem to be mostly collaborative at the moment, do you foresee any sort of situation in which some of these countries' interests might drive things to become more competitive or possibly even conflictual? And, if so, what types of things in particular do you think might be the leading drivers of increased competition and conflict?

M. Lindsey: **[Q3]** Sure. So, as I mentioned earlier, there are various space races going on in the Asia Pacific region—the big ones being between China and India, and then to a lesser degree between China and Japan, and these are more tied up in nationalism and global prestige—they're not head-to-head competitions for their own sake. But, having said that, of course there are countries in the region that do have military space capabilities and military counter-space capabilities, so I think it is a logical extension to say that a conflict on the ground can easily extend into the space domain if it involves those countries, and, arguably, a conflict could begin in the space domain and then spill over to the terrestrial side. I mean, certainly leaders in our own country over the past couple of years have been expressing concerns with the risk of that happening and the need to be ready to deal with that.

[Q3] So, I think that's a real concern, and I think it's a concern for countries throughout the world because there's a recognition that any type of kinetic conflict in space doesn't get limited to the parties that are directly involved; it spills over to everybody that uses that region of space. So, I think countries are concerned about it, and I think a lot of countries are still in a position of knowing that they can't really do much about it directly.

[Q3] So, is the risk increasing or decreasing? Well, I think it's double-edged. It's increasing from the standpoint that the technology is improving and making it easier to get into space and do things in space where you could do actions that would constitute conflict. On the other hand, I think there's a growing realization that the things that happen in space affect everybody and the risks of escalating a terrestrial conflict go up exponentially because of the increasing dependence on space. So, I think it's double-edged, and, at this point, I'm not sure which direction a lot of countries are going to go in. From observation, again, we see things that disturb us with certain countries, but we'd have to talk somewhere else about that.

Sergeant First Class Jerritt A. Lynn

Civil Affairs Specialist (United States Army Civil Affairs)
17 August 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

While the military application of space activities was a driving factor during the first space race and continues to be of concern, there is another motivator that is almost as important to recognize in international politics. The role of prestige in influencing a state's actions cannot be overstated. The way states perceive one another within the international system is a motivator that can literally send a man to the moon. International prestige was a factor during the space race, and it continues to be one as other states are pushing their way into the international spotlight. China just recently finished construction on the Five-hundred-meter Aperture Spherical Telescope (FAST) in Pingtung. This is currently the world's largest radio telescope and is supposed to enable research of the furthest stars, search for extraterrestrial life, and detect new galactic and extragalactic pulsars (Williams II 2015). As the international scientific community uses this platform, it will garner international prestige, grant the opportunity to conduct cutting-edge research, and aid in China becoming a global leader in the space and science community.

In December 2016, China's Information Office of the State Council released a white paper detailing China's space strategy and principles of development (David 2016). Wu Yanhua, deputy chief of the China National Space Administration (CNSA) stated the goals are to land a rover on the dark side of the moon by 2018, its first Mars probe by 2020, and to become among the major space powers of the world by 2030 (Jiang 2017). These are clearly articulated goals for China to reach parity with the U.S. within a relatively short timeframe. China's first successful satellite launch was in 1970, a year after the U.S. landed the first human on the moon. Despite that gap, China is proving its willingness to allocate resources to become a global leader in space. In August 2016, the Peoples Republic of China launched the first prototype quantum-communications satellite into orbit (Chin 2016). The intent is to use subatomic particles to send secure communications between two points, one in space and one on land (Merchant 2017). Although this extraordinary leap in science received little in the way of headlines in the United States, its significance is noteworthy. The science behind quantum communications is still in its infancy, but it can change the field of secure communications.

Researchers have been successful in sending quantum communications but only by land (Merchant 2017). If the Chinese are the first to progress in quantum communications via space, they will have a marked advantage over the U.S. If they are successful the quantum communications system would secure their data and render it theoretically unhackable, giving them a sizeable lead in defensive communications measures (Chin 2016). Although the space race in the second half of the 20th century was bipolar in nature, the proliferation of space technology and assets in the 21st century has allowed for a multitude of participants in the contemporary environment.

Achieving such a feat only garners China more notoriety and prestige for accomplishing so much within such a small amount of time. This can assist the Chinese government in reaping domestic and international support. Prestige itself may not be easily quantifiable, but it is a resource a state must capitalize on to their own advantage.
The allocation of resources is also manifesting itself in the development of a new space station. Launched in the fall of 2016, the Chinese currently have the thirty-four-foot-long Tiangong-2 space lab orbiting Earth. China's vision is to commission the Tiangong-3 space station in 2022 (Nowakowski 2016). This launch coincides with the 2024 retirement date of the International Space Station (ISS), which is the orbiting laboratory utilized by the U.S. and other international space partners. Currently, neither the U.S. nor any other state has planned to construct or operate a space station. If the ISS is retired and goes into disrepair, the Chinese would be the only state with an operational space station. They have already begun to leverage this position by signing agreements with the United Nations Office for Outer Space Affairs (UNOOSA). This is going to have further implications for U.S., as UNOOSA announced a recent agreement with the China Manned Space Agency (CMSA) to conduct space activities. In addition to the planned spaceflight mission, the UNOOSA and CMSA agreement allow for UN member states to apply for permission to conduct research and experiments aboard China's planned space station, Tiangong 3 (United Nations Information Service 2016). It is unknown what the long-term effects of this would be, but it would be hard to argue that China owning and operating the sole space station would be beneficial to U.S. strategic concerns or ease diplomatic relations between the two. It is too early to tell whether or not the Chinese space station will be successful. But, if so, the Chinese will have an additional strategic means to create partnerships on their terms.

Even though one could argue the current international system favors the U.S., they have only been successful because of the international partnerships and alliances she is able to maintain. These are at risk as other states become more dominant and find means (i.e. such as space activities) to entice other states traditionally aligned with the U.S. to reconsider their strategic partnerships. One of the ways space activities provide other states with the opportunity to subvert U.S. diplomatic efforts are the U.S.'s Technology Safeguard Agreement (TSA), which has limited its willingness to share technology and development in the realm of space activities, particularly orbital satellites. This approach has created friction between the U.S. and many foreign nations, which has opened the door for China to build strategic relationships with states looking to develop their space capabilities: "The CMSA gives a lot of countries a nice opportunity to develop new partnerships to stay active in space exploration," says Alanna Kolikowski, an expert in Chinese technology policy and visiting professor at the University of Gottingen in Germany (Dillow, Lin, and Singer 2016). China has assisted countries like Venezuela, Laos, Nigeria, Belarus, Pakistan, and Brazil with satellite launches and military grade hardware (Dillow, Lin, and Singer 2016). Currently, China is constructing a space telemetry, tracking, and control facility in Argentina that will provide China with a node in the Southern Hemisphere, allowing it to retrieve data from satellites before they pass over mainland China (Economic and Commission 2016). Brazil is particularly of note because of the leadership position it plays in South America. A strategic partnership with Brazil provides access and placement to the majority of South America and their resources.

Since the beginning of the space race in the late 1950's, Brazilian leaders have recognized that the development of a space program was integral to achieving a status as an economic and diplomatic leader. Brazil's current position as the primary leader in South American space activities also puts pressure on them to achieve success in order to remain the continents de facto leader. Brazil has been developing its Agencia Espacial Brasilieria (AEB), (their national space agency) because they believe space is intertwined with their national defense and economic prosperity (Anderson, Conrad, and Gamberini 2014). Due to a series of setbacks, such as failed launches resulting in the deaths of technicians, tensions between military and civilian agencies, and unsuccessful cooperation between the private and governmental sectors, Brazil has had to look internationally for assistance. Since 1999, China and Brazil have worked in tandem, successfully putting the CBERS-1 satellite into orbit in 1999 without relying on technology or support from the dominant space powers (US, Russia). Since then there have been multiple launches, all with Chinese rockets (Anderson, Conrad, and Gamberini 2014).

Moving from South America to the Middle East, the United Arab Emirates (UAE) has a few goals that they have set their sights on achieving, such as establishing the first space center in the Middle East (Mohammed bin Rashid Space Center (MBRSC), conducting the first mission to Mars by an Arab/Islamic country, and becoming one of the primary leaders in space by 2021 (UAE Space Agency 2016). The expanse of space activities within the global community has the chance of expanding the breadth of scientific knowledge, but it also adds additional actors into space, increasing the chance for diplomatic and military opportunities and conflict. The UAE has also signed a Memorandum of Understanding with China to define a framework for collaboration in space science, as well as the peaceful exploration of outer space (UAE Space Agency 2015). In addition to securing a partnership with China, the UAE and the U.S. have also entered an agreement to cooperate in aeronautics research, and the exploration and use of airspace and outer space for peaceful purposes (NASA 2016). This is but one example of how the proliferation of space activities is influencing the international political environment and is setting the stage for cooperation, competition, and potentially conflict.

The U.S. has been the hegemonic leader in space for decades, so it is understandable that policy-makers would be concerned about the proliferation of space activities to other states. Space has traditionally been a domain for the U.S. that had little competition; therefore, it required little maintenance. It is no surprise then that there is a concern every time a newspaper reports that the Chinese space program is working on sending a rover to the moon or that they are building their own space station. This dynamic challenges the unquestionable hold the U.S. has on hegemony in space, and because power is relational, it directly affects U.S. power in diplomacy, information, military, and economics (DIME). The domain of space is integral to the ability to project national power in each of the DIME categories. Therefore, a challenge to space supremacy is a challenge to U.S. national power writ large. The growing number of state actors with space programs is changing the international power

dynamic and altering international diplomatic relations. Instead of the more predictable bipolar space competition with the Soviet Union, the contemporary environment is comprised of a growing number of actors in space, in which each entity has their specific interests in mind, creating both the chance for opportunity and conflict with the United States.

References

Anderson, D. J., Conrad, D. W., & Gamberini, S. (2014). Space and Defense. Space and Defense, 7(1), 6–25.Chin, J. (2016, August 20). China's Latest Leap Forward Isn't Just Great—It's Quantum. The Wall Street Journal. Retrieved from http://www.wsj.com/articles/chinas-latest-leap-forward-isnt-just-greatits-quantum-1471269555

David, L. (2016, December 28). China's Lofty Space Ambitions Include 2018 Landing on Moon's Far Side. Retrieved February 25, 2017, from http://www.space.com/35156-china-moon-far-side-landing-space-goals.html

Dillow, C., Lin, J., & Singer, P. W. (2016). China's race to space domination: let's go to the moon! Space stations, moonwalks, and spy-proof satellites--China leaves no doubt about its soaring ambitions. Popular Science, (5), 64.

Economic, U.-C., & Commission, S. R. (2016). 2016 Report to Congress of the US-China Economic and Security Review Commission. US Government Printing Office.

Jiang, S. (2017, January 5). China: We will be on Mars by the end of 2020. Retrieved January 7, 2017, from http://www.cnn.com/2016/12/28/asia/china-space-program-white-paper/index.html

Merchant, N. (n.d.). China's launch of quantum satellite major step in space race. Retrieved April 24, 2017, from https://phys.org/news/2016-08-china-quantum-satellite-major-space.html

NASA. (2016, June 12). NASA, UAE Sign Significant Outer Space, Aeronautics Cooperation Agreement. Retrieved February 25, 2017, from https://www.nasa.gov/press-release/nasa-uae-sign-significant-outer-space-aeronautics-cooperation-agreement

Nowakowski, T. (2016, May 22). China reveals design for planned Tiangong 3 space station. Retrieved February 25, 2017, from http://www.spaceflightinsider.com/missions/human-spaceflight/china-reveals-design-planned-tiangong-3-space-station/

UAE Space Agency. (2016). Missions. Retrieved November 22, 2016, from http://www.space.gov.ae/

United Nations Information Service. (2016, June 16). Press Release: United Nations and China http://www.unis.unvienna.org/unis/en/pressrels/2016/unisos468.html

Williams II, R. L. (2015). Five-Hundred Meter Aperture Spherical Radio Telescope (FAST) Cable-Suspended Robot Model and Comparison with the Arecibo Observatory. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.727.1253&rep=rep1&type=pdf

Colonel David Miller

Commander, 460th Space Wing (US Air Force)
7 July 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q3]** Perfect. So, my first question is what are the major, central things that we should know about these countries' space programs, their space interests, and their space ambitions both with respect to government and commercial realms? Though, as you noted, please feel free to focus on the government and military realms here.

Col. Miller: **[Q3]** From a big-picture perspective, the reasons why various nations go to space are not fundamentally different. The wherewithal these nations have to pursue actually going to space and, as a result, the areas that they focus on will be different. But the basic reasons for going to space haven't changed, and this is certainly the case for the United States in the 60+ years we've been interested in space.

[Q3] We can trace this back to the first months after the Air Force became a separate service in 1947. We had a dedicated focus on going to space, and the reason had to do with the physics of the Earth. If you want to see, shoot, move, or communicate over the horizon, there's only so much you can do line of sight with terrestrial-based systems. So, from a military perspective and a national security perspective, after World War II, with the Cold War ramping up, and concerned about missile gaps and things like that, we went to space—to see over the horizon. And when you're talking about potential adversaries or potential hostile states—at that time the Soviet Union—you have a lot of denied areas. You have a lot of areas where you're not going to be able to fly an aircraft, place a radar or be able to do the surveillance and verification you'd need to assure both your own civilian or political population, as well as allies, what the level of security was. So, I don't think that that is fundamentally any different than why the UK, Australia or Canada or any other very strong partners of ours is interested in space. They recognize that adversaries or potential adversaries or just nations in general don't want you flying over their territory or basing terrestrial-based surveillance systems. If you want to provide some level of security as to the intent and capability sets of potential security challenges on the horizon, you're going to need a way to get that information—space provides a way to do that and has historically been relatively secure from adversary influence or denial.

[Q3] As you can see, the most visible manifestation now, certainly commercially, is in remote sensing and navigation to communicate and navigate over the horizon. The Europeans obviously have their own global positioning or position navigation and timing efforts that they're pursuing. The Russians have theirs. The Chinese have theirs. The need to provide the ability for not just people in their Armed Forces, but for everybody for commercial civil use as well as national security missions. Hence, the requirement to be able to navigate and move over the horizon drives you into certain areas of operation or new domains, and those tend to be, like I said, remote sensing and satellite communications. You're not going to be able to string fiber and wire everywhere across the globe—there's, number one, security reasons why people wouldn't let you do that, but also it just doesn't make sense monetarily. Therefore, actors tend to go to space to ensure global communications as well. So, as you can see, I don't think that those space mission sets we have pursued over the past 60+ years have fundamentally changed really.

[Q3] In the Defense Department, we typically lump those mission sets from a national security perspective under the term "force enhancement." That those capability sets (intelligence,

surveillance and reconnaissance; positon navigation and timing for GPS; military satellite communications; etc.) provide our military forces an unmatched, asymmetric advantage which allows that our military leaders to see the battlespace with clarity, provide early warning, strike with precision, navigate with accuracy, communicate with certainty, understand weather impacts and operate anywhere on the globe—which ultimately results in fewer causalities for us, as well as fewer casualties from collateral damage. And the principle reasons we're able to do this so effectively are the capabilities I just described to you that we derive from space. We know where the adversaries are. We can mass quickly if needed. We can communicate over the horizon and fight in large formations on a scale that, frankly, nobody has ever seen before. We can do all of this so efficiently that our decision loop for targeting is often inside a potential adversary's decision loop, and we can assess how we've done and ensure we minimize civilian causalities as well as threats to US forces or allied forces on a level that we have never been on before. That's why the focus in recent years has been so much on protecting our space capabilities in the United States.

[Q3] Over the past 25 years since Desert Storm, when we first really started to see this in earnest, adversaries have started to seek the ability to 1) obtain their own capability to do what the US is doing and 2) look to deny that competitive advantage that the US or allies have if a security challenge arises.

[Q3] So, if you look at any of those nation states that you have listed in your question, I bet you they want to be able to communicate over the horizon. I bet you they'd want to have, from a security standpoint, indications and warning of threats to their state because, ultimately, they have a lot of security concerns. Maybe they have adversaries or potential adversaries in their region contesting, or at least concerned about, airspace in the ocean areas off their coast. Those are all things that they're interested in, so the things that they want to derive from space are those same capability sets. From a military standpoint, you say they want to: see, shoot, move, and communicate over the horizon. But if you're a civilian, obviously, it's not necessary to shoot over the horizon, instead those other capability steps are fundamental reasons for their interest in space, and certain things have developed certain levels of expertise. I think you can see that these other actors are able to invest in certain aspects of that to allow them to be pre-eminent, in some sense, or at least globally competitive.

[Q3] For example, some British firms are really good at building small satellites. As technologies have improved, and as the need for bigger sensor and/or communications packages has been reduced to smaller requirements, you start to see things like Surrey Satellite Technology, which is an example of a whole lot of capability in a very small satellite. Different states or different companies have different strengths that certainly play to the base that they have, typically within their own government, but on an international scale they can certainly sell those to anybody.

Interviewer: **[Q3]** At a more country-specific level, how do these countries' space interests and investments differ in comparison to each other? What are the key differentiators between these countries' interests and investments in the space realm?

Col. Miller: **[Q3]** I don't know that I'm capable of answering that question for any other country. Though, I think, obviously, a lot goes into that—each of these countries has to make its own very specific calculations. Undoubtedly, factors like geography, the environment, and the country's specific neighbors are important. Certainly, the country's history matters as well—what has happened and the country's perspective on things is driven by that history.

[Q3] Ultimately, a country's interests will drive what it incentivizes within its own commercial or civil industries in order to support its specific development efforts. I don't think this general

process is different for any particular nation, but it certainly explains maybe why a given nation or a consortium of nations would invest in certain things versus others.

Interviewer: **[Q3]** Okay. So, are there any glaringly obvious differences in the types of things, materials, and/or activities that some of these countries have been investing in or focusing on in the space domain?

Col. Miller: **[Q3]** Of late, I think there's pretty good documented unclassified evidence—and you could look at the reports of the Defense Intelligence Agency or the Department of Defense releases for more details—that the Russians and the Chinese have invested heavily in all of those force enhancement capabilities that I described to you earlier. Whether it's remote sensing, navigation and timing, communications, etc., both Russia and China have been investing heavily in order to improve their military capabilities. Russia and China are doing so for different reasons, because they're at different stages in their development, but they've invested certainly heavily in those.

[Q3] China and Russia have also invested heavily, particularly lately in the last decade or so, in counter-space capabilities. They are investing in the capability to deny, disrupt, defeat, degrade US or allied space capabilities, in particular, in an effort to deny us our military advantage. A lot of Russia's and China's capability sets are linked between both space and cyber, so you'll see commonalities in their investment portfolios.

[Q3] It's no secret that we have partnered with allies to invest in certain capability sets. We've partnered with some allies for investments in satellite communications, for example. Australians have made investments in things like wide-band global satellite communications.

[Q3] We, as the United States military, look to ensure interoperability of our military weapons systems with our allies. It's not a very good coalition force if the equipment and capabilities can't talk to each other. So, as we move forward with our NATO allies or others, we like to ensure that our capabilities are interoperable (i.e., the capability to process and receive remote sensing information, the capability to leverage different navigation and timing communications, etc.). Making sure that we are interoperable is a priority for us—it's obviously on a different scale with different allies, but interoperability brings a lot of credibility to the coalition or the allied military force you're trying to generate.

[Q3] These are the types of investments that I've seen. What you can see is a lot of nations that have the capability to launch satellite capabilities—the Japanese have the capability, the Indians have the capability, the French have the capability, etc. Likewise, the Russians and Chinese obviously have that capability as well. Having the capability to do your own launch and reconstitution if needed, or certainly generation of capability, is part of the consideration for classification as a "space faring nation" from a national security perspective.

[Q3] Why does that matter? Well, in order to do that, you've made investments in launch vehicle delivery to orbit, typically ballistic missile technology or missile technology overall whether liquid or solid fuel; you've made investments in navigation; and you've made investments in technology for operations in orbit, batteries, etc., and you've made investments in ground infrastructure and launch range capability.

[Q3] So, there's industries that all support nations that operate in, through and from space, and in order to sustain yourself as a credible nation state doing that, you'd need investments in all those industries.

Interviewer: Okay great. I promised you that this discussion would only be 30-minutes and we are approaching that half-hour mark right now. So, I just want to conclude by asking one last

general question. Is there anything that I haven't asked you that you think I should have? Or is there any final point that you'd like to conclude with as closing remarks?

Col. Miller: **[Q3 indirectly]** I guess the only point I would add is one to help provide some additional context. There's been a lot of interest lately in having discussions about 1) what trends we're seeing in terms of space, 2) the implications of those trends to US national security, and 3) what the US needs to do in order to ensure that it maintain a competitive advantage for the American men and women who are in uniform.

[Q3] Several years ago there was a lot of hesitation to talk about space as a war fighting domain. In fact, I think you'd probably hear from some leaders that they probably couldn't even use that terminology some years ago. And I don't think at all that the Department or the Air Force, in particular, is looking for conflict in space, but my concern after doing this business now for 24-years is that I don't know that the American people or even some in the military appreciate the unique advantage that they derive from space. This advantage simply cannot be provided by terrestrial means—there's no aircraft that's going to replace space because there are denied areas and there's no radar or suite of radars that's going to be close enough to replace the capabilities you have from space, particularly in terms of geospatial accuracy over the horizon. All of these systems need to be developed to be complementary….all are necessary and neither alone is sufficient.

[Q3] So, if you value the speed, precision, and force protection, as well as the limitation in casualties that we derive from space, then you need to make investments in order to protect and defend it. I think the sooner we start to have that discussion about what that needs to be and to what extent we want to do that, which I think needs to be a national discussion, not just a military discussion, I think the better off we will be. There is only so much that we're going to be able to protect and defend with the current architecture and environment that we have right now. A lot of these systems are years to acquisition cycles. It has been 20-years since I first came here to Buckley Air Force Base as a Captain, but it's the same weapons system that we were acquiring then that is being fielded now. It is capable and needs upgrades, but it's basically the same thing. The assumptions about the need to protect and defend at that time were minimal to none. It was largely a "benign environment."

[Q3] There needs to be a strategic level discussion on what is the advantage that the US derives from space? And how much do you value that? Whether it can be replaced or what other mitigation strategies can be put in place, and then make a determination of where we need to go in the future. We can't keep studying this and debating it for the reasons I tried to describe to you today at the unclassified level. The pace of development for counter-space activity is significant and if we, as a nation, don't act quickly enough, we just may jeopardize the asymmetric advantage that our space capabilities provide which our joint warfighters have become so reliant on. We really need to start having the discussion about the advantage we derive from space and how much we want to protect it in the future.

Dr. Deganit Paikowsky

Tel Aviv University
11 September 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

"Motivations of Nation-States to Contest Space"

** My answer to this question is based on my newly released book:
Paikowsky, Deganit. *The Power of the Space Club in World Politics* (Cambridge University Press: 2017).

Main argument: Nations develop indigenous space programs because they assume that this is expected of them in order to maintain their power and international standing, or because they aspire to higher power and status for geo-political and domestic reasons, regardless of clear tangible cost/benefit considerations.

In different eras in history, certain qualities or areas of expertise are identified as indicators of power and symbols of high standing. Usually, acquiring and developing these qualities require massive investments of resources and large-scale national efforts. Despite the difficulties, risks, and high costs, or because of them, nations that aspire to power and high standing often invest valuable resources and efforts in acquiring expertise in these areas. The nations that have succeeded in this task are recognized by many as an elite group—a club.

Under the axiom developed in the Cold War space race that the "Control of space means control of the world," the countries reaching outer space were recognized as a superior and exclusive group.[19] In line with this reality, decision-makers and state officials often choose to emphasize the political aspect of their country's accomplishments and justify national efforts to acquire such qualities by arguing for membership in the club. Up until today, the space club is not a formal international organization. Nevertheless, despite the absence of a formal organization, it has an actual and significant role in world politics.

Accepted explanations for the motivation of states in their quest for space capability are tangible materialistic or practical, functional reasons, which fall into three main categories: national security and military considerations; economic growth and prosperity, development, and benefit to society; and/or the desire for international prestige. These considerations may be intuitively appealing; nevertheless, they are challenged by empirical evidence.

These considerations may explain nations' interest in using space applications. However, they are inadequate for solely explaining national decisions to undertake large-scale space programs and to develop indigenous capacities in space technology, let alone projects that do not provide immediate tangible benefits. Carrying out an indigenous space program requires enormous efforts, massive investments of resources, a high level of technology and a large scientific infrastructure. Relying on the purchase of satellites and services for space applications is much cheaper, especially as space technology becomes a commodity and many space applications that provide tangible/functional benefits can be purchased at a sensible per unit cost, or are available through cooperation.

The decision to indigenously develop space technology is not trivial. Nevertheless, a large number of states are active in space and seek their own capabilities. They attribute strategic value to a variety of technological and scientific missions, as well as to national records and visible achievements. Furthermore, their decision-makers and

[19] Johnson, Lyndon B., Summary Statement, Hearings of the Preparedness Subcommittee, Senate Armed Services Committee, Senate Inquiry on Missiles, January 8, 1958.

state officials often emphasize the political achievement of their country's accomplishments in space by arguing for membership in the space club.

Based on a rich and detailed analysis of a range of space programs of states which are not usually at the focus of world politics and its research, comes out that joining the space club is a legitimate and rational decision. The strategic significance of space technology and its dual civil-military nature made the space challenge very much appealing to many nation-states. As a result, space capability became an important mark of great powers. Since the early days of the Race to space, joining the space club is a legitimate and rational decision. A country that sees itself as a power deserving of a seat at the table of world governance is expected to race for space. Therefore, states often engage in indigenous development of large-scale space programs with no direct cost-benefit to security or economic considerations. This is not to say that tangible security and economic considerations are irrelevant to states' decisions to embark on large-scale projects. In most cases, these considerations do exist. Nevertheless, states are unlikely to pursue the development of indigenous capacity only for clear tangible cost/benefit considerations. As noted above, they are likely to do so when such behavior is consistent with a wider set of domestic and national perceptions of what is expected of them, given their power and position.

Dr. Edythe Weeks

Adjunct Full Professor and Fullbright Specialist in International Relations, International Space and Outer Space Development, Webster University and Washington University, St. Louis)
16 August 2017 (Interview)

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q3 indirectly]** So, let's jump into those specific questions from our list that you identified. Let's start with Q11 first. So, what opportunities are there to leverage ally and commercial capabilities to enhance the resilience of space services for commercial and national security critical space services, and what are the major hurdles to doing so?

E. Weeks: **[Q3 indirectly]** Okay. In preparing my answer to this question, I kind of tried to identify and address the main problems. So, it seems like the purpose of your study is to examine how the US government can retain initiative in the space domain and counter any intent to deny US and partner freedom of action in this vital domain, which has become critical to military operations and other national security activities across every domain. As such, before I answer this specific question, I'd like to provide an insight to you: I don't believe the US government has lost its initiative in the space domain. Then, what I'm curious about is that this effort seems to have a two-pronged purpose. The other half of the purpose is to counter any intent to deny the US and its partners from freedom of action. So, I'm suspecting that there may be a concern that if maybe China or Russia decide to go in and partition off a certain area of space and do not allow the US to come through, perhaps the USG and military wants to know what type of protection they have (i.e., what the Outer Space Treaty would say about that, or something like that).

[Q3 indirectly] Okay, so, in light of my curiosity about the main purpose of your study, here's my answer to your specific question.

[Q3 indirectly] I believe that a once in a lifetime opportunity exists for America to regain its image as a great leader. Once upon a time, the US was seen as a great nation. Everyone wanted to come to the United States. The United States of America was seen as starting to lose that power, by the way, but at one point, after World War II up until about 10 years ago, the

United States was seen as like the Disneyland of the world—the new world, the great place where magical things could happen. And, in my experience traveling to various countries, most people throughout the world feel like they have some vested interest to protect America because, In my opinion, people tend to see America not just as another country but as everyone's country, so long as they could figure out a way to get there. But, we're starting to lose that.

[Q3 indirectly] I believe that outer space will be developed, and this is certainly in process now, and the United States has an opportunity to remain as being seen as a leader in space, as well as across other realms, by creating a new vision—a vision that would include the United States as the great giver, who cares, and who wants to include every single person in the planet to somehow connect themselves to contribute to and, therefore, also find a way to benefit from this grand new development opportunity that's in process.

[Q3 indirectly] One thing we know is that there's a direct link to inequality, real or perceived, and conflict. So, if we are talking about reducing conflict, or winning conflict, we must consider the power of ideology. I may be the only person in the world that realizes just how powerful the United States still is in terms of its soft power ideology (i.e., blue jeans, Michael Jackson, McDonalds, Coca Cola, etc.).

[Q3 indirectly] Okay, so in terms of space, I believe the US can reshape its vision as the US leading the world into this domain called space. I think this could propel itself like a glue and even attract the nations that we have placed on the list as being our adversary, because no leader wants to lose control of their population. No leader wants to risk that. So, what do most people in the world want? Most people in the world want some sort of economic opportunity, security that translate to a place to live, clean water, food, taking care of themselves, their family, health, etc. So, this tends to be linked to opportunities, career, or economic opportunities, and space, given its nature of unlimited untapped "resources" (i.e., not just one planet, but possibly many planets, particularly given the Kepler discovery that I think confirmed that their up to 30 Earth-like planets). This vision, to feel good at a time when there's nothing else to make people feel good, is powerful.

[Q3 indirectly] So, to answer the question. What opportunities that are to leverage ally and commercial capabilities? So, this would include the private sector, the commercial sector, government, allies, the international community, etc.—it would include everyone. And, I'm suggesting teaching on, as an ideology, an invitation to other people who currently just see space as something for rich white male elites. Because this what people say, "Space?! What are you doing in space? Isn't space just for rich white male elites?" And as long as that perception of space continues, the NASA is in jeopardy every year and the same is the case with space programs throughout the world. There's been a missed opportunity to actually accept a broader range of people throughout the globe into space in a way that means something socially relevant for their real lives.

Interviewer: **[Q3 indirectly]** Okay. So, it sounds like you're suggesting the US sort of take the initiative to lead a global outreach campaign type effort to emphasize the mutual benefit of investment in space. Sort of like a "one for all, all for one" type of initiative where everyone can benefit from the US leading the effort to create global cooperation.

E. Weeks: **[Q3 indirectly]** Yes. I love the way you said that. Now, if we were in a room with people from all around the world, you might be attacked. These people may say, "What? That's naïve." Within the US, some people operating within the space community are not American, per se, or come to the US because the US is the leader when it comes to space. There is a discourse in the US that we will lose that leadership if we don't do something soon, though I don't know

where this fear and suspicion is coming from. But, right now, we have the leadership, so there's a rhetorical truth and a discourse coalition that tends to raise concerns about suggestions that we share resources, wonder why we should share, and raise concern about redistribution, but that isn't what I'm talking about. How much is the cost to share a vision? Motivational speakers do this all the time, and they're not sharing their millions of dollars, they're doing motivational talks and showing others opportunities and then what can be done to capitalize on those opportunities.

[Q3 indirectly] I've been doing this now for several years myself on buses, to school children in throwaway communities, on airplanes, in classes, and with everyday people all over the world. What I've found is that people just haven't been invited to allow themselves to think about space, and, therefore, that's the only reason they're not translating all of this to themselves in some realizable personal way. That, I think, is a missed opportunity that can be capitalized to leverage ally and commercial capabilities, and it can also enhance the resilience of national security.

[Q3 indirectly] For example, let's look at the Iraq war situation and the insurgencies and the IEDs, so let's take that scenario. So, watching that playout over the years, several thoughts come into my mind. One, you have some obviously brilliant people who have no money or very little money that came up with some very powerful things that were causing the most powerful military force on Earth not to win as eagerly as it had anticipated. So, what was backing that? Well, I've come up with a term that I use in teaching international relations called "*brewing resentments*." This concept points to the existence of repressed hostilities, which have been allowed to remain unaddressed. There's some hatred, and there is resentment against the United States because of perceptions regarding things that occurred in the past. To me, this seemed to happen during the development and modernization paradigm after World War II and up until the Cold War period. So, people in the world are still waiting. They are waiting for America to be great. They are waiting for things that they believe were promised would happen but never happened. Adversaries of the United States can use these sentiments to turn people against the United States, and if we don't do something quickly, this sentiment is likely to spread, as we saw in the case of Iraq, Afghanistan, and more recently with the Syrian refugee crisis and all the millions of people who are leaving North Africa and the Middle East and running into various places in Europe. These things are caused by what we call "inequality" in international relations. No matter who's fault it is, when inequality exists it causes people to feel desperate and to be more likely to do desperate things, and because the United States is still a unipolar power, it's easy for people to direct their attention and focus to that unipolar power.

[Q3 indirectly] My concern is that we could see situations similar to the IED phenomenon but in the space domain—new people, new groups, even people within the United States focusing their attention on the space domain. So, why are so many people upset? Why are so many people trying to destroy other people? For me, the key is a perception that there's a lack of realizable economic opportunities for them. In addition, another key may be that people feel an injustice has occurred that has been directed at them, and those they love. Real, historical or imagined, these psychological factors can be built into ideologies by key actor to amass power tremendous amounts of power to trigger large populations to consent to specific actions or to take specific actions themselves.

[Q3 indirectly] So, if the proponents for the development of outer space are correct, outer space development, asteroid mining and other industries, can become the new game changer - not just for 200 or 2000 people, but a game changer for every single person in the world. So, wouldn't it be wonderful if outer space activities did actually create situations to produce economic prosperity for everyone. Wouldn't it be wonderful if the United States could lead?

My grandmother was a firm believer in the American Dream—anybody can be like Edison and invent something great—so, what about that? We've lost that. The United States seems to be losing that precious thing that only it had, and that's this vision and the ability to make people feel great.

[Q3 indirectly] When I was about 23 years old, I was a law student and I traveled around the world, and so many people came up to me and said, "Where are you from? Wow! You're from America?! Wow! Why are you here?" And the feeling then in the 1980s was still an extreme interest and hope in traveling to America and the rest of the world. Most of the people in the world can't leave their country, and if they can, they can't get in to other countries. That has always stayed in my mind.

[Q3 indirectly] America is still a very special place, and it is a land full of opportunities. If we lose this, then the whole world loses this forever, and there is no telling where things will devolve to. But, we can save this now with space.

[Q3 indirectly] In reading through your effort's various documents, I saw Russia, China, North Korea, Iran, etc. listed as adversaries, but if you deconstruct the discourses of negative statements towards the US from some of these leaders, it's no mystery what is driving the resentment. It's the same thing that drives young people in the Middle East to feel the need to create IEDs. People resent the United States because they feel like it hasn't lived up to its promises. People feel kind of tricked by the feel-good ideology and they are tired of waiting.

[Q3 indirectly] So, I see space as an opportunity for the US to emulate and to make good on the promises made. The US is in space, and it still gets the greenlight and international salute from people throughout the international space community because of what has resulted with respect to sharing technology. People admire the way the United States encourages businesses through technology transfers, contract loans, research and development, etc. The way we share those kinds of things with the world and with the private sector is really admired by people throughout the world.

ViaSat, Inc.

Richard A. VanderMeulen
Vice President of Space and Satellite Broadband

Ken Peterman
President, Government Systems

Shannon O'Meara Smith
Executive Director of Strategic Initiatives

Fred Taylor
Vice President, Space and Cyber Applications

Bruce Cathell
Vice President of Government Operations

15 August 2017

WRITTEN RESPONSE

[Q3] What are the motivations of nation-state and non-state actors (e.g., violent extremists, etc.) to contest use of space in times of peace, instability, and conflict? What are the political, military, environmental, or social costs associated with acting on those motivations?

Economic, societal, and even military activities in land, sea, and air domains depend on space ecosystems; thus, a motive to disrupt economic, societal, or military activities could lead to a contest against space ecosystems. The most easily identifiable motive of nation-state and non-state actors against space ecosystems, including SSA, EO, PNT, and Satcom is to disrupt military command and control (C2). In order to disrupt these capabilities, these actors will most likely focus their actions on those that afford the least attribution, provide the most significant detrimental effects, and are implemented at the lowest cost and within the shortest amount of time possible. For example, significant damage to the ground segment may create an equally or even more detrimental effect to the ecosystem than contesting assets in Space.

Actions taken against these space ecosystems in non-space domains, can reduce, deflect, or even eliminate the political, military, environmental, or social costs associated with potential nation-state and non-state actor actions or motivations against these ecosystems. Escalation into the Space domain must still be considered; but should be considered along with an analysis of the full ecosystem in order to understand the least attributable, most detrimental, lowest cost threats that exist in all domains.

To optimize military/government performance and threat defense and deterrence, all the elements Space ecosystems must be harmonized across all of the domains they operate in. We believe the values we gain from our National Security Space systems will continue to be at higher risk until the leadership and operations of all the elements or domains of these ecosystems are aligned and harmonized.