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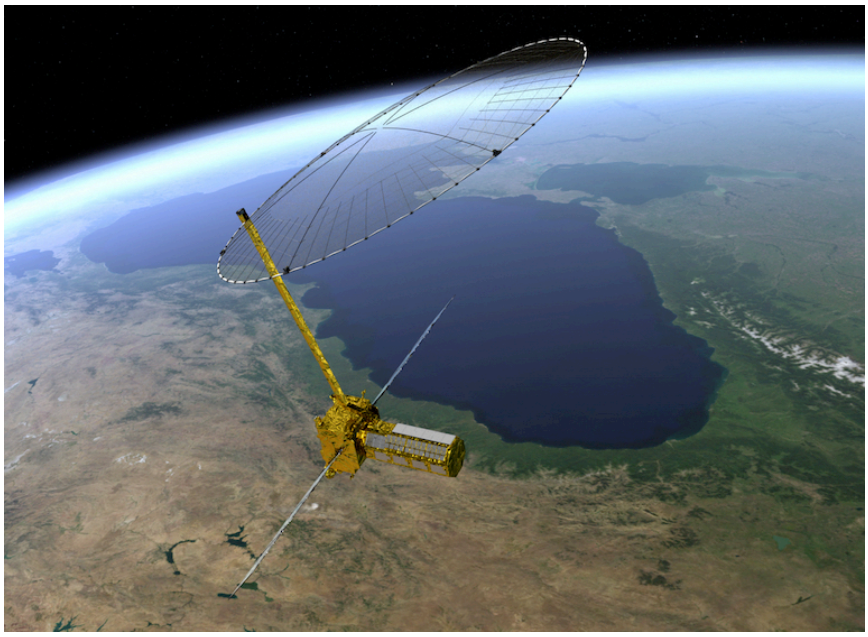
Use of the Commercial Space Industry for Military Purposes by Non-Western States

A Virtual Think Tank (ViTTa)® Report



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What is ViTTa®?

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

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

Cover Art: https://www.jpl.nasa.gov/missions/nasa-isro-synthetic-aperture-radar-nisar/

Question of Focus

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

Expert Contributors

Roberto Aceti (OHB Italia SpA, Italy); **Adranos Energetics; Brett Alexander** (Blue Origin); **Anonymous Commercial Executives; Major General (USAF ret.) James B. Armor, Jr.**[2] (Orbital ATK); **Marc Berkowitz** (Lockheed Martin); **Brett Biddington** (Biddington Research Pty Ltd, Australia); **Caelus Partners, LLC**; **Elliot Carol**[3] (Ripple Aerospace, Norway); **Chandah Space Technologies**; **Dean Cheng** (Heritage Foundation); **Matthew Chwastek** (Orbital Insight)**; Faulconer Consulting Group**; **Adam and James Gilmour** (Gilmour Space Technologies, Australia); **Harris Corporation, LLC**; **Dr. Jason Held** (Saber Astronautics); **Theresa Hitchens** (Center for International and Security Studies at Maryland); **Dr. Moriba Jah** (University of Texas at Austin); **Dr. T.S. Kelso** (Analytical Graphics Inc.); **Victoria Samson** (Secure World Foundation); **Spire Global Inc.**; **Stratolaunch Systems Corporation**; **Charity Weeden** (Satellite Industry Association); **John Thornton** (Astrobotic Technology); **ViaSat, Inc.**

Summary Response

All the experts who contributed to this question noted that it begins from the incorrect assumption that space industries in other countries are organized in a similar manner to the US—with clear delineations among civil, military, and commercial space industries. Furthermore, most indicate that, taking advantage of the dual use nature of much space technology, many states both non-Western and Western, are already tapping commercial and civil space capabilities for military use. Their responses suggest that a better way to frame this question might be: "Which nations outside the West are tapping into their civil (commercial and/or government run) space industry for military purposes?"

Lack of separation between public and private space sectors

Several contributors comment specifically on the organization of space sectors in countries outside the West. Marc Berkowitz of Lockheed Martin notes that while both our European and Asian allies have separate public and private space sectors, "there is a very permeable membrane between their governments and commercial industry" (see also ViaSat, Inc. and Roberto Aceti of OHB Italia SpA). Faulconer Consulting Group suggests there is no separation at all in China. Victoria Samson of the Secure World Foundation similarly observes that, although the Indian space agency ISRO has a commercial wing (Antrix) that develops a lot of their commercial capabilities, it is funded by the Indian government and not, she argues, truly commercial. Berkowitz mentions that Russia, Iran, and North Korea are comparably organized, with "commercial" space enterprises wholly owned by the government.

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

In effect, there are fewer institutional barriers to military use of civil (government and/or commercial) capabilities and, in many non-Western states Aceti contends, there are in fact institutional incentives for government and commercial entities to work together. Additionally, the "[c]utting edge of technology and performance is being defined by truly private sector capital investments" (ViaSat, Inc.), incentivizing militaries to tap commercial capabilities. Such arrangements also benefit commercial entities, as joint ventures provide protection by national governments (Caelus Partners, LLC). Major General (USAF ret.) Armor[4] regards this as part of the development of the industry: "It's blending in all directions, not unlike the IT industry."

Military utilization of civil capabilities

An anonymous commercial executive contributor stated that it is a "safe assumption that other countries see the benefits of space from a military perspective and have the vision to know it will only grow in the coming decade." This view is reflective of almost all of the other experts' responses, although Matthew Chwastek of Orbital Insight, focusing on capability rather than intent, does offer a qualification to this. He notes that none of these states currently has the "depth of capital formation, governance, and regulatory flexibility" needed to develop civilian (government or commercial) space capabilities that could benefit the military, although this situation could change in the next decade.

How is this being done? Dual use

As Table 1 shows, there was considerable agreement amongst the experts that the crossover from civil (government and/or commercial) to military use most commonly takes advantage of the dual use nature of much space technology. As Brigadier General (USAF ret.) Thomas Gould of the Harris Corporation points out, "the same rocket engines used to boost satellites into orbit can deliver conventional or nuclear warheads" (see also: Adranos, Cheng, and Samson). Theresa Hitchens of the Center for International and Security Studies at Maryland (CISSM) contends that, with the possible exception of Russia, most space activities outside the US are concentrated on dual use technologies and applications.[5] Dr. Moriba Jah of the University of Texas at Austin agrees with her assessment, and adds that the US has been behind in this regard, something he sees as a detriment to the US.

Conclusion

The contributors' responses to this question all either directly or indirectly challenge the assumption made in the question that other states organize and conceive of their space industry in the same three-part structure—civil, military, and commercial—that we have in the US. In some cases (Russia, Iran, North Korea, and India), this is a reflection of the separation, or lack of separation, between public and private sectors in general. In other cases, it reflects the fledgling nature of many state's space industry, where government funding and private research and investment have been combined for greater efficiency. Furthermore, this type of collaboration is already underway. While, as the summary table shows, there is some difference of opinion among experts regarding which commercial capabilities are currently being tapped by specific countries, their responses collectively reflect Dr. Jason Held's (Saber

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

[5] For discussion and examples of dual use by Western states, see: Biddington; Carol; Faulconer Consulting Group; Gilmour Space Technologies (A. Gilmour); Hitchens; Jah; Samson; Spire, and C. Weeden.

Astronautics) comment: "Bottom line answer is: absolutely. Defining the nature and scope of that commercial industry is the big question."

Table 1: Non-Western States Identified by the Contributors as Currently Tapping Civil (Commercial and/or Government) Space Capabilities for Military Purposes

The table below summarizes the experts' assessment of which Non-western states or regions are, and are not, currently tapping civilian space capabilities for military purposes. Where specified, the particular civil activity or capability being used by the military is indicated.

Country/region	Military Use			Expert
	No	Yes	Capability (If specified)	
China		1		Berkowitz Faulconer Consulting Group Thornton
		1	PNT	Samson
		1	SatCom	ViaSat, Inc.
		1	Launch	Nixon Brig. Gen. (USAF ret.) Gould
Russia		1		Berkowitz
		1	Earth Observation	Spire Team
		1	Launch	Brig. Gen. (USAF ret.) Gould
Iran		1		Berkowitz
		1	Launch	Samson
North Korea		1	Launch	Adranos Berkowitz
India		1		Spire Nixon
		1	ASAT	Samson
		1	SatCom	ViaSat
		1	Earth Observation	Spire
		1	Satellites	Samson
Middle East		1	SatCom	C. Weeden
Saudi Arabia		1		Chwastek
UAE		1		Chwastek
Qatar		1		Chwastek
Asia	1			Faulconer
Japan		1	Earth Observation	Spire
Singapore		1	Satellites	A. Gilmour
Malaysia	1			A. Gilmour
Thailand	1			A. Gilmour
Philippines	1			A. Gilmour
Vietnam	1			A. Gilmour
Latin America		1	SatCom	C. Weeden

Subject Matter Expert Contributions

Roberto Aceti

Managing Director (OHB Italia SpA)
9 September 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Okay. Wait a little bit. We'll move on to the next question here. Again, speaking to your experience, from OHB and their perspective on this. So how are other nations outside the west or if it happened to their own commercial space industry, military purposes in the next 5 to 10 years?

R. Aceti: **[Q7]** I'll try to see what I understand with the question. So the question is if we believe that other nation outside the west, use commercial space industry and use projects which are bon face value, represented as commercial venture and in reality, for also military purposes. Is this the question?

Interviewer: **[Q7]** In other words, if OHB as a Multinational Corporation recognize the opportunities for other nation whether in Europe or elsewhere, the opportunities for them to have them do a commercial space industry that could be simultaneously exploited by military ventures.

R. Aceti: Exactly.

Interviewer: Exactly?

R. Aceti: **[Q7]** Yes. It should not be a surprised because that is also what is happening or that's happened in our case in Western Europe and I guess in US. From my perspective, the driving force that has developed this industry, the space industry, is the government. So is the institutional market, and so the institutional interest let's put it in this way, are clearly intertwined with commercial business that pops up at a certain point in time when the technology become sufficiently mature to enter into a commercial venture. So, I see it rises outside the US and the Western Europe of institutional interest and commercial ventures to work hand to hand. Quite frankly as it has been happening also on our side. So the answer is yes.

Adranos Energetics LLC

Chris Stoker
Chief Executive Officer

Brandon Terry
Founder and Chief Technology Officer

11 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7] [Q8]** Okay. Thank you so much, Chris. I'll kind of combine the next few questions. So first of all, other nations outside the West force to tap into their own commercial space industry in the located purposes in the next five to ten years? If you can speak specifically, are there countries which excel in a particular area of this space industry and what is that specific sector? If you can identify now which country, which sector, but from a timeframe in which they're likely to excel.

B. Terry: **[Q7] [Q8]** I think I can answer at least one of those. From the conferences we're going to in emerging countries, I guess they really are part of the west but what is that small country, Chris, in Europe?

C. Stoker: **[Q7] [Q8]** Luxembourg. But they're so small. I don't think that they're ever going to be a group that build a launch platform and launch but they are kind of… what's the right word? They're very progressive in terms of the regulations governing who owns what in space. So I guess that's it meant to be seen how they actually impact the commercial market.

B. Terry: **[Q7] [Q8]** But I mean as far as nations outside the West, I mean the obvious answer there is the rapid improvements that North Korea has been doing on their rockets program. They're right there now making an ICBM and the only difference in an ICBM and a satellite is you let go of a reentry vehicle, right? That platform is the satellite. So I mean North Korea is the obvious go-to in the next five to ten years for nations outside the West.

Interviewer: **[Q7] [Q8]** Right, okay. So if we can speak a little bit more specifically in terms of the commercial sector. Is there a specific nation which like I said, is excelling at a sector of the commercial industry? To give an example, let's say Australia in particular producing a lot of launch companies or cube-sat startups or anything like that. Is there a specific sector of the commercial industry that seems to be focusing not only in the West but outside of the US in particular?

C. Stoker: **[Q7] [Q8]** Well, I mean we could say New Zealand, but that's not because New Zealand pushed it. It's because Rocket Lab is started by a guy from New Zealand. So that's one. I don't know. I can't think of anything that comes in mind although I'm sure there is an answer.

B. Terry: **[Q7] [Q8]** We have a lot of stuff going on in Norway but I don't particularly know Norway is part of the West.

C. Stoker: **[Q7] [Q8]** Sure. Norway is in particular trying to come up with a launch vehicle that they can launch from the ocean. I don't know. All of the small sat groups there in the US that I know of.

Interviewer: **[Q7] [Q8]** Right, but would you say that that is likely to continue or is there a movement or a shift to other nations outside the US.

C. Stoker: **[Q7] [Q8]** I don't know. Brandon, correct me if you disagree with me. But even Rocket Labs in New Zealand, they are moving to the US and they establish all of the available launch companies that have all the money that you could take to succeed, they're all US based. Unless there can be stuff out there that I don't know about.

B. Terry: **[Q7] [Q8]** I think the main reason for that is the eccentric VC realm that is funding this currently are all here domestic in the US. Even Rocket Lab in New Zealand, it's main backers are still domestic here in the US. Until that changes to where you have these pocket investors, eccentric investors outside of the US starting to fund this, I don't think you're going to see the commercial market start to expand elsewhere, until you get those VCs elsewhere backing you.

C. Stoker: **[Q7] [Q8]** I mean obviously NASA has their kind of SVAR program that we're kind of trying to get to use it but I don't… I'm not aware of other sovereign nations that funds space nearly as much as the US. That's maybe your little point on here.

B. Terry: **[Q7] [Q8]** I've heard some rumors that Canada might be trying to start fund some of that stuff but I haven't heard anything concrete.

Interviewer: Okay. I think you touched on an important asset that the US has that specifically comes from the VC component of the commercial sector and some shining examples of Jeff Bezos, Elon Musk, Robert Bigelow etc. or other eccentric billionaires that have really spurned a lot of innovation, right?

B. Terry: **[Q7] [Q8]** I heard a really interesting talk not long ago at a conference. They went to the history of the space industry and they basically have put it into three phases on the history. Originally it was all nations state-based. So you had a push from the US, push from Russia, push from China and later push from Japan to get to space. I mean they're all funded by the nation stage. Then there're around the turn of the millennium, around 2000, you had this change and they call it I think phase two or era two, and it was rise of the eccentric billionaire. So you have your Elon Musk, your Jeff Bezos, your Richard Branson, those kind of single billionaire eccentric people. It brought on kind of phase two and those companies are all up and running now. Now they're calling it the phase three and it's the eccentric VC group. So rather than having one billionaire funding it, it's a group of millionaires basically, right, or with VC funds that are funding it, that have that eccentric mindset. So that's kind of where… at least US is that is information state, to eccentric individual to eccentric pools of money. I mean that other phase, that second phase only occurred in the US. So it's never those eccentric billionaires outside the US funding it. The question is whether it takes the eccentric billionaires to agree on the phase three in other countries or whether they will eventually just go to the VC realm immediately.

Brett Alexander

Director of Business Development and Strategy (Blue Origin)
14 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Are other nations outside the west poised to tap into their own commercial space industry for military purposes in the next five to ten years?

B. Alexander: **[Q7]** Yeah, I think most other non-Western countries, they are, their space industry really is not commercial, and it's state run. Those [state-run] enterprises do both government, civil government, national security and what we would call commercial missions, particularly on the launching and the communication satellite side. So those industrial actors, you know, act in multiple capacities and are fully coordinated with their government in that respect.

Anonymous Commercial Executives

24 August 2017

WRITTEN RESPONSE

[Q7]: Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

That question is best answered by the IC. From our prespective, the space community gathers information on this matter from chatter within the community or whatever is read in the press. The information is rarely verified, but there is a safe assumption that other countries see the benefits of space from a military perspective and have the vision to know it will only grow in the coming decade.

Major General (ret.) James B. Armor, Jr.[6]

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

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

- YES, but it is mostly the other way around: they are poised to tap (unleash) their own NSS/Civil space industry for commercial space purposes. Even EU commercial firms are mainly part of government industrial base.

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

- Again – part of maturation/normalization of the space industry. It's blending in all directions, not unlike the IT industry (internet, electronics, computers, comm)

Marc Berkowitz

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

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

Yes. Few nations, however, emulate the United States' separation between its public and private space sectors. Russia, China, Iran, and North Korea have "commercial" space enterprises or front companies that are wholly-owned by the regime and are used to obtain currency, technology, and know-how for military purposes. While our European and Asian allies have separate public and private space sectors, there is a very permeable membrane between their governments and commercial industry. The space industry is now globalized. Russia, China, Iran, North Korea, and many other nations will continue to tap into the international commercial space marketplace for military and intelligence purposes.

Brett Biddington

Principal (Biddington Research Pty Ltd; Australia)
9 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q2] [Q7] [Q8]** 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: **[Q2] [Q7] [Q8]** Civil and commercial space in Australia is the responsibility of the 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, although in September 2017, the Commonwealth announced at the International Astronautical Congress in Adelaide that a space agency will be formed. Initial funding is expected to be announced in May 2018. There has been no central point of coordination. There is 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"). Responsibility for space in Australia been spread across many departments and agencies over many years.

[Q2] [Q7] [Q8] 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, 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.

[Q2] [Q7] [Q8] 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.”

[Q2] [Q7] [Q8] 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" Government is having to react to these initiative. 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. Of course this development is of great interest from a security perspective to Australia.

Caelus Partners, LLC

Jose Ocasio-Christian
Chief Executive Officer

Anonymous Representative
n/a

24 August 2017

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

At this time, we have indications that there are other nations outside the west poised to use commercial space industry for military use in the next 5-10 years. However, it may be a reaction to the US government interest in commercial space for the same reason. As mentioned previously, the arrangement of joint ventures between a government and a commercial space entity would also benefit the commercial industry in terms of protection by its national government. To Caelus Partners, we see opportunities for the US to mitigate this dynamic by providing clear guidance for scientific collaboration practices. These collaboration practices can improve international perception of the US, help the US gain expertise from abroad indirectly and allow for private companies to maximize revenue.

Elliot Carol[7]

Chief Financial Officer (Ripple Aerospace)
7 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Okay, great. We'll go on to the next question then. I'll narrow this down a bit to focus on your experience in Europe AND with Ripple. Are there nations outside the Weston poised to tap into their own commercial space industries for military purposes in the next five to ten years? We'll tailor this a bit to address how regulations and European markets might be different than that in the US. Let's say Europe wanted to highly incentivize a build-up in their commercial space industry for military purposes. What would be the obstacles to doing that? What would be the concern for the US in the event of that?

E. Carol: **[Q7] The** European launch industry is a very interesting market because they are controlled by Airbus through their Ariane Group which has a complete launch monopoly on European institutional payloads. The European government space sector is structured as Supranational agencies and national space agencies. The supranational agencies include the European Space Agency and for military the European Defense Fund and then each individual country has their own space agencies, some more powerful and better financed then others.. But the national space agencies and ESA are not actively going after launch vehicle technology for military purpose as far as my understand is outside of the development of ArianeGroup Launch Vehicles, since their primary purpose is European institutional payloads. As well, I believe ArianeGroup is not incentivizing a competitive launch market, since it is in there interest to maintain there monopoly. However, Europe has a very robust satellite manufacturing industry and they are actively pursuing some very sophisticated satellites. DLR Germany just signed a big contract, I think it was a €300 or €400 million-euro contract for new communications satellites, and as well they're developing some very unique cube sat technologies which will enable them to scale very quickly when they want to modify or change existing technologies that could very easily be militarized for communication purposes.

[Q7 Q11] Based on my conversations and from what I've seen they are very aligned, and they recognize US dominance especially in the commercial sector with US based space systems. I have not seen a strategy to attempt to compete against US systems space systems outside of their satellite industry. As well, I currently do not see a business to be made for European space systems trying to compete vs. Americans. Also, Ripple is developing partnerships with numerous governments, none of which have expressed interest to us about using it for military payloads.

[7] The responses here represent the sole views of Elliot Carol, and are not intended to represent the position of Ripple Aerospace.

Chandah Space Technologies

Dr. Helen Reed
Co-founder & Chief Technology Officer

Adil Jafry
Co-founder & Chief Executive Officer

Lee Graham
Senior Research Engineer (NASA)

Christian Fadul
Co-founder & Business Development

Andrew Tucker
Co-founder & System Engineering

17 August 2017

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

In general, today we don't immediately view non-Western nations having the depth of capital formation, governance, and regulatory flexibility needed to build and manage a vibrant commercial space sector that is actively contributing to the state's military goals.

Having said that, over the next decade, potentially certain non-Western states will likely have the financial wherewithal among their private citizens, which could allow the governments of these countries to harness private enterprise to support military goals.

Dean Cheng

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

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q2] [Q8] [Q7 indirectly]** Okay. That's helpful, and I think segues nicely into the second question I was hoping to ask you, which has to do with how US allies, partners, and adversaries conceive of space operations for military and commercial purposes. mentioned these three categories. So, from your perspective, how do other actors conceive of space operations for both military and commercial purposes? And, given your expertise, please feel free to focus on China here if you'd like.

D. Cheng: **[Q2] [Q8] [Q7 indirectly]** Sure. So, I will talk mostly about China. I would say that China uses space holistically because they've used space as a part of the broader information networks—so, in China, space industry is part of information industry, space dominance and space

superiority is part of information dominance and information superiority, and space business is part of the larger portfolio of information business and services.

[Q2] [Q8] [Q7 indirectly] Thus, the Chinese are looking at commercial space as more than just either manufacturing satellites or launching satellites—they are looking at it as things like getting people to use BeiDou instead of instead of GPS. In all likelihood, in the future as we watch the Chinese establish quasi-private companies that do space things, they are going to try and blur the line between state enterprises and private enterprises because those "private enterprises" are always going to be responsive to mandates from the state.

[…]

Interviewer: Okay. So, we always conclude these interviews with a generic question, which I will ask you as well. Is there anything that I haven't asked you that I should have, or is there any final point that you would like to emphasize?

D. Cheng: Sure, I will highlight a few final additional points.

[Q8] [Q7 indirectly] With respect to the commercial sector, there are a couple of things that I want to highlight. One is, we need to think of the commercial sector as a conglomerate of different players. We tend to even assume that commercial is all open to the highest bidder, where they will be pro-blue, and that's a very dangerous set of assumptions. I would suggest that we need to think of commercial players in all of the realms—satellite operators, launch services, satellite services, etc.—as a minimum of three baskets: 1) solidly pro-blue, 2) solidly pro-red, and 3) green. For the solidly pro-red basket, these are partly solidly anti-blue—there's a difference between pro-red, whoever red is, and being anti-blue. The greens are going to be differently neutral—some are going to go for the highest bidder, some are going to respond to threats, and many of them are going to be thinking post conflict (i.e., how am I going to be postured after the conflict depending on who wins?). If I think, in a conflict, that China is going to win, it's not that I hate blue—I'm not even pro-red—but I've got to think long-term about my customer base and how China is going to respond, and that's going to be true for Russia, Iran, or whomever.

Matthew Chwastek

Director of Product Management, Public Sector (Orbital Insight)
22 July 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer 2: **[Q7]** Sure. This is George. I have one. How do some of the commercial space industries of other countries compared to that of the US? I know in some country, there's large government ownership within the commercial sectors. How does some of the foreign commercial space industries compare in terms of number of players within the commercial industry, capabilities, development progress, things like that in terms of US?

M. Chwastek: **[Q7]** Sure. In my opinion, generally, the US is really not that in space technology industry in the last two decades. But funding for space related technologies is growing across the world. I'd say between Europe, Asia, and Middle East. Many international governments are like clearly identifying it and realizing those infrastructures are important for them now, as well as the fact that they're now within reach of affordability. They keep coming back to like that's the change and price point and the disruption that SpaceX and other up and comers others have created

where they multi-billion dollar investment and turned them into the same quality of capability at tens or hundreds of million dollars. Now, it is then in reach of those countries that can't make those type of large investments.

[Q7] In Europe, you've got agencies like the ESA and others that make new investments in R&D for launch and resiliency, the French are also making investments in Space Science. You see a really big difference in the Middle East (Saudi Arabia, UAE, Qatar) all those countries are definitely making investments in partnering with companies to put up their own contributions to have assets in their own constellations and their launch team that is also very impressive. I would say as we're seeing very heavy investment in non-traditional space players because now they see return on investments that would not have the same amount of return in the past.

Interviewer 2: Thank you.

Interviewer 1: Okay, anyone else?

Gen. Elder:[8] **[Q7]** Well, I guess in terms of the information that you are able to get from commercial sources or from the government in terms of how… again, I realize you're not in satellite operations but maybe it's your sense that the information really needed to operate these satellites in a way that's commercially viable that you get all the information you need pretty quick.

M. Chwastek: **[Q7]** Yes. I think what you're asking is from satellite operative perspective. Do you have enough information to be both commercially viable and to operate in a diverse ecosystem of satellite in space? Is that the question you're asking?

Gen. Elder: **[Q7]** Yeah, that's the question. To follow on, I think you already semi-answered when you said the more information you get the better. You see these smaller satellites where they're 3U or even smaller. Would they be able to provide information of utility for your typical client?

M. Chwastek: **[Q7]** Yes. The first thing I would say is on the topic of satellite operation and information to operate a satellite in space. I think it just depends on the satellite operator. Some satellite operator that are putting in satellite that they expect to burn off in the next year or two. They don't necessarily have the same concern for resilience for individual satellites just for their overall constellation. I think some of their solutions for that is to just put up more satellites. With that said, they need to make sure they put their satellites in orbits where they will decay very quickly and not become just more debris. For more sophisticated satellite operators, I hope and believe and I don't think we're going to finish, but if they're working very closely with the government agencies that monitor space. Space traffic is a very vital source of data in my opinion, and that's all analysis that I've never seen or done. I think that's really as a US government endeavor through the DoD. Does that answer your question now?

Gen. Elder: It does. Yeah. Thanks.

M. Chwastek: **[Q7]** Sure. Then the other question of do these small satellite providers provide value. I actually believe they do and that my reading of this is kind of three-fold. First, I think the smaller satellites they send into space, especially with the small resolution, they provide broader spatial coverage as well as better temporary visits on those broader spatially covered areas and the idea that we can now see economic flows or land use changes or agriculture differences at a country scale, on a daily or weekly basis. It's extremely valuable in terms of providing speed and information for people to make decisions on. I also believe that the combination of very high-rise satellites, be it 50-centimeter range with three to five-meter

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

resolution satellites with some of the government provided satellite systems that are in the 15 or 30-mieter range. That's the synthetic structure of the world that is very important. Because you want to use those low-res guys to track changes that are that resolution (5m-30m). Then if you really need the high-rise to follow up on, you want to be able to queue to do the right thing.

[Q7] Then the third piece, really the fact that I think the advancement through machine learning is fundamental to our company existing are making this data pipeline explosion and find out what's meaningful both hiring hundreds of thousands of people to look at data on a daily basis. I think those same things will apply in satellite communications. I think the same thing will apply to non remote-sensing phenomenon. I think the same thing will also apply to as you get smaller satellites operating together really get better quality out of four, five, six small satellites at a much-reduced price point than you would from one giant satellite that would cost billion dollars.

Gen. Elder: **[Q7]** Sure. That makes sense. My last question, from the standpoint, I know you got the… some of these companies where you basically are given the machine interface, basically get a shop that you need or a set of shots. You're probably on the ones that do not have or have the lower resolution. That is one if you're looking at the characteristics. Do you have the capability to very easily with the interface to be able to go after the very high resolution since I know it is more expensive, but is itjust as easy to get them?

M. Chwastek: **[Q7]** I'd say, actually, we have our best initial traction with the high-rise providers. I'd say the reason being is that we've got a different business model. We're not necessarily paying for those duel shots, we're harboring those providers so that we benefit from other products they use in the market. We try to get access to their full archive where those products are from. Generally speaking, that doesn't matter to us if there's a low-rise or a high-rise picture or if it's one picture or 10,000 pictures. We can process them all. It's really focused on what that data can be implied to and what we can use it for, and whether it meets our customers' needs. We're in the business of solving problems from the people we work with. That's what we focus on. We find the data that support in doing that.

Faulconer Consulting Group

Walt Faulconer
President

Mike Bowker
Associate

Mark Bitterman
Associate

Dan Dumbacher
Associate

15 August 2017

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

Given all of our interactions the European, Asian countries all make it clear that they are in the space program to help develop technology for their economies. There are 71 plus countries now in the world that at have some kind of space program. Many have learned from the United States on the value and benefit of such programs from national pride, economic development, technology advancement, education and of course strategic advantage. The United States segments its space program into "Military/Intelligence", Civil and Commercial. Other nations like China do not. It is all the same and therefore better integrated to take advantages across the artificial boundaries we place on our space programs.

Gilmour Space Technologies

Adam Gilmour
Chief Executive Officer

James Gilmour
Director

13 July 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Okay, good. Okay, I think that covers that question. Moving on. Are other nations outside the West or it has happened to their own commercial space industry for military purposes in the next five to ten years? Obviously, I want to get the Australian point of view on this. But, if you feel knowledgeable on the other Asian-Pacific nations or elsewhere, I'd appreciate that input as well.

A. Gilmour: **[Q7]** Yeah, we think our government's pretty behind the eight ball on looking at space capability, but they're getting there and we've had some decent conversation this year with people in the Defense Department. I'm pretty confident in the next five to ten years, the

Australian government will look at domestic commercial space industry for launching military satellites and stuff like that.

[Q7] We operate in Singapore and Australia. We've had discussions with the Singapore military about technical satellite launches and they're interested. Again, very similar to Australia, taking their time to develop a mandate or request for capability.

[Q7] I'm not aware of any significant desire from the rest of the ASEAN countries, like Malaysia, Thailand, Philippines, Vietnam, to do any domestic space launches or space industry for the military. I'm not aware of that.

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

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Okay. Great. I think that soundly answers that question. We'll move right along to the next one. Are other nations outside the west poised with [to tap into abilities] of their own commercial space industry for military purposes and the next five to ten years?

T. Gould: **[Q7]** In general, I think there might be other organizations in a better position to answer this but we think it's fair to say that most of the capabilities and services out there, could be considered dual use. As an example, Gill likes to use the same rocket engines used to boost satellites into orbit can deliver the conventional or nuclear warheads. So every nation that builds an indigenousness space launch or satellite manufacturing capability, is almost certain to be able to utilized the capability in support of national security requirements.

[Q7] The global proliferation and continuing growth of small sats manufacturers offers a significant avenue for all nations to use and exploit space for commercial, civil, and military purposes. Small sats obviously are less expensive to launch than larger spacecraft and historically been the principle option for what we'll call "aspiring nations" as they look to satisfy a large range of military and intelligence missions. With some slight modifications most commercial capabilities can be used for military purposes as they offer…disaggregation, resiliency, distributed operations. I think overall in the near term what we will call offensive and defensive space operations will most likely remain exclusively within the purview of national government. Jenn, anything else to add on that?

Interviewer: **[Q7]** General Gould I have a follow-up question... From a commercial perspective does an entity like Harris Corporation view any particular nation whether it's the large corporations in Europe or in Russia and China as a major competitive threat to the commercial interests of Harris Corp or is it exclusively US competition?

T. Gould: **[Q7] [Q8]** That's a great question. I know that several nations are developing capabilities with some US technology onboard. As you know, as their capabilities mature they will begin to develop those capabilities indigenously. I cannot speak to, China and Russia but there are lots of other nations that are looking to get into the commercial side. I can think of one off the top of my head there in the Middle East who is looking to develop an indigenous space-weather capability. Certainly, that would include technology that not only supports weather but could support advanced imaging whether EO, IR, hyperspectral, etc. Most of them are trying to develop the capability maybe as an integrator but leveraging US technologies.

Interviewer: **[Q7] [Q8]** One way to sort of mitigate the concern of proliferation of commercial technology that we keep hearing is simply that the US commercial sector is far ahead as we are of everyone else to go on unhindered and that is the best way to prevent ubiquity of what could be, certainly could become as you mentioned, dangerous technology or technology that can easily be converted into military use. Is that a sentiment you would agree with?

T. Gould: **[Q7] [Q8]** I would and I think you could apply that to Space Lift particularly. I mean if, SpaceX and companies like Space X that are trying to, capture low cost lift technologies, if the United States can stay ahead of that curve and companies to be **[0:19:34 inaudible]**

Operator: Gill has joined the conference

T. Gould: Hey Gill.

G. Klinger: Hi, this is Gill Klinger. I'm sorry I was running late. My apologies.

T. Gould: **[Q7]** No problem. We're talking about… I think we're on the third question with commercial space industry and Wes has asked about, techniques to prevent the proliferation. One technique is to corner the market on our own side, the US side, and I'm using the example of Space Lift capability. If we were to corner the market on what I'll call inexpensive space lift then it would be very difficult for anyone else to compete and they would be forced to come to the US for our cheap Space Lift, driving even more money into cost effective lift, making it even cheaper. The same could be applied to other technologies whether they are sensors, comms, etc.

G. Klinger: **[Q7]** Yeah, I guess I have a little bit of a different view here. I think there is just way too much money involved here in terms of the potential returns on investments and the technologies are proliferating at such a high rate that I think we can certainly pace the markets. In other words, we tried to do the same thing with commercial remote sensing, in other words the policy sets the resolution limits , which is basically commercially available and tends to move that limit to better resolution in front of where the rest of the world is in terms of its commercial offerings. I think a similar strategy is something that we might think about with respect to small-sats in terms of both how affordable our products are and how versatile our products are.

[Q7] [Q8] I think that there is just, there's just too much money involved and too much national importance involved for space faring countries that they are going to make those investments. If that is a priority to them for either commercial or military reasons they are going to make those investments... If you look at, historically if you look at India, sort of a case in point. I mean India made a conscious decision 30, 35 years ago that it might take them a lot longer and might cost them more but they were going to be an indigenous space faring nation and that's what they are. That's what they have become in sort of the front-line space faring nation in part because of that strategy. Now again, I think Tom you're exactly right there are certain technologies that nobody's going to come close to us but in the mainstream, you know,

I think our long suit, our technology is in building Maserati is not building Honda Accords to use the car metaphor.

Dr. Jason Held

Chief Executive Officer (Saber Astronautics)
17 August 2017

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

Every nation uses commercial space assets as part of their military and national data acquisition. Australia for example pays $2-3Bn annually to use other products (imagery, etc.) imported from other nations. The motivation previously has been to seek bilateral agreements to supplement with services on barter—a common example being an exchange of free ground station time for free imagery services. Since the recent announcement of a space agency, Australia is seriously considering sovereignty. The NewSpace scene is still young but growing very quickly. There are now reported 60 new space companies with 1/3rd of them funded from Seed to Series-A rounds. In comparison, India the 6th largest space nation reports only 12, with most commercial efforts being closely funded and controlled by defence. Singapore and Japan also have growing programs with increasingly commercial efforts.

Bottom line answer is: absolutely. Defining the nature and scope of that commercial industry is the big question.

Theresa Hitchens

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

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

Most space activities outside of the U.S. (possible exception of Russia) are concentrated on dual-use space technologies and applications. Canada, Germany, Italy have SAR sats, for military and commercial use, and have had them longer than us. Others have launch capabilities and ambitions, launch companies outside the U.S. are of course all dual use. Chips, etc. are made outside US including in China, again for dual uses. Companies build ground stations and GPS receivers, enhancers. Most other countries very interested in imagery and navigation, and have commercial interests in that. And weather applications. Luxembourg has a keen interest in space mining.

Dr. Moriba Jah

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

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7] [Q8]** Okay. So, let's transition into two of our other more commercial-focused questions, and I actually want to combine two of our questions that relate to each other here to see what you think. How are the components of the commercial space industry allocated outside of the US? And, are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

M. Jah: **[Q7] [Q8]** Yeah, absolutely. I think that the US has very big bureaucracies and its space activities are definitely compartmentalized (i.e., here is the DoD-type stuff, here is what Intel agencies do, here is the commercial stuff)—things are very stove-piped in the US. In other countries, because their space programs aren't that large, it doesn't really make sense for them to have that compartmentalization, so they have come out of the gate with very strong partnerships commercially and are investing in dual use technology. Germany is a prime example of doing a really good job in this sense. For example, in Germany, all of the research dollars, by law, have to be dual use technology. They have these things called Fraunhofer Institutes that are very similar to University Affiliated Research Centers (UARCs) in the United States (e.g., the applied research labs here at UT Austin are an example of a UARC). So, Germany has had a lot of success doing that, and I think it's to the benefit of the country. And I think many countries are aligned with that idea of strong industry partnership and dual use technology stuff. However, the US has been fairly behind in that, and I think it's to the detriment of the US.

Dr. T.S. Kelso

Senior Research Astrodynamicist (Analytical Graphics Inc.)
4 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Yeah. That makes sense. So, shifting gears a little bit here into one of our other questions, are there other nations outside the West that are poised to tap into their own commercial space industry for military purposes in the next 5-10 years? We've focused so far mostly on the space from the US perspective, and the relationship between the US government and US commercial space entities, but could you talk a little about some of the commercial space industries across the world and the relationships they have with their governments?

T. Kelso: **[Q7]** So, the stuff we're doing at AGI with the Space Data Center (SDC) is actually multinational, and we have dozens of countries represented in the SDC at this point. When we do interface with governments, it's only with the US government at this point, but we represent operators from countries all over the world including Australia, Europe, South America, and pretty much everywhere except for Russia, China, and India at this point.

[Q7] In terms of what we're seeing for commercial SSA or even conjunction analysis and collision avoidance types of work, we're seeing some clear effort. In Europe, for example, the French Space Agency (CNES) has been working with some of Europe's radar assets, which are primarily military assets, and have been able to get information from them—now, whether or not they are getting more information than what we get from the US government is hard to say because they haven't been particularly transparent about what is going on. So, we have seen a kind of nationalistic approach to the problem. There's this notion that "if we track our satellites really well, then that that solves the problem," but it really doesn't because we run into a problem where there is a whole host of other operational satellites that are maneuvering to perform their mission, and we largely have no insight to what is happening unless you have reliable information from some other source—whether it's that operator or some SSA asset. So, I don't know how we address this.

[Q7] But, ultimately, there are clearly indications that there are commercial interests working with their governments to try to build capabilities. These efforts tend to be very narrowly focused on just protecting their nation's satellites, at least from what we can tell. But, what they're actually looking at and what they're willing to share, doesn't seem to be a whole lot at this point.

Victoria Samson

Washington Office Director (Secure World Foundation)
22 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q2] [Q8 indirectly] [Q7 indirectly]** That's interesting. I didn't know that a country like India doesn't have a national space policy. So, this actually segues nicely into the next question I was hoping to ask you. This question has a lot of parts, but it's about how US allies, partners, and adversaries conceive of space operations for military and commercial purposes. So, I'm wondering if you could talk about this, how do other actors conceive of their space operations both with respect to the military realm and the commercial realm? And, as you can see, this question lists out a number of countries to address, but feel free to focus in on whichever countries from that list you feel most well-suited and comfortable with speaking to.

V. Samson: **[Q2] [Q8 indirectly] [Q7 indirectly]** Sure. Let me just start with India since I just brought it up. India went to space for developmental purposes. It was peaceful, or, I should say, non-military—peaceful use of space is another example of a contentious space term, because there isn't a lot of agreement about whether it means non-aggressive or non-military. Either way, India was basically using space for civil, national development capabilities for decades.

[Q2] [Q8 indirectly] [Q7 indirectly] But over the past decade or so, there have been a couple of changes. First, I think the Indian military has recognized that there are definite interests for them to utilize space, particularly since they have areas of conflict in mountainous regions where it's difficult to communicate and do imagery otherwise. Space is pretty helpful for that. But also, like a lot of countries, India is very worried about China, and when China had its 2007 ASAT test, it was kind of a wakeup call for many actors, and India immediately thought, "okay, maybe we should have something as well."

[Q2] [Q8 indirectly] [Q7 indirectly] As an aside, India and China are really interesting. India is super interested in China, whereas China seems to be barely interested in India. That's a bit of an exaggeration, but I think in terms of security and space issues, India is not really on China's radar.

[Q2] [Q8 indirectly] [Q7 indirectly] Anyways, India's space program is typically run through the Indian Space Research Organization (ISRO), which is a civilian entity, but more and more their Ministry of Defence (MoD) has been getting involved in space and satellites, and they actually have two national security satellites now out of about 24-26 total Indian satellites. And they're starting to have a lot of dual purpose type capabilities (e.g., an ISRO satellite provides services that the Indian military uses).

[Q2] [Q8 indirectly] [Q7 indirectly] As well, India traditionally has not had a solid independent commercial space sector. They do have a commercial wing of ISRO that is called Antrix, and they're the ones that develop a lot of the commercial capabilities in India. But Antrix is funded by the Indian government, so it's not truly, I would argue, a commercial sector. Antrix just recently announced that they were going to start seeking subcontractors completely independent of the government, so I think India is slowly getting an independent commercial sector. India has a huge small satellite community and is really interested in the new space-type stuff—there is a lot of interesting technological research coming out of India these days.

[Q2] [Q8 indirectly] [Q7 indirectly] And, like I said, India is finally gearing up to the fact that there are national security interests that they can have in space, so they need to figure out what sort of space capability they need. Additionally, India has a missile defense program that they've been working on for some time, and they're using it as a way in which to develop an anti-satellite capability without actually testing an anti-satellite weapon. Currently, there are tons of quotes from Indian officials—I think more for the domestic audience than anything else—saying, "look, India wants peace in space. India doesn't want a conflict in space, but if anything should happen, then we have an ASAT capability done and dusted." I'd argue that this is probably optimistic on their part, but it is what it is.

[Q2] [Q8 indirectly] [Q7 indirectly] So, it's interesting to see kind of how India's space operations have evolved over the past couple of years. But, like I said before, India doesn't have a national space policy. Supposedly, they've been working on one that's in draft form, but it's hard to get it through their government. India's Parliament doesn't really have committees like we have here in Congress. Indian Parliamentary efforts depend upon individual members to push things through, and I don't know that they have any strong supporters of getting a national space policy out. And I've been told by some military people that India actually likes not having a national space policy because it gives them a lot of room and flexibility to maneuver—if you haven't been told what to do, you could do whatever you want, right?

Interviewer: **[Q2] [Q8 indirectly] [Q7 indirectly]** Great. Can you talk about any of the other countries that are listed in this question?

V. Samson: **[Q2] [Q8 indirectly] [Q7 indirectly]** Sure. Russia is interesting because, going back to the Cold War, the Soviet Union did not want to acknowledge any kind of commercial activity—they didn't want space to be used for commercial activities. I think this was largely because they felt that the United States would have a leg up on them because the United States could have US national space activities and then commercial activities, and that would kind of give us a leg up. When you look back to when the Outer Space Treaty was written, there were a lot of arguments over whether or not commercial activities should even be allowed in space. The United States was able to prevail on that issue, so that was a victory in our time. But that has

changed because I think the Russians are looking at current circumstances and realizing that oil prices aren't what they used to be, so they need other outside sources of funding, and they've also had a few restrictions elsewhere due to other activities, so they're looking for new ways to use the space domain as a tool for making money.

[Q2] [Q8 indirectly] [Q7 indirectly] ROSCOSMOS is weird because it was the Russian Space Agency, but then they shut it down and renamed it, and they also made a commercial sector also named ROSCOSMOS. Honestly, it's very hard to understand what the difference is, as well. I don't think the Russians actually have a national space policy either. They have a couple competing documents, and I'm not sure which one is uppermost—a few years ago, I tried to actually track down what exactly Russia's national space policy is, and I had no success. I think that's kind of indicative of their confusion regarding where they want to go in space and where they want to go as a country. I always say that NASA kind of has a crisis because they don't really know what they're supposed to be doing or what the raison d'être is, but Russia's space program truly does not know what it's supposed to be doing—they're just kind of hanging on, hopefully not exploding too many rockets while they're doing it.

[Q2] [Q8 indirectly] [Q7 indirectly] The one positive thing Russia has right now with respect to its space operations is that they're the ones taking people up to the International Space Station, and they have a lock on this. But, Russia is looking at other things regarding space operations. There has been a rise of Precision Navigation and Timing (PNT) satellite constellations around the world, and Russia is interested in this. Of course, the US has GPS; the Chinese have Beidou, which is doing pretty well; the Europeans have their own version called Galileo; and Russia has GLONASS. Russia is really trying to make GLONASS a thing that people use, but it's hard because they don't have exactly the right coverage, the satellites tend to malfunction, and it just doesn't have the broad use that GPS has. This is changing, though—a lot of the newer cellphones now have chips for both GPS and GLONASS when you buy them, but GLONASS is clearly not as widespread.

[Q2] [Q8 indirectly] [Q7 indirectly] So, I think Russia is trying to follow the US's lead, actually, in terms of how we've diversified our space capabilities, but they're having a hard time doing it because I just don't think there's a lot of leadership. It seems that Russia is just fearful of being left behind and being perceived as being weak.

[Q2] [Q8 indirectly] [Q7 indirectly] I know Russia does have some new space actors, but, to be honest, our organization has had a very difficult time reaching out to the Russian space community. We know that people that show up at COPUOS—a couple of them are very good technicians and experts on the issues—but it's hard to get a beat on what the Russian space policy makers are thinking just because of language differences, visas, and just general difficulties between our two countries' relationships.

Interviewer: **[Q2] [Q8 indirectly] [Q7 indirectly]** Okay. What about North Korea?

V. Samson: **[Q2] [Q8 indirectly] [Q7 indirectly]** Well, this is obvious, but North Korea doesn't really have a commercial sector. I'm sure you guys have heard a lot about North Korea lately. Supposedly North Korea has launched some satellites, but these don't really seem to do much more than maybe broadcast a tune, if they can actually broadcast it.

[Q2] [Q8 indirectly] [Q7 indirectly] However, North Korea is absolutely using its space launch capabilities to further its missile launch capabilities. I don't know that North Korea would necessarily sell those capabilities, so it's not like they're doing this in the sense of commercial

operations or interests. I think they're more using these capabilities and operations to further their interests regarding security concerns more than anything else.

Interviewer: **[Q2] [Q8 indirectly] [Q7 indirectly]** So, how would you define North Korea's key ambitions and interests with respect to the space domain?

V. Samson: **[Q2] [Q8 indirectly] [Q7 indirectly]** I think North Korea's ambitions and interests are portrayed by the way in which it has developed its missile capabilities. North Korea isn't like other countries where economies are reliant upon space—North Korea isn't reliant on space. I think the leadership's interests revolve around regime continuity, and I'd imagine that drives whatever policy they decide to do. So, I think that any research into the North Korean space program has to look at the underlying issues. North Korea isn't going to do space for science's sake or for development's sake or for STEM promotion's sake—they aren't going to do anything like that. They're going to focus on national security concerns, and there are always national security interests.

[Q2] [Q8 indirectly] [Q7 indirectly] Having said that, because North Korea doesn't have space assets at the level of pretty much anyone else, I know a lot of people often point to North Korea as being the actor most likely to launch a nuke or do an EMP or wipe out a lot of satellites. However, I don't see them doing that, largely because I think it would be so hugely escalatory—it would require a regime-ending response, and they are aware of that. I don't think they would be able to target missiles by doing an ASAT operation, and I don't think they have the guidance or situational awareness strength to be able to do that either. They have not mentioned counterspace in public documents. But that doesn't mean there aren't other things they could try and do, though, to make people concerned. I just think that they're focused too heavily on their nuclear program and missile program to really develop an ASAT capability because it is rocket science and it is complicated, and they're doing a lot of work there that depends upon getting access to other people's technology. So, I think North Korea is limited in terms of what their indigenous science and technology can accomplish.

Spire Global Inc.

15 August 2017

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

Yes, it is clear that a number of countries (both outside and within the West) are using commercial space capabilities for military services, and are providing services to their commercial entities. In some respects, a number of other countries are even pulling ahead of the U.S. in this area. For example, commercial Chinese operators have greater access to launches funded or provided by their governments, as well as full support (financially and logistically) from their governments.

Other examples of nations that have a close commercial space utilization and cooperation with their military include the following:

- Launch capabilities: China, Iran, North Korea, and Russia.
- Earth observations: India, Russia, Japan, France, and Germany.

Stratolaunch Systems Corporation

Steve Nixon
Vice President for Strategic Development

Melanie Preisser
National Systems Director

18 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Okay. Yeah. I agree with all of that. I'm going to move on to the next question here. Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

S. Nixon: **[Q7]** Yeah. I think that's definitely a good question… India and China are both very aggressively working space launch and things in space. We see a lot of crossover between what they're doing for military and government purposes and commercial, and a lot of concern about subsidies. Which makes it hard for commercial companies. But also, helps the other countries ensure that they have launch also available for military purposes.

[Q7] There are recent articles about Russia's space agency Roscomos planning to compete with SpaceX. In those articles, the Russians are worried about SpaceX as a threat to them in the global market for satellite launches, and they're talking about making things cheaper including innuendos of government subsidies to keep things cheap.

Interviewer: **[Q7]** We're aware of that after the United States, Russia is the next leader in the launch industry. Speaking maybe nations like India and China and maybe European nations, where in the launch world are the commercial sectors about to flourish or on the cusp of a lot of innovation and development? Or is it strictly only in the US and Russia that there's any feasible commercial space industry?

S. Nixon: **[Q7]** At the class that we are concerned with, we talk mostly about India actually and their Polar Satellite Launch Vehicle (PSLV) . They're doing launches both for international and US small satellites. Out of frustration for a lack of capability in the US, a lot of US companies are putting payloads on PSLV launches. For the small satellite launches that we really focus on, the Indians have found a nice sweet spot in launch capability that seems to attract people, even despite all the hassle of going over to India and launching over there. They're still doing it, even DARPA is planning to launch there.

[Q7] I think China is being very aggressive too. It seems like… I would not expect DARPA to go to China for launch -- the way we're insulated from competition along those lines in China just because of all the rules. I'd say India is the one that we focus a lot on. Although, yeah. I mean Russia tends to do pretty well. But mostly for bigger things, I think.

Interviewer: **[Q7]** Now, is the comparative advantage of launch in India is strictly the price and affordability or is there a specific launch system or type of innovation that India is excelling at or exploit to in the next five to ten years?

S. Nixon: **[Q7]** It seems to be mostly price coupled with increasing… the reliability had gotten good enough where people feel pretty good about launch on it. Then after that it becomes a price shootout. They're keeping the price of launching ride-share, small satellites. It's really

aggressive. We're all having to watch out to see if they can create systems and business model that are attractive even despite the prices from India.

John Thornton

Chief Executive Officer (Astrobotic Technology)
11 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** We'll move on to the next question here. Are other nations outside the west poised to tap in in their own commercial space industry for military purposes in the next 5 to 10 years?

J. Thornton: **[Q7]** Yes, but there's a question about what China's intentions are on the Moon. They have plans to send multiple rovers and a spacecraft to the Moon. China is planning on landing at the poles of the Moon to retrieve resources. There is conversation that they've had about landing people on the surface of the Moon as well. If they get there first and capture those resources that could be a strategic benefit for them and potentially a large economic benefit as well. Also Russia has plans, but we haven't seen as much traction. We tend to think that their budget is probably not sufficient to go after it, but China's certainly is. China is the biggest one to track from a strategic military standpoint, but there's just a question mark around it. We don't know their true intentions and what they're really going after.

ViaSat, Inc.

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Vice President of Space & Satellite Broadband

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Vice President - Government Operations

15 August 2017

WRITTEN RESPONSE

[Q7] Are other nations outside the West poised to tap into their own commercial space industry for military purposes in the next 5-10 years?

Today, private sector capital investment in private sector space ecosystems, including SSA, EO, PNT, and Satcom, is at a record high. Historically, government space agencies, like the National Aeronautics and Space Administration (NASA) or the European Space Agency (ESA), have been the technological, funding, and leadership force in a

nation's or region's investment in space ecosystems. In today's space environment, private sector investment and capabilities are surpassing government funding and capabilities. The cutting edge of technology and performance is being defined by truly private sector capital investments. Further, the private sector technology trajectory is moving rapidly and with agility such that the gap between the USG and private sector is continuing to widen.

Investment in space includes private or semi-private entities in nations outside the West. Beyond, historic coalition nations like Australia, we are seeing significant interest by entities in China and India striving to make systems similar to those achieving business successes in the western nations. One indication of the level of interest in private space in these nations is illustrated by the construction of China's first commercial space industrial park in Wuhan is currently under construction and is scheduled to receive a total investment of over 100 billion yuan (~$15B USD).[9]

The very large and rapidly growing economies of these nations will allow them to leverage private sector technologies and trends to quickly close the capability gap that exists between the West and these nations. Within ten years, these nations may well possess commercial Satcom capabilities that significantly outperform US Military Satcom capabilities.

Charity Weeden

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Former Assistant Attaché Air and Space Operations (Canadian Defence Liaison Staff, Washington DC)
22 August 2017

INTERVIEW TRANSCRIPT EXCERPT

Interviewer: **[Q7]** Okay. Okay, we'll keep it moving along again. I want to rephrase this question just a little bit. Now we know most of the commercial satellite industry is based in the US, but looking outside of North America, what would you say are the nations that are poised to expand their own commercial satellite industry for military purposes?

C. Weeden: **[Q7]** Okay, so for military purposes, I don't have a good oversight on that. However, I think in the SatCom-satellite communications environment, Latin America is utilizing commercial SatCom, I understand, for defense purposes. The Middle East potentially it could be a place that is looking to leverage more commercial or encourage commercial SatCom to be launched and therefore opening the doors towards utilizing it.

[9] http://en.hubei.gov.cn/investment_2017/photos/201703/t20170303_959478.shtml