KPMG

SPACE FOUNDATION

Navigating space

A vision for space in defense

August 2021

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Foreword

The space domain is becoming more congested and contested. New technologies are rapidly emerging. Barriers to entry are falling. New players – both governmental and commercial – are vying for advantage. At the same time, humanity's reliance on space activity is becoming more ingrained every day. Once supreme in the space domain, the defense sector is being forced to reassess the role they play in this increasingly critical domain.

To better understand how the domain and the ecosystem are evolving, KPMG International and the Space Foundation teamed up to talk to nearly two dozen industry and defense leaders at the highest levels of the space domain. We asked them about their views, opinions and predictions on the future of the domain over the short, medium and long term. And we gathered their perspectives on key sector challenges such as security, capability and competition.

Using their perspectives as guideposts, this paper offers key predictions on how the sector may evolve, identifying important new capabilities, commercial opportunities, partnership initiatives and sovereignty considerations along the way. We also provide a number of considerations and recommendations to help defense and industry players ensure the long-term sustainability and safety of operations in space.

Ultimately, this paper finds that – while the domain is evolving at a rapid pace with rising competition and potential for risk – the path to sustainable space operations and human habitation lies in connection and cooperation. As such, we hope this paper serves to inform the ongoing development of the space domain and acts as a catalyst for diplomacy and collaboration in the field.

On behalf of KPMG International and the Space Foundation, we would like to thank the national and global leaders who contributed their time, insights and predictions to this paper. To learn more about how the predictions raised here might impact your organization, we encourage you to contact your local KPMG firm or any of the contacts listed at the end of this paper.

Grant McDonald
Global Head of Aerospace & Defense
KPMG International

Jacob Hacker
Global Space Industry Co-lead
KPMG Australia

Thomas Dorame
Senior Vice President
Space Foundation

Megan Wenrich
Manager, DC Operations
Space Foundation

Into the constellation

Since the dawn of space exploration, the military has been on point. The first satellites were funded by defense departments. The first astronauts were air force and navy personnel. Many of the technologies now driving space exploration were born in government labs and research facilities.

From the very beginning, the potential for conflict has been clear. It started with the 'space race' between the US and the Soviet Union.

Since then, space assets have been directly involved in theaters of war – ground stations were attacked during the 1991 Gulf War and in the 2011 conflict in Libya. A number of countries have developed direct assent, kinetic capabilities (even though the impact on Earth's orbits are now well understood). The jamming of SatCom and GPS networks has been reported in numerous regions and theaters of conflict. Defense departments have long viewed space as a key domain of warfare.

Now, however, the hegemony of a handful of military departments over the space domain is being eroded. A growing number of countries are realigning their defense organizations to recognize the importance of space. The US has, perhaps, been the most public with the creation of the Space Force. But many others – including Australia, Canada, China, France, India, Japan, Russia and the UK – are also busy establishing space commands in order to develop domestic capabilities and enable foreign partnerships with likeminded nations.

At the same time, there is growing recognition of the value that investment into space capabilities can provide to the military, governments and humanity more broadly. Indeed, humanity increasingly views space as a domain of opportunity and inspiration – in orbit and on the planet surface. Many of the capabilities now being developed for space can deliver broad benefits to civilians (things like assured communications, the protection of space assets, manufacturing in space, space tugs, laser and optical communication, and others as yet unimagined).

Non-governmental organizations are crowding into the domain – most notably led by commercial ventures such as SpaceX. And that is changing the focus for many military players. Whereas in the past, government spending tended to focus on things like new earth observation, space situational awareness (SSA) and satellite communication capabilities, these are increasingly being offered commercially, as 'off the shelf' solutions.

It is not surprising, therefore, that space has become an increasingly important domain for defense and national security operations. As one of our interviewees aptly stated, the space domain is becoming more contested and more congested. Between 2019 and 2020 the number of spacecraft launched per year more than doubled, with expectations there will likely be 100,000 satellites in orbit by the end of the decade. And, with more countries and companies now joining the ranks of the space-faring, the focus on the domain and the role played by the defense sector is growing.

As many of our defense and industry interviewees noted, we have entered into a period where the rules of the road must be defined if society would like to ensure the longevity of human habitation and operation in space. Achieving broad consensus around global norms of behavior and policy will likely be critical to humanity's ability to achieve benefits from the space domain. And it is more important than ever to help stakeholders as they aim to ensure humanity's safety in space and on Earth.

Against this background, we offer the following four key predictions on the likely future of defense in space.

1. Space will define the future of national security
2. The pace of innovation will continue to quicken
3. Partnerships will be crucial to long-term success
4. Alignment on norms will unlock advancement.

In the following chapters, we will explore each of these predictions in more detail, supported by actionable recommendations and practical advice.

Prediction 1

Space will define the future of national security

Space will become the dominant domain for national security by 2030. Defense forces around the world are already developing specific organizations focused on the space domain. Some, like Australia, Canada, China, France, India, Japan, Russia, the UK and the US have significant programs. But other countries are also starting to stake a claim to the domain – African countries, for example, placed 41 satellites into orbit in 2019 alone, while Middle Eastern nations have national strategic priorities in the domain, including the launch of Mars bound missions. Many of our interviewees believe the path to acceptance will be short; it took almost 70 years for the air force to be fully integrated into most joint forces – most seem to expect the integration of the space domain to be much faster.

> In the long term, I believe space is going to become the most vital domain for national security, surpassing air, land and sea. I think that we will see an increase to the human presence in space, and eventually there will be people living on other planets as we do today on the International Space Station. A heightened need to secure the domain will follow that increase in human activity beyond our planet. Additionally, space will become more critical as an economic hub. In the long-term, the level of wealth generated in the space domain will be significant.
>
> **Gen. John W. "Jay" Raymond**
> Chief of Space Operations,
> US Space Force

Space sustainability will become a top national security issue. On the one hand, it is clear that there is mounting concern about the growing density of debris and traffic now circulating in space, particularly in low earth orbit. At the same time, countries are seeing space-based assets start to play an increasingly important role in supporting sustainability efforts on Earth. As markets and societies become more dependent on space assets (not just for sustainability efforts, but also a range of needs such as financial transactions, location services, and so on), the need to ensure the sustainability and proper management of the space environment may increasingly be seen as a national security issue.

> We have to behave as a global community to think about sustainability in space and concerns such as debris. If you get too much debris up there, you're not going to be able to commercialize things like space hotels. So the international community and international law needs to come together in many ways.
>
> **Rick Ambrose**
> Executive Vice President,
> Lockheed Martin Space

Prediction 2

The pace of innovation will continue to quicken

Data and AI capabilities will be fundamental to future success. The ability to manage massive amounts of data and integrate new technologies such as Artificial Intelligence and Machine Learning is rapidly becoming a key capability for successful space ventures, both governmental and commercial. Access to publicly-available intelligence sources is expanding rapidly with commercial players now offering a range of Earth Observation data in near real-time. In fact, some of our interviewees expect public sources of intelligence data to rival classified sources within the next few years. As it does, a new landscape of Open Source Intelligence may emerge.

> Information as a service is becoming more commoditized. And key milestones – like achieving geointelligence singularity from Earth Observation – will be enabled through the use of AI and mobile technologies that could allow almost anyone to pull down data with their phone, showing any point on this planet at any time in almost any type of resolution. That has important implications for the national security side.

Steve Isakowitz
President,
The Aerospace Corporation

Cyber security and resilience capabilities will evolve rapidly. As governments start to integrate the space domain into their defense and social networks, much greater focus will likely be placed on protecting space-based and lunar assets. While significant investment has already been made into the field, the reality is that satellites and spacecraft are inherently vulnerable to cyber-attacks, jamming/spoofing and physical attacks. At the same time, concerns about the resilience of technology in space is leading some to move away from 'exquisite' large satellite configurations and towards diversified constellations, thereby creating additional redundancy and resilience in the network. Expect capabilities to evolve quickly.

> Government must find ways to leverage these commercial capabilities on time scales that are relevant – not only to the defense missions and users being served, but also matched to the pace of commercial innovation. Our model centers on an ability to put up a higher quantity of lower cost satellites on faster timelines – building resiliency across an architecture. This pipeline creates frequent opportunities for technology insertion and experimentation, and enables us to focus on what can be done with this new commercial data and analysis – delivering knowledge and mission impact.

Kari Bingen
Chief Strategy Officer,
HawkEye 360

New capabilities will emerge and scale. Given the rapid pace of technology development in all spheres of the economy, it is not surprising that many of our interviewees predict that new – currently unfamiliar – capabilities

and technologies may emerge. Expectations are high for breakthrough innovation in areas such as proximity operations (life extension technologies for refueling vehicles, for example) and space manufacturing. Yet what is noteworthy is not that new unimagined technologies will likely emerge, but rather the pace at which they will be adopted, scaled and commercialized. Proactive efforts to help ensure new emerging technologies are secure will be key.

> I think we're going to see the cislunar space become increasingly interesting and regularly populated. And there will start to be the foundations of real space logistics – things like tugs, propellant structures and other technologies that may not exist today.

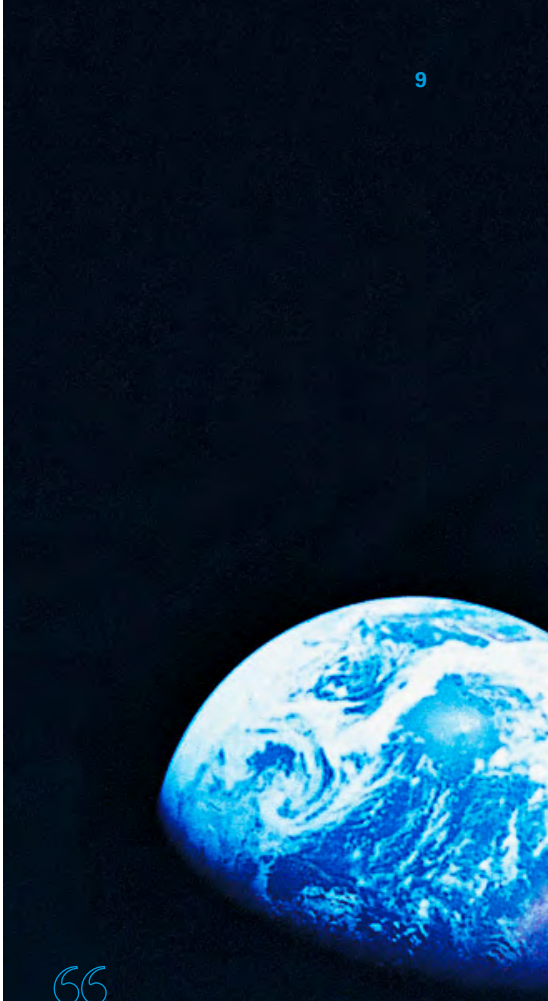
Mandy Vaughn
CEO, GXO Inc and former CEO, VOX Space LLC

Commercial companies will play an invaluable role. Already, we are seeing a plethora of new commercial ventures focused on supporting and defining capabilities and mission architecture, particularly in the fields of Space Situational Awareness (SSA) and Earth Observation. In fact, a number of companies already boast commercial capabilities that are highly competitive when viewed against those of many defense functions. With this data now being offered 'as a service' from commercial players, defense advantage may increasingly come down to who has the best analytical tools to derive useful intelligence from the data.

> Having that mix of defense-owned and commercially-delivered services adds to the resilience and the robustness of our capability. A very complex and diverse web of both military and civilian contracts is much harder to attack than one single piece of equipment that holds all of your capabilities.

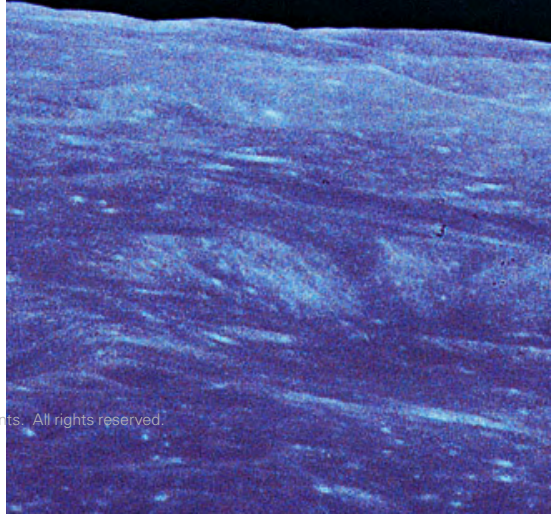
Air Commodore Phil Gordon
Director General Air Defence and Space, Royal Australian Air Force

Agility and speed will define capability development in the future. Traditional approaches to defense capability development and procurement are not fast enough or flexible enough to keep up with the pace of innovation and development in today's space domain. SpaceX reportedly builds 6 or 7 StarLink satellites every day. Many launch new capabilities every three months. As such, defense leaders are rethinking how they might develop new procurement and development capabilities that would help them work with a broader range of smaller providers. Expect to see more Initiatives like the US's Space Development Agency and the UK's Space Pitch Day in the future.



> We're really focused on new models for our space capability acquisition. We want more agile, slimmer processes that help companies engage with us without all the legacy red tape. That being said, it's easy to say you want to 'fail faster', but in practice this can prove challenging as we are spending public money – the trick will be to implement acquisition processes that are more agile, whilst retaining an acceptable amount of oversight.

Air Vice Marshal Harvey Smyth
CB, OBE, DFC, Director Space, UK Ministry of Defence



Prediction 3

Partnerships will be critical to long-term success

Existing partnerships will strengthen and expand.
Recognizing the value of partnership and collaboration in space activities, development and investment, we are seeing significant efforts to expand existing partnerships and alliances. NATO, for example, is establishing a space center to enable better coordination around space communications and intelligence. The US-led Combined Space Operations Center (CSpOC) aims to improve collaboration between the US, Australia, Canada and the UK, with support from France, Germany and New Zealand. In most cases, particular focus is being placed on encouraging collaboration between allies and commercial and civil operations including the use of dual use satellite partnerships with civilian and defense payloads.

> Many NATO members already have their own space domain capabilities. And it is clear that those national entities are here to stay. What we can do is help them enhance their collaboration, share ideas and work together.

Lieutenant Colonel Henry Heren
US Space Force, NATO Joint Air Power Competence Centre

Newer markets to the domain will focus on specific strengths.
With more than 100 countries now boasting satellite programs, there are greater opportunities for collaboration on defense-specific capabilities. Working with established leaders, the UAE, for example, went from having no space program to launching a mission to Mars in just 6 years. That being said, our interviews suggest that smaller and emerging market players may find more success in focusing on a smaller number of strengths that can deliver a longer economic and technological impact.

> From a geopolitical, physical and capabilities perspective, Thailand is well positioned to lead Southeast Asia in areas like Space Situational Awareness and Space Traffic Management. We are now looking at capacity-building through training and knowledge transfer to help us operate in space activities.

Thagoon Kirdkao
Chief of SSA/STM Education and Network, Advisor to the Subcommittee of SSA/STM Thailand, previously Director of Space Affairs Division, Royal Thai Air Force

Prediction 4

Alignment on norms will unlock advancement

Norms will support the development of new capabilities. Transparent and open communication from military actors in space will be key to avoiding conflict. Yet there is growing criticism that the traditional international forums for agreeing space norms and treaties (the UN Committee on the Peaceful Uses of Outer Space and the International Conference on Disarmament, for example) are now too slow to meet the rapidly evolving realities of the space domain. While there are differing views on whether industry or government should lead these initiatives, there is growing support for these issues to be managed at a higher level in the future (perhaps at the UN General Assembly level or between industry bodies).

> We have an opportunity now to build new norms for space actors; how they act and what rules they play by. I believe the development of these norms will be a reason for celebration, because it will enable a future of utilizing the orbital environment in an effective and safe manner for the benefit of all, not limiting the utilization which will inevitably happen if we do not institute responsible norms of behavior and accountability.

Charity Weeden
Vice President, Global Space Policy and Government Relations, Astroscale

The scope of anti-collaborative agreements will be reduced. As space organizations and governments seek to encourage greater collaboration, we expect to see existing limitations (such as ongoing export restrictions on space-specific hardware or barriers that slow the sharing of classified data between allied nations) start to fall away. In many cases, this may require policymakers and administrators to start to reduce (or find ways to work around) collaboration-limiting policies and regulations. The Technology Safeguard Agreement in place between the US, New Zealand and the UK is a strong example of allies overcoming regulation to drive collaboration. At the same time, we expect the influence of other regulation – such as the US Wolf Amendment – to gradually reduce, enabling greater collaboration with non-traditional partners.

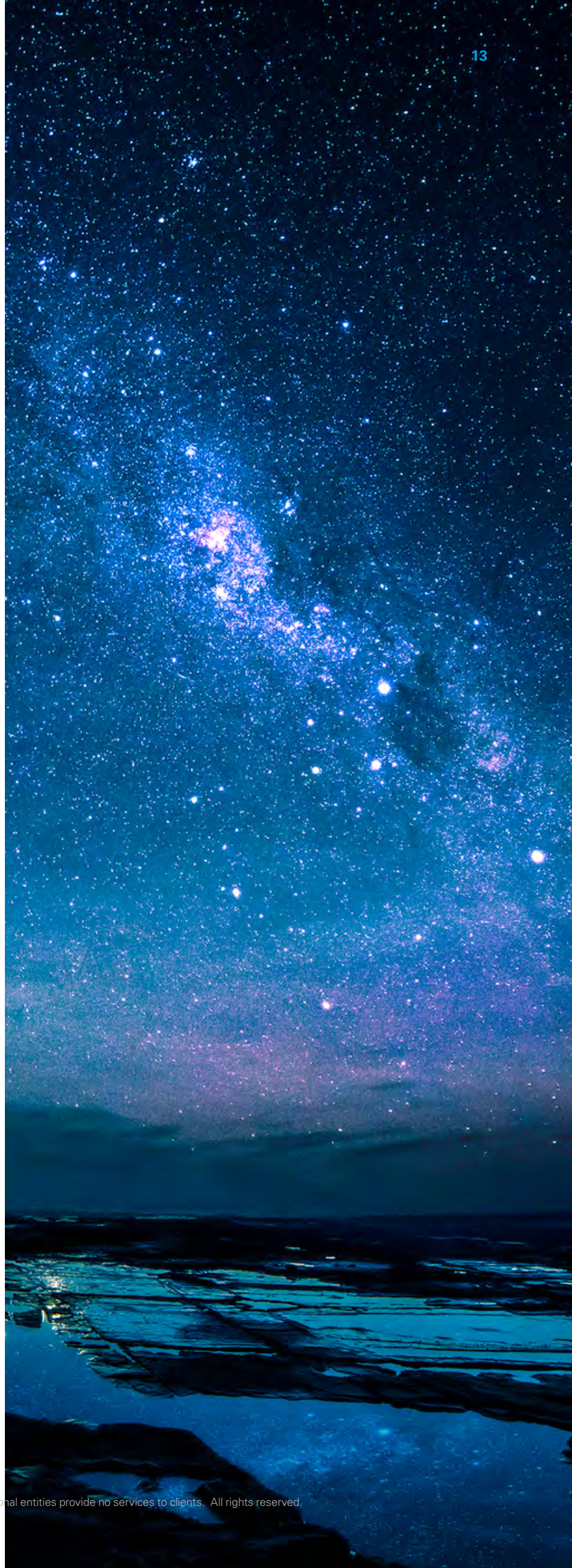
> Moving forward, I believe we need someone to provide guard-rails that ensure freedom of action. The problem is that space issues are often overclassified. But if we want to properly highlight what irresponsible behavior looks like, we will need to have these conversations in unclassified forums.

Victoria Samson
Washington Office Director, Secure World Foundation

Organization structure, workforce and training will be reimagined. Defense organizations need to evolve from 'industrial age' organizations into 'information age' ecosystems. And that means capabilities and decision-making frameworks need to change. As social expectations shift and governments redefine the meaning of 'defense' in a digital era, it is expected to see a range of new challenges and potential points of conflict and partnership to emerge. And each can manifest differently, impacting different players and sectors. To efficiently and effectively evaluate and address these rapidly-emerging issues, therefore, the space domain needs a framework of norms, policy and doctrine that is flexible enough and robust enough to meet a range of potential situations.

> Our defense departments and our defense businesses are really still set up for the industrial age. They were set up for the Navy, Air Force and Army. But we have transitioned into the information age – cyberspace, space, electronic warfare, information operations. Conflicts in cyberspace are over in seconds. It begs the question, is our infrastructure of bureaucracies set up to handle that type of conflict?

Lieutenant Colonel Henry Heren
US Space Force,
NATO Joint Air Power Competence Centre



Key takeaways for defense:

Actively work towards consensus and collaboration.

While focusing on existing forums and on new capabilities (such as proximity operations), look for higher-level platforms that may lead to more impactful and timely results. Consider reducing classifications and integrating unclassified intelligence data from commercial sources.

Get the policy right in the short term.

Historic players may want to focus on encouraging iteration; emerging players may want to identify areas where they can lead and they are willing to share. Create demand signals for industry up front so they can invest accordingly.

Look for dual-purpose opportunities.

Work with national space agencies and others to develop local industry and emerging capabilities. In particular, look for dual-purpose opportunities (there is little difference between the sensors for monitoring carbon levels and those for missile detection, for example).

Leverage industry capabilities and capacity.

Adjust the risk appetite and encourage 'fast failure' in order to enable faster iteration and reduce time to development by using industry capability and capacity. Consider seconding defense personnel into primes and 'NewSpace' companies in order to encourage best practices and two-way learning. Also leverage civilian R&D capabilities including university partnerships.

Elevate space as a defense domain.

Fully integrate space as part of the joint forces in order to ensure they are interconnected and interoperable in the future. Like other domains, space requires unique capabilities that cannot easily be repurposed from other branches of defense or government.

Look for new partnership opportunities.

Expand existing partnerships and explore opportunities to work with more international partners where possible. Start with areas where there is clear alignment of objectives – Space Traffic Management, for example – and build from there.

Key takeaways for the public sector:

Encourage rapid procurement.

Redesign procurement models across government and defense to accelerate requirements development through to contracting. Be prepared to adapt your risk appetite and 'pick winners'.

Facilitate and incentivize innovation.

Remember that government investments are key to growing the space industry. Consider how these can be expanded beyond grant programs into contracted products and programs and government ventures to provide early capital and accelerate technology development. Leverage cooperative research and development by providing facility access to emerging companies for testing and guidance.

Encourage cooperation through treaties and regulation.

Avoid unnecessary regulation and siloed thinking. Look for new treaties and agreements that will support international collaboration, such as the 'Technology Safeguards Agreement' model between the US and a number of allied partners.

Modernize civil legislation to prepare for new capabilities.

Prepare for the development of new space capabilities by reviewing existing and related civil laws in areas such as privacy (improved resolution), spectrum licensing (mega constellations), national and cyber security. Collaborate internationally to align future policy.

Invest in the future workforce.

Identify and assess the national skills and capabilities required for success in the space domain. Consider how local, national and regional policies could be adapted to encourage skills inflow. Encourage relevant skills development from secondary schools through to entry into the workforce.

Coordinate on Space Traffic Management.

With the space domain increasingly dominated by commercial spacecraft, the need for defining policy on managing space traffic and collaborating and coordinating internationally is essential to avoid collisions and manage spectrum.

Key takeaways for industry:

Rapid iteration is key to success.

Explore opportunities to rapidly cycle capabilities (both hardware and software) in spacecraft development and operations. Leverage industry standards to improve on innovations achieved by others. Consider diversified architectures as a route to risk mitigation.

Expand your value proposition.

Consider how dual-purpose technologies can help broaden the business case and increase awareness and understanding of the benefits of the space sector across a wider range of government stakeholders. Think about how your solution can help solve broader policy objectives.

Build local teams to drive innovation.

New space companies, new markets and even adjacent industry sectors have a lot of ideas and value to offer within the space domain. Use local teams to identify emerging capabilities in AI, advanced materials and manufacturing that can be leveraged in the space domain.

Take the lead on sustainability and transparency.

From requirements development and design through to decommissioning and de-orbiting, consider how your organization can contribute to space sustainability. Similar to the move to renewables on Earth, industry has an opportunity to take the lead.

Build the ecosystem and value chain.

If you are a large company, consider how you can serve as a 'mentor' to emerging ventures. Support them in obtaining clearances (often a significant barrier to new companies). Help grow these companies into future ecosystem partners.

Bridge the 'user-provider divide'.

Avoid developing technology in search of a solution and focus on the practical needs of your customers. Deeply understand your clients' needs. Leverage forums like Space Works, the SBIR and the Defense Innovation Unit to build your network.

Voices

Leaders of Space in Defense

KPMG International and the Space Foundation teamed up to talk to nearly two dozen industry and defense leaders at the highest levels of the space domain.

We asked them about their views, opinions and predictions on the future of the domain over the short, medium and long term.

General John W. "Jay" Raymond
Chief of Space Operations,
US Space Force

ON PARTNERSHIPS

The space domain is inherently global– it has the ability to unite global partners like no other domain. That is why we are putting partnerships front and center.

Space has historically not been as highly valued as other domains from a national security perspective because it was largely seen as being benign. As space becomes more contested and congested, the need for partnerships with our international allied partners, our inter-agency partners and our commercial partners has increased significantly.

Within the Space Force, we have made great strides in strengthening and expanding our partnerships. In a very short time, we have gone from having virtually no partnerships in the national security space to creating a vibrant ecosystem of partners and allies. We are already seeing the benefits of those collaborations today.

When the Department of Defense re-established US Space Command, the focus centered on creating combined C2 (command and control) centers where allied partners and US personnel worked hand-in-hand – operating together, training together, wargaming together and exercising together. In supporting this effort, the Space Force has evolved its partnerships with allies to include building capabilities together, and doing so at reduced cost and increased speed.

In the mid-term, I believe that our partnerships are going to start paying even larger dividends as our collective capabilities grow and we continue developing capabilities together.

Indeed, I firmly believe that our best opportunity to address those challenges we face in the near-term, mid-term and long-term as a domain lies in our ability to develop strong and robust partnerships.

Victoria Samson
Washington Office Director,
Secure World Foundation

ON MULTILATERAL COOPERATION

Where people go, conflict inevitably follows. The problem is that the multilateral forums that have been created to handle this topic aren't making any progress.

We are seeing initiatives like the Artemis Accords, but that doesn't include the Chinese or the Russians. And the commercial sector has been pretty proactive on this with initiatives like the Space Safety Coalition which was put together by outside operators to formalize how they are going to operate safely in space.

Where I see the most hope for multilateral agreement right now is in Resolution 75/36 at the UN General Assembly, put forward by the UK at the end of last year. It hopes to find some consensus on what member states determine to be a threat in space security and stability, to determine what constitutes responsible behavior, and then how we move forward. My hope is that this effort will re-frame the conversation somewhat and allow us to accelerate progress.

Air Vice Marshal Harvey Smyth
CB, OBE, DFC, Director Space,
UK Ministry of Defence

ON LEVERAGING COMMERCIAL CAPABILITIES

There is a massive amount that Defense Space can learn from the commercial sector, and there are definitely capabilities in the commercial sector that Defense could leverage.

In many cases, there's really no need for me to do the R&D, build the kit and get it launched; somebody else is already doing it. In fact, as we properly examine Defense's requirements, we are finding that a high percentage of them can be satisfied by simply accessing the commercial market. There is one slight problem though – if I can buy it, so can everyone else. So whilst this approach presents opportunity, it could also pose threat.

There are lots of considerations that go into those decisions and you need to properly understand what you need to own, and what you don't need to own. Some capabilities might be important to you to own as a strategic deterrent, for example. There are others you might want to move into the ecosystem in order to encourage the development of your own sovereign space sector. There are lots of facets to the debate.

Ultimately, however, I believe the decision comes down to your ability to maintain the operational edge. That's where you need to really focus your sovereign capability.

Major General Michel Friedling
Commander,
French Space Command

ON DEVELOPING NEW CAPABILITIES

Our ambition at the French Space Command is really to maintain our freedom of access and our activity in, from and to space.

That means we need to be in a position where we can respond to any threats to our space capabilities – not only the military capabilities, but also those capabilities that are strategic to our interests and those of our partners.

It's not an ambition you can accomplish in a year or two. It's a 10-year timeframe. And right now, we are working to rapidly develop space surveillance capabilities and, perhaps most importantly, the capability to protect and defend our space interests.

For example, we recently launched a project called YODA which is a demonstrator for RPO (rendezvous and proximity operations) and space surveillance in GEO orbit. The concept involves putting satellites into GEO orbit to essentially patrol the orbit and report back on what is going on there. Eventually, it will also be able to neutralize those threats if necessary. It's just a demonstrator for now. But we intend to have full capacity by 2030.

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Air Vice Marshal Andrew Clark
Chief of Air Force,
Royal New Zealand Air Force

ON DEVELOPING SKILLS AND CAPABILITIES

New Zealand is a fairly new player in the space domain. If you look at the NZ specific environment, just looking at the search and rescue region we are responsible for supporting, it literally goes from the equator to the south pole, so you can see the challenge. So part of our focus is really on upskilling people around the opportunities, risks and considerations in the fast-moving space technology sector.

At this stage, there are two categories of people development that requires our focus. One is the specialist knowledge sets, around those people who are going to be the people we reach for as specialists who understand the domain. The second is one where we are going to have to grow a basic level of appreciation among as many people as possible to understand the broad risks and opportunities around the space domain.

Simply put, we need a small set of space specialists, and a large cadre of space-savvy professionals within the wider defense force.

Air Commodore Phil Gordon
Director General Air Defence and Space,
Royal Australian Air Force

ON INTEGRATING SPACE INTO THE DEFENCE DOMAIN

In a modern defense force, I don't think any domain or any mission can be neatly segregated and put under the command of only one individual. The days of owning everything you need to do your job are largely over. Everyone's mission is going to be enabled by everyone else. So I think it's about being clear about the accountabilities, responsibilities and authorities and assigning resources, generating expertise, and achieving a critical mass so that the people that are responsible for our outcomes can drive those outcomes – without having to own every part of the value chain.

And that's where I think the real sophistication of our future approach will be. Not by ensuring there is one Australian space organization that owns everything related to space. But rather by ensuring we have unambiguous leadership with the authorities and levers in place to take a forward thinking enterprise view so we can effectively coordinate, shape the behaviour, drive the standards, influence the integration and help set the priorities, such that it all comes together in a way that adds value to the Australian Defence Force (ADF).

That, of course, leads to some challenging questions. Where does military or defense responsibility end? How far do we go into national security? Are we just focused on military operations or are we focused on all of defense? Are we responsible for safeguarding continued access for commercial and other government capabilities in space, should they be threatened? We haven't landed on an answer to those yet. But it is a journey we have started.

Having that mix of defense-owned and commercially-delivered services adds to the resilience and the robustness of our capability. A very complex and diverse web of both military and civilian contracts is much harder to attack than one single piece of equipment that holds all of your capabilities.

ON BUILDING THE ECOSYSTEM

It's going to take a lot of trust and collaboration to accelerate innovation in the space domain. Defense organizations like Space Force will need to create a North Star vision that makes funds available by mission area, not by program of record. The big primes need to be mentoring the smaller companies, bringing them in as part of their infrastructure and helping them navigate the system. The little guys need to be finding those pockets of good customer interactions – areas like the SBIR and space works are often good entry points.

We really need to be Sherpas for those companies – whether it is through organizations like GXO, through the primes or through groups like the Defense Innovation Unit – we need to be actively encouraging these pockets of innovation and helping them join the ecosystem.

Mandy Vaughn
CEO, GXO Inc and former CEO,
VOX Space LLC

Lieutenant Colonel Henry Heren
US Space Force,
NATO Joint Air Power Competence Centre

ON DEVELOPING NORMS FOR SPACE

There's a lot of interest in finding and establishing international norms for the space domain. But how those actually get fleshed out will be interesting. Who signs off on them? What are people willing to sign off on and what aren't they willing to sign off on?

I think the issue now within NATO and the 5Eyes is that there is an increasingly uneven playing field between members. Some nations like the US are really reliant on their own indigenous space capabilities, while other nations are using capabilities that are commercially available or being shared. The uneven playing field means it is difficult to forecast how this is all going to net out.

Steve Isakowitz
President,
The Aerospace Corporation

ON THE NEED FOR STANDARDS

One of the big challenges in space today is that when someone builds something, it is often so unique that they are the only operators with that capability. But that makes it very difficult for potential partners to onramp and offer up new innovations and ideas. In the future, I expect we will be building in orbit – putting things together, repairing them, moving them around and refueling them, all while in orbit. That will require a certain level of interchangeability going forward.

If you imagine a world where we are sending humans to Mars, the most important commodity will likely be fuel. If we can develop fuel depots that allow any rocket with the right docking adapter to come up and fuel at the depots, we can open the market up to commercial and international participation. That's the kind of advances that are starting to take shape. But they require a much greater level of modularity and standards.

ON THE IMPORTANCE OF SPECTRUM

There is increasing discussion on the need for space infrastructure to become more standardized and modeled more like open architectures where you can plug in and add the intelligence. We are likely to see a lot more software defined payloads. Now, there are laws of physics involved which will not allow you to just shift through all bands with an efficient architecture, but how you use the capacities will be an enabler. I think the one big gating item that might stand in the way, however, is the spectrum. It's a finite resource. So whoever is in a good spectrum position and can maintain that will likely have an upper hand in terms of creating value.

Amit Somani
Chief Strategy Officer,
Al Yah Satellite Communications Company (Yahsat)

Thagoon Kirdkao
Chief of SSA/STM Education and Network, Advisor to the Subcommittee of SSA/STM Thailand, previously Director of Space Affairs Division,
Royal Thai Air Force

ON DRIVING MILITARY AND CIVILIAN CONNECTIVITY

The relationship between civilian and military space activities is key, particularly as we try to share capabilities and experiences between the two.

Our National Space Board is Chaired by our Deputy Prime Minister and it includes not just military but also civilian viewpoints. And that board is in charge of ensuring connectivity and links to capabilities between different sectors in Thailand.

At this stage, the Ministry of Defense is mainly focused on the policy level and the strategic level, while the Space Operations Center is focused on the operational level. But I am confident that is evolving as we mature in our capabilities.

ON THE NEED FOR DEFENSE ACTIVITY

I expect the presence of human beings in the space domain will start to grow exponentially. And I believe we will quickly start to see more and more businesses and people working in space – bringing new benefits to Earth and increasing the dependence that people have on space.

That's going to be a big challenge for the defense sector – how to make things safer, how to protect national interests, how to protect the systems, and so on.

Major General José Vagner Vital
Executive Vice President,
Brazilian Air Force

Dr. Yasuhito Fukushima
Senior Research Fellow,
National Institute of Defense Studies, Japan

ON SIMMERING SPACE WARFARE

Space warfare – in the broad sense – is already happening. We've seen attacks on ground segments and link segments of space systems. And while there have not been any confirmed reports of attacks on the space segment – the satellites themselves – it is not mere conjecture to think that an attack could occur there at any time. Not just the destruction of a satellite, but there are other methods of attack such as laser and microwave, electromagnetic pulse and capture and orbital changes. There are countries that already possess these capabilities.

Shlomi Sudri
Vice President and General-Manager,
Space Division, Israel Aerospace Industries

ON THE NEED FOR A NATIVE SPACE PROGRAM

We are seeing more and more markets re-thinking the question of whether they need satellites when they can buy the pictures commercially?

The increasing answer is that a sovereign satellite provides the optimal independent solution for flexible use during any geopolitical situation without third party considerations.

At the same time, a lot of countries want to build a space industry for two main reasons – it encourages the industry to develop high-tech and high-end capabilities and it drives more young people to STEM academic studies which brings economic benefits.

Moreover, the fact remains that people like satellites, space and rockets. It's very exciting.

IAI is supporting the Israeli space ecosystem to obtain new capabilities and with academia to ensure the right skill sets are available.

Kari Bingen
Chief Strategy Officer,
HawkEye 360, and former US Deputy
Under Secretary of Defense for Intelligence
and Security

ON GETTING VALUE FROM THECOMMERCIAL SECTOR

The commercial space ecosystem is rapidly changing. And many defense organizations are challenged in understanding how to maximize the value and contribution to mission that they can get from the commercial sector.

What is clear is that the relationship between government and private sector has changed. The commercial sector no longer needs the government to serve as an 'anchor tenant' for the development of new capabilities. There is tremendous private capital being invested into new space ventures. As an example, our company – HawkEye 360 – is planning to have up to 10 privately-funded satellite clusters (of 3 satellites per cluster) on orbit over the next two years, introducing a new commercial radiofrequency (RF) data layer and analytics for the government to leverage.

There is a cost avoidance benefit to the government, but in order to shape these investments, the government must signal its demand and demonstrate a willingness to purchase commercial data and services. It should emphasize experimentation and exercises—leveraging different data distribution pathways, new models for tasking, and novel ways to better integrate government and commercial data.

It must also find ways to leverage these commercial capabilities on time scales that are relevant – not only to the defense missions and users being served, but also matched to the pace of commercial innovation. Our model centers on an ability to put up a higher quantity of lower cost satellites on faster timelines – building resiliency across an architecture. This pipeline creates frequent opportunities for technology insertion and experimentation, and enables us to focus on what can be done with this new commercial data and analysis – delivering knowledge and mission impact.

Rick Ambrose
Executive Vice President,
Lockheed Martin Space

ON INNOVATION

People innovate, not organizations. And one can get just as much innovation from a big company as you can from a small company. The difference is that small companies focused on niche areas can often be highly innovative and take on more risk since the consequences of failure is much smaller. Big companies tend to face bigger risks – often in the form of penalties or customer consequences – which means they innovate differently.

That's why we play in both dimensions. We've got robust R&D investments on our own side. And we have venture funds that invest in startup companies with a technology at a risk point that we could accelerate into our customers. It's this convergence of innovation between large companies and small companies that, we believe, will really power this domain forward.

Given this rate of continuous innovation, I believe we need to move away from building fit-for-purpose solutions and instead move towards capabilities that are able to rapidly change or upgrade. Our partners are increasingly going to need architecture that enables mission flexibility over time. So we need to be designing systems that can flex, expand, grow and evolve over time. That means it needs to be more connected, more agile and more adaptable.

ON PROCURING INNOVATION

Procurement and innovation cycle times are out of synch. China demonstrated they could disable satellites in 2007, however it wasn't until 2015 that the US launched the third offset strategy focused on new technologies and innovation, resulting in what is now NSDC [National Space Defense Center].

Part of the problem is that it takes about 5 years to move from a request to Congress for funding through to an operational program. But Moore's Law suggests that innovation will have cycled two to four times while that funding was moving through the system. So now you have earmarked money that needs to be spent on something that may not exist anymore.

Paul Graziani
CEO and Co-Founder,
Analytical Graphics Inc (AGI)

Bill Gattle
President,Space Systems, L3 Harris Technologies Inc.

ON KEY ENABLERS AND INNOVATION

Currently, there is a focus on what the key enablers are going to be for operating in the domain in the future and I see two key thrusts. To start with, we need a ubiquitous network to provide zero latency connection. We then need a proliferated sensing network for space situational awareness. This will enable us to protect and defend high value assets, by knowing what is around them and with the tracking of hyper-flight vehicles. Ultimately, these two focus areas are going to enable a proliferated system well beyond LEO and GEO. The one thing we must get right in the near term though, is a standardized infrastructure that everyone can play with and interconnect through, just like the terrestrial cellular network.

Defense are increasingly bringing mission issues to industry to solve, to find the fastest, cheapest and most effective solution. Industry are coming up with very different and unique solutions to these problems which is also driving more innovation in the domain. Getting the standards right will enable this to all come together.

Rick Pitre
Brigadier-General (Retired),
Former Director General Space, RCAF,
Special Advisor Space,
Aerospace Industries Association of Canada

ON THE MEANING OF SECURITY AND THE NEED FOR STRATEGY

People often refer to big 'S ' Security as that relating to National Defense and Security, but we've seen most notably that Security comes in many forms: Energy Security, Food Security, Water Security, Transportation Security, Health Security and Climate Security. All of these will compound the challenges that nation states will face individually and collectively and space, given its vantage and persistence, will contribute to more precise alerting, awareness, planning and preparedness and the best responses to manage and mitigate. Increasingly, all security domains will merge and with this the need to ensure not only cohesion in the way space-based systems will operate, but their continuity in being able to do so. The traditional threats and actors have evolved and so too will nations in the ways they perceive and act to address them.

We need a clear and unequivocal space strategy that is underpinned by policy that is equally clear and enables us to develop plans that are prioritized, resourced and responsive to both the planned needs and unplanned circumstances we will face. Governments are no longer seen only as customers, but as providers and enablers for innovation and investment purposes.

Competition in space is intensifying. Countries who have been strong players in the past are upping their game as new players also emerge with equal ambition and plans to access and claim their piece of the global marketplace. If Canada is to remain competitive in space, it too must adapt in a more deliberate and concerted way with an overarching aerospace strategy that includes a clear and visible plan for space for decades to come. Every other aerospace nation has a national strategy to position their industries for recovery and growth, and to seize their share of the multi-trillion-dollar emerging aerospace-cleantech market.

ON CONGESTION

If left unchecked, Space congestion – which is a problem today and will be a bigger problem in the future – is particularly concerning for defense organizations.

We have an opportunity now to build new norms for space actors; how they act and what rules they play by. I believe the development of these norms will be a reason for celebration, because it will enable a future of utilizing the orbital environment in an effective and safe manner for the benefit of all, not limiting the utilization which will inevitably happen if we do not institute responsible norms of behavior and accountability.

Space Congestion is not just limited to debris. We're operating a space environment where there's a lot of traffic, access to space is opening up and launch costs are falling. That means congestion is going to increase. And there are so many different actors – traditional space players, industry, universities and even NGOs

The challenge is that this is not the same type of congestion we understood just one generation ago. Now we are seeing activities that don't necessarily follow your predictable Keplerian orbit. Satellites and missions are maneuvering more and performing various new missions for different space actors. So on top of space congestion, it's also getting harder to characterize and predict actions in space. That's a huge challenge when you have active defense operations working in that environment.

The question is, how long does it take to build up these new norms.

Charity Weeden
Vice President,
Global Space Policy and Government Relations, Astroscale

Debra Facktor
Head of U.S. Space Systems for
Airbus U.S. Space & Defense Inc.

ON AWARENESS

The pandemic made everyone – commercial, civilian and military – realize how much we rely on space for information and data. But while we recognize how critical these assets are to our entire global ecosystem – everything from financial data to weather, communications and sensing – there is a growing realization of just how fragile our space assets are. If I think about our position on Earth today, climate change is a civil space focus, however there's not a universal responsibility for the well-being of our planet. I see an increasing impact from climate change on National security and as a result a split role between defense and civil space to gather information and provide the space tools and technologies to manage it.

ON CONGESTION

Collaboration with our allies and with industry is essential to protecting our interests in space and ensuring freedom of action by creating new capabilities, sharing data and intelligence and executing coalition operations.

These partnerships are critical to bringing focus to the issues that are unique to the space domain, particularly space asset protection. So much of the innovation we're working on with government, with commercial companies is around asset protection, resiliency and multi-domain operations. These partnerships are going to continue to grow, particularly where there is opportunity to improve integration and increase system interoperability with our allies.

Roy Azevedo
President,
Raytheon Intelligence & Space

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