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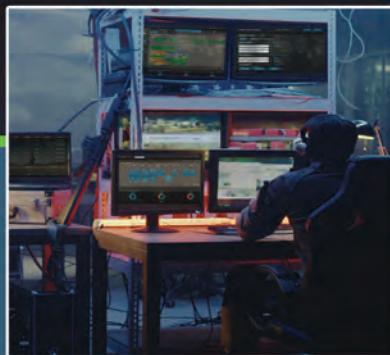
Global Military COMMUNICATIONS

Q&A Comtech

Mission in motion

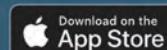
Q&A Viasat

Extending the life of assets in space



*Front cover photo courtesy of
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● ● Integrated capacity management and NewSpace technologies. See page 24

Photo courtesy INTEGRASYS

MARSS completes demonstrations with UK MoD, showcasing its NiDAR-powered C2 systems ●●

MARSS Group has successfully demonstrated its NiDAR powered Command and Control (C2) systems to the UK MoD – showcasing its ability to present multi-domain data on a single screen.

Over three consecutive days, on the Isle of Portland, MARSS Group played host to delegates from the UK MoD, demonstrating the effectiveness of its NiDAR enabled C2 systems across all four domains – air, land, sea and underwater, showcasing NiDAR 4D.

MARSS' NiDAR system seamlessly consolidates data from multiple sensors simultaneously, to provide a full tactical picture in a single stream. At the same time, the system, utilizing MARSS' proprietary Hybrid Intelligence platform, is able to autonomously detect, classify and track potential threats, as well as recommend an appropriate countermeasure to the operator.

Over the course of the demonstration, utilizing multiple sensors for air, land, sea and underwater detection, visitors were shown how NiDAR 4D leverages artificial intelligence and machine learning to detect and track all objects, across all domains, on a single screen – dramatically reducing the burden on the operator.

Following the demonstration, users were given the opportunity to experience, first-hand, how intuitive the NiDAR user-interface is, with minimal training required.

Mike Collier, MARSS' Business Development Manager, NATO, commented, "We were delighted to host multiple teams from the MoD, and show how MARSS NiDAR systems can autonomously manage the threat detection across all domains. While each group had different needs from a C2 centre, all the visitors could quickly understand the power of MARSS' next generation system, powered by NiDAR.

"NiDAR provides a world-leading evolutionary and agile approach to addressing emerging threats and can quickly integrate with new sensors and effectors to defeat them. We look forward to ongoing discussions around the MoD's future combat requirements, and demonstrating how MARSS can enhance national security by protecting lives and critical infrastructure."

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●● Mike Collier, MARSS's Business Development Manager, NATO



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FREQUENTIS C4i and Lockheed Martin unite to strengthen Australian national security ●●

AIR6500 is the RAAF's multibillion-dollar plan for an integrated communication network promoting seamless operability and connectivity across sensors, weapons, jets, and warships to protect against threats. Lockheed Martin was selected to lead the project in late August 2023, contracting 10 leading-edge Australian companies to support this mission.

As a supplier to Lockheed, Australian defence company, C4i, a member of the Frequentis Group, will provide its secure VOICE C2 technology. This secure communication system acts as a bridge, linking operators, radios, and telephony across the RAAF's operations. This integration will enhance the RAAF's ability to respond effectively in high-pressure situations.

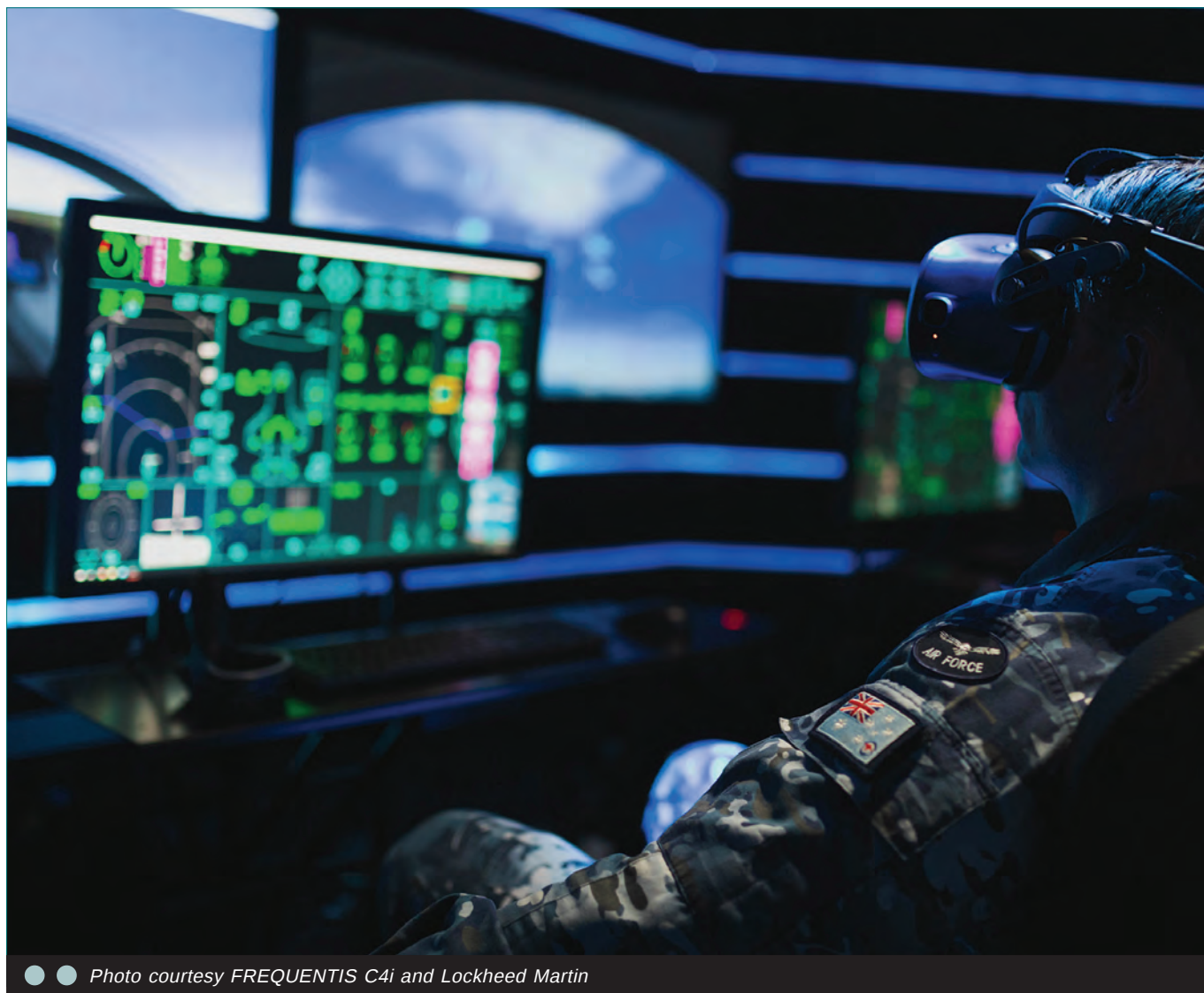
Together C4i and Lockheed have been contributing their expertise in the design, test, and integration phase for over 18 months before selection by RAAF from the final two suppliers. The goal of the project is to advance the systems that will seamlessly integrate with the next-generation Joint Air Battle Management C2 networks. These technologies are essential for enhancing situational awareness, improving rapid decision-making capabilities, and fostering interoperability across air, land, sea, cyber, and space domains.

"We are thrilled to be collaborating with Lockheed on AIR6500, building upon our successful partnership in the Air Battle Management realm," says Darren Gardner, Managing Director C4i. "During the design, test, and integration activities of the competitive evaluation phase, we have been able to showcase our abilities to advance the secure communication systems that will seamlessly integrate with the next-generation Joint Air Battle Management C2 networks. The collaboration outlines our dedication to supporting Australia's national security strategy by delivering advanced secure communication capabilities."

Leveraging the success of the demonstrated system, the pair will continue to develop the ecosystem with an intuitive HMI that connects operators while integrating various systems – including data, radio, telephony, and recording – from anywhere and at any time. This system will bridge classified and non-classified networks, aiding RAAF's air battle managers in making faster data-driven decisions to stay ahead of emerging threats.

"Lockheed Martin Australia has advanced a sovereign AIR6500-1 system solution that has been built from the ground up in Australia by Australians to safeguard Australia's national security and we are pleased to have contracted 10 leading-edge companies to support this mission, including the VOICE C2 solution from C4i," says Warren McDonald, CEO, Lockheed Martin Australia and New Zealand.

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●● Photo courtesy FREQUENTIS C4i and Lockheed Martin



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● Daniel Faber, Orbit Fab's Founder and CEO

Orbit Fab: Extending the life of assets in space ●●

We spend a great deal of money getting satellites into orbit only to disable and destroy them after a few short years. Once we can refuel them, the paradigm will shift dramatically. Not only will on orbit refuelling reduce upfront capital, but it will also vastly improve utilization and extend the lifespan of the satellite. We interviewed Daniel Faber, Orbit Fab's Founder and CEO, to find out more about how his company will revolutionize the way we use our space-based assets.

Crispin Littlehales, Executive Editor, Satellite Evolution Group

Question: Gas stations in space...easy to say, very difficult to do. What inspired you to take on this massively complex endeavor?

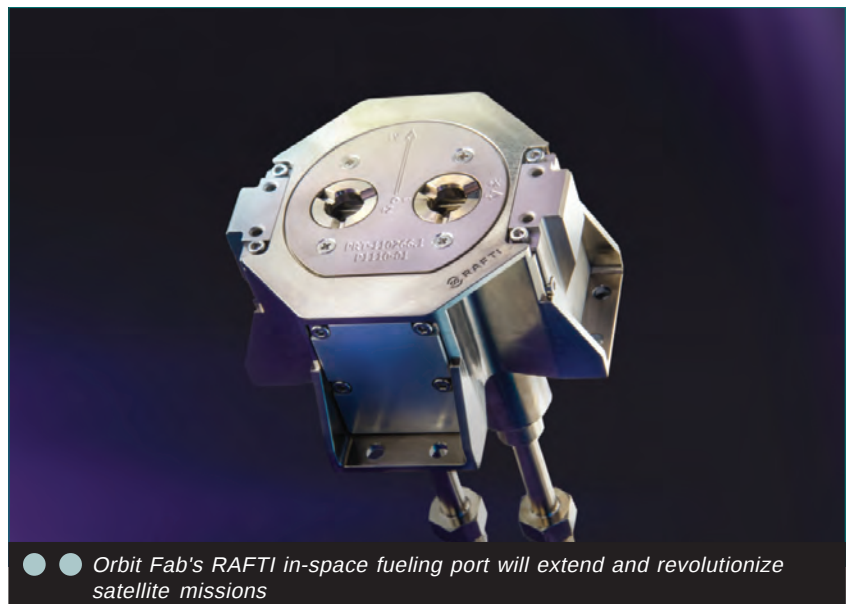
Daniel Faber: When I was a first-year undergraduate student looking for something that would be beneficial to humanity, I decided that getting humans off Earth would address a bunch of existential risks and probably make for an interesting career. I wrote down a list of industries that might pay for the first permanent jobs in space—tourism, mining, and space-based solar power. I focused on all things relating to asteroid mining and that led me to an engineering degree; the building of a dozen satellites; and the wherewithal to create companies that could lead to permanent jobs in space.

For a few years I was the CEO at Deep Space Industries working on technologies that would eventually be strategic to asteroid mining. We bought a small thruster to move satellites around in orbit and then started building a line of thrusters. When the company was acquired by Bradford Space, I ran a bunch of different business models looking at what was interesting and talking to some of those customers we'd had for the space propulsion systems. I asked them, "What would it be worth if we had extra fuel in orbit and how much extra revenue could you get from one kilogram of fuel?"

I was blown away when the answer came back: more than a million dollars of marginal revenue per kilogram of fuel. After hearing the same answer eight times in a row, I decided to drop everything else and concentrate on this difficult business problem. It's been five years since I founded Orbit Fab, and we've made some progress.

Consider this: everybody's in a paradigm right now of not having the ability to refuel and not being able to touch an asset once you get it into space or on the moon or on an asteroid. Think about what can happen if you can do repairs or

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● Orbit Fab's RAFTI in-space fueling port will extend and revolutionize satellite missions

maintenance. You can then start to treat satellites and other spacecraft like an asset that increases in value. At that point, the business models change. The financing models change. The operating models change.

Question: If you can protect and preserve these satellites, will there be fewer of them going up into space and will that have a positive effect on space debris?

Daniel Faber: It's hard to run a garbage collection service if you can't refuel the garbage truck. That said, I don't expect that on orbit refuelling will mean fewer satellites. If you look at economics in history, when we make things more efficient and bring down the costs, people end up finding more utility.

We must use the new capabilities; make it safer and more reliable so when there is refuelling, you can have the garbage truck service and clean up the debris. Even if you have thousands of assets in orbit, they can move out of the way and not worry about burning up their fuel. If satellites can't be removed, maybe there can be a recycling center and a junkyard in orbit. Again, the whole paradigm changes so we can make a safer environment whilst finding a thousand or a million times more utility by having more activity in space.

Question: In addition to the RAFTI fuel port, Orbit Fab has plans to create a whole refuelling infrastructure. Can you describe all the pieces and how they will work?

Daniel Faber: In theory, it's very simple. Today, we are focused on getting fueling ports on satellites. We plan to work with suppliers who will manufacture fueling ports as drop-in replacements for the valves that satellites currently use. When our clients are equipped with the ports, the next step is to provide a vehicle in orbit that can deliver the fuel. That shuttle will have the guidance and navigation capabilities necessary to maneuver and it will also be able to dock to the ports and transfer the high-pressure fuel. Of course, the shuttles will run out of fuel, so we'll also have fuel depots which are relatively lower cost large tanks.

Question: What kinds of fuel will you be providing and how are you acquiring those?

Daniel Faber: While launch vehicles use cryogenic propellants, satellites require storable propellants that don't boil off or

degrade. The most common of those is hydrazine, which is a mono propellant that you put on a catalyst and as it burns it decomposes. You can get decent fuel efficiency and a good high thrust. The second most common is xenon which is a noble gas. You put xenon through an electric propulsion system—effectively a particle accelerator—and you get much higher fuel efficiency but very low thrust.

Hydrazine is produced by chemical manufacturers and is not difficult to acquire. On the other hand, xenon is a trace composition of the atmosphere—one gram per 1000 tons of air—and is extremely rare. It gets produced on the back end of air liquification plants used by big industrial companies making gases and Orbit Fab has good relationships with those companies. As context, about 50 tons of xenon is produced every year and the space industry uses maybe 20 percent of that.

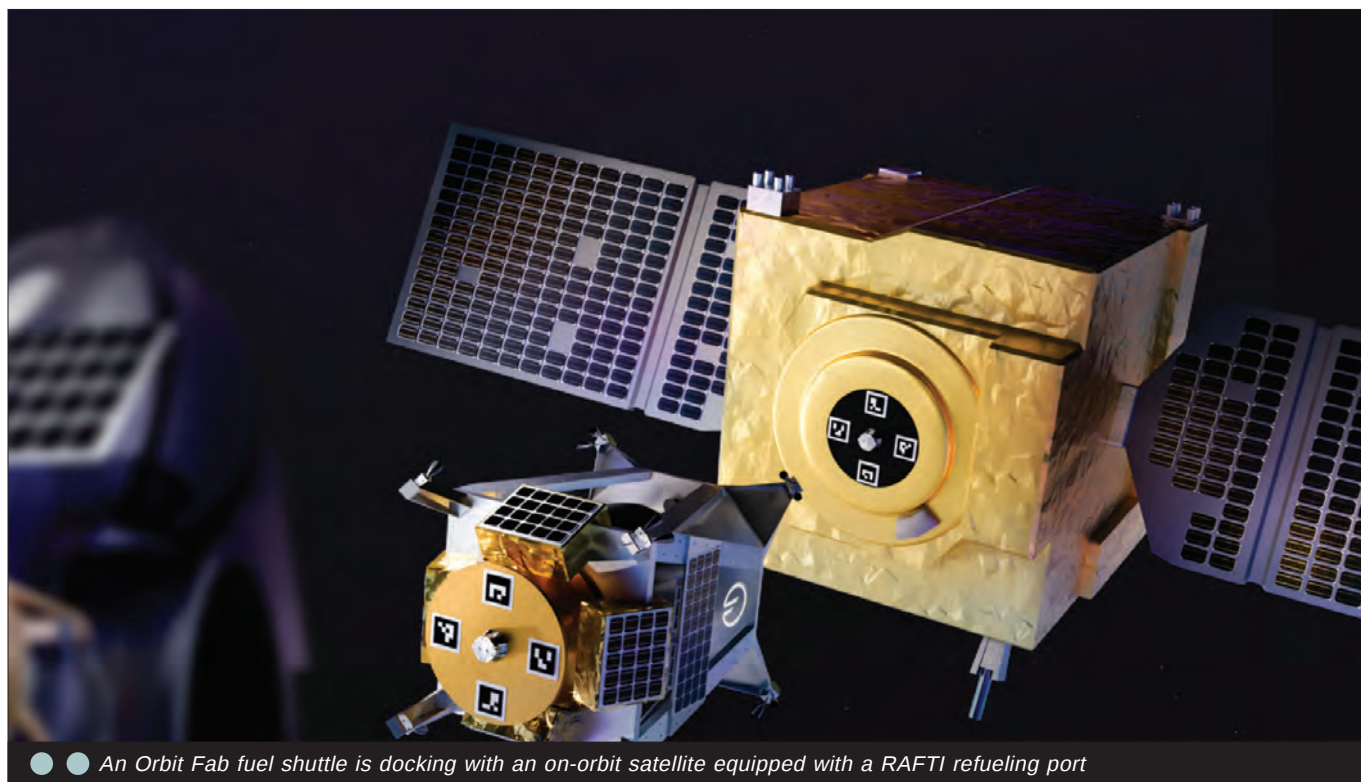
Question: The World Economic Forum has named Orbit Fab as a "Technology Pioneer". Are you in a league of your own or are there other companies that are in the space refueling business?

Daniel Faber: There are several space companies that the World Economic Forum has selected as tech pioneers. When it comes to refueling though, we are in a unique position. The industry need has been realized with the company's growth. Currently, I think we are the thought leaders in satellite refueling, but there are other people looking at what they might do as this is destined to be a competitive marketplace.

Question: What is Orbit Fab's timetable for the creation of a space-based refueling architecture, suite of delivery systems, and fuel options?

Daniel Faber: We are contracting with the US government to make the first delivery in 2025. We already have one fuel depot in orbit, and we did two tests for the interfaces and for pumping the fuel in zero gravity on the International Space Station (ISS). We are also the first private company to resupply the ISS with water. We did all that the first year that we were operating in 2018 and 2019. We worked very closely with NASA on what the requirements were and how to make everything safe. NASA said it would take two years to get through it, but we completed everything in four and a half months.

When we closed our seed round, we realized that we needed



● ● An Orbit Fab fuel shuttle is docking with an on-orbit satellite equipped with a RAFTI refueling port

to fly our fueling port and use it on the ground at the launch site, which is the most dangerous time because there are people around and you're dealing with very highly energetic fluids. We went through the entire range of safety requirements and then flew our depot to orbit so that it would have flight heritage. That was a six-month development program. We are not afraid to progress quickly.

We haven't done much 3D printing yet. It's been easier to do the usual milling and machining. We build some of the fuel systems here in house and build the fueling ports as well. But we subcontract out for the spacecraft bus and the propulsion systems. We have a lot of suppliers who are experts in what they do. We tap that expertise and focus heavily on the refueling parts.

Our first contract was with NASA, the second was with the National Science Foundation, and the third was with the Air Force. Right now, our biggest contracts are with the Space Force. We are selling fuel to the US government through the Defense Innovation Unit. We have a small office in the UK as well and a contract with the UK space agency. Then, too, we have commercial customers so there is quite a range.

Question: What are your biggest technological and business challenges?

Daniel Faber: The biggest challenge, honestly, is the timing of the market. We are riding on the back of all the rendezvous and docking work that has been done by NASA and DARPA as well as other agencies. A lot of technology was already there when we formed the company. There were 7 or 8 companies that were working on the tow truck, garbage collection, tugs, or life extension where they attach and take over the thruster—those types of things. Now there are almost 200 companies.

The paradigm has changed. Everyone believes that satellite servicing is inevitable, and they can see the huge value that creates. When we started the company, we were asking investors to take a risk on that. Now we feel as if we nailed it in terms of timing, but I still worry about it. We need to spend a lot of capital upfront and then wait until people have the fueling ports and are ready to be refueled. Our business is all about closing that gap which is not trivial. The fueling ports must be very reliable, the docking system and the navigation has to be impeccable, and we must make certain that everything works and that we can justify the investments that are needed.

Question: How will Orbit Fab revolutionize the way spacecraft operate. What exactly is going to change?

Daniel Faber: Nobody knows for sure. It's like asking someone in 1985, "What is the internet going to do?" Back then, when the protocols had barely been created, no one knew about social networks or advertising potential or search engines. That's the situation where I liken it to what's going to happen in the space industry.

Look at the vacuum pump. Once it became accessible, you could take air out of a jar which sounds completely useless. What do you do with a jar with no air in it? The answer is all sorts of things—vacuum refrigeration, vacuum packaging, freeze drying, and many chemical processes that operate better when you have a vacuum unit with vacuum tubes. Vacuum technology eventually brought us to computers.

Now we have access to zero gravity. What do you do with that? Again, the answer is plenty—you can contain materials without touching the walls, you can remove buoyancy forces, you can mix materials that would never mix. The list goes on: you can create such a quiet environment that crystals will grow in interesting ways; materials can be combined and layered and do things that we've never thought of before.

Nobody knows what the limitations are because we have no experience but when that comes online, we'll see the potential unfold. It will be possible to manufacture enormous structures in space, because you won't have the limitation of gravity. You will be able to manufacture incredibly pure new materials and

create things you can't make on Earth. Raw material feedstock will be sent back to Earth.

In time, more and more of the manufacturing processes will be done in space because if you need the first and tenth steps to be done in zero gravity, you'll do all the other steps there as well. Over the next 50 years, industry will start to move into orbit to the point where we'll probably save the planet because instead of pumping greenhouse gases and burning oil on the ground, we'll move industry off Earth and that means taking 10 gigatons of carbon emissions off Earth. That's the future of humanity.

All these pieces of infrastructure are fundamental to that end and fuel is one of the most critical pieces of the puzzle. The ability to inspect, repair, and upgrade satellites; the ability to gather trash, run a garbage collection service and do recycling; the ability to run a manufacturing service and then distribute to other places in orbit; the ability to get to an asteroid, get back, and get that material to a refinery and then elsewhere; and the ability to fly low at the top of the atmosphere where there's drag—all of these require thrusting and fuel.

From a national security perspective, you want to be able to appear and disappear without warning, to be mobile. Look at the history of conflict. Whoever has the best maneuverability wins. That's what we aim to enable with on orbit refueling.

Question: Looking out over the next 1 to 5 years and beyond, what do you see as the future trajectory for the company?

Daniel Faber: We are focused on selling the fueling ports, getting those widely adopted, and making sure they are reliable and function with all the propellants under the different pressures and temperatures. The second thing is to get the fuel shuttles flying along with the depots. In five years, I expect all that to be fully operational.

In ten years, I expect us to be heavily investing in building refineries in orbit. We can launch water and turn it into hydrogen or oxygen or even hydrogen peroxide. Once you throw in a hydrocarbon, you end up with a huge range of chemicals. We want to take material such as methane from the commercial space stations and recycle that for other chemical processes. So, the future of Orbit Fab is to be an industrial chemical supply company and to have the refineries in space.

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● Daniel Faber, Orbit Fab's Founder and CEO. Photo courtesy Orbit Fab



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● ● Daniel Gizinski, Comtech's Chief Strategy Officer

Partnering with the Department of Defense ●●

The US Department of Defense (DoD) is changing the way it does business with the goal of building out all domain communication capabilities as swiftly and effectively as possible. Partnerships between the DoD and commercial satellite communication suppliers are solidifying as both sides grapple with myriad challenges. Daniel Gizinski, Comtech's Chief Strategy Officer, provides a first-hand look at how his company is turning feedback from the front line into software-defined systems and helping to future proof military communications.

Crispin Littlehales, Executive Editor, Satellite Evolution Group

Question: There has been a shift in the US DoD's approach to building out all domain capabilities. Can you explain how this new approach has impacted Comtech and other players in the SATCOM industry?

Daniel Gizinski: The DoD is starting to partner earlier and more thoughtfully with commercial companies. We are seeing an increased emphasis on funding research and development, testing, and evaluation associated with new capabilities. This includes trying out 70 percent and 80 percent solutions before deciding on how to progress forward. This provides a tremendous degree of flexibility in fielding new capabilities on an operationally relevant timescale. In addition, there is more emphasis on non-traditional contracts connected with things like Other Transaction Authorities (OTAs) that allow the government to procure things outside formal procurement rules. Leveraging these non-traditional contracting approaches is increasingly allowing the DoD to procure commercial capabilities more quickly and keep them in-step with the increased rate of commercial innovation.

There has been an unbelievable rate of change in the communications space over the last 10 to 15 years. It's difficult to go through a 5-to-7-year procurement cycle and come out on the other end into a market that looks so different than the one you started with but be locked into a solution that was defined a decade ago. On the commercial side of the industry, we have a lot of experience with starting to build a system and then continually innovating and introducing new capabilities into the project right up until final delivery, and then continuing to innovate. The DoD is starting to follow that same approach. For example, the Space Development Agency was established in 2019. It already has 23 satellites in LEO and estimates it will have another 1,000 by 2026. Ten years ago, that pace of change was unheard of – and so the solutions in the future must include contracting approaches that allow for procurement of as-a-service offerings that keep pace with the technology trends.

Question: Obviously, cybersecurity is a top priority. How can militaries rest assured that today's security solutions will continue to protect their communications, particularly in a wartime situation?

Daniel Gizinski: Cybersecurity starts with an appreciation for the user and the user experience. Comtech strongly advocates for the minimization of the cognitive burden on the user who has multiple mission critical jobs to do and cannot be memorizing 12 different passwords and constantly re-typing those in, and we see a lot of these methods designed to make a system more secure actually have the inverse effect, as users do things like writing down their passwords. There has been a lot of work on the development of other ways to do multifactor authentication including biometric identification.

I like to point to the evolution of the iPhone - where many of us were typing in long passcodes, but now use biometric data, like a thumbprint or face recognition. That's not only easier for the user, but it is also quite secure. We try to take the same approach to deliver a SATCOM system that is both secure and user friendly, which means designing cybersecurity in at the outset, in addition to the means to grow and scale.

When you look at the systems that are out there today, many of them were designed 10 to 15 years ago, and our understanding of the threat landscape has

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Q&A



Photo courtesy Comtech

changed dramatically over that period of time. For a customer that has equipment out in a remote location, often as part of mission-critical communications, it isn't practical to take the equipment out of the field for a month to send back for an update, so we've focused on delivering software defined flexible networks that can be updated and upgraded in the field without taking the system out of commission for a long period of time.

We understand the cyber threat profile is changing rapidly and we are committed to continually providing the latest and best capabilities. We are putting the right hooks into the solutions we are delivering today to ensure they remain resistant to evolving threats. In addition, we are helping drive adoption of the DoD's zero trust architecture framework, recognizing that there is a need to move security practices beyond just that external perimeter.

Question: The military in the US has a sprawling SATCOM infrastructure that is in part based on legacy systems and equipment that's 10-20 years old. Is there a way to bring these systems up to date?

Daniel Gizinski: There is a significant challenge in that the DoD has such a huge volume of equipment that they have fielded – which means any update results in the fielding of several different generations of a capability simultaneously. If you want to roll out a new capability, a new satellite terminal, or a new radio, there must be a way for that new item to be backwards compatible with the existing equipment. If not, you have separate stovepipe networks between the old and the new.

Comtech is partnering with various government customers to build adaptable software-defined systems that can easily blend legacy modes and the modern capabilities. That allows our systems to take advantage of the innovations in technology and the advances in the latest technology whenever possible and they still have the option to revert to legacy mode. Our software-defined systems are also designed to remain current as long as possible. So, our current systems are not only able to bridge to the previous systems they are also built to work well into the future.

Question: How are Comtech's MILSATCOM solutions fielded and tested? Is there a feedback loop?

Daniel Gizinski: We have more than 200 people within Comtech who directly support the various DoD organizations not only for cyber training and cyber skill development but also for engineering and operational support.

I've personally gone out on several different events with some of our government customers to see how things work in the field first-hand. It's a sobering realization to recognize the difference between using a system in an engineering lab in an air-conditioned environment where you have access to high-speed internet and a user manual versus being in a forest or a jungle or a dusty field. And while plenty of our systems go through a testing regimen to prove they can survive, it's critical they are intuitive enough to be used in an operational context.

We find that our customers benefit from this direct feedback loop of reporting operational experiences into the design team. This often provides us with design insights, as well as some new opportunities. A lot of our government users are very clever, and they find creative ways to use products that we might not otherwise have thought about. We are very thoughtful when it comes to collecting that customer feedback and finding ways to drive that valuable information into the next iteration of our products.

Question: Comtech has recently introduced a concept called "Insights at the Edge". Can you elaborate on what that entails?

Daniel Gizinski: There is a lot of convergence in the communications world, and Comtech is thrilled to be at the forefront of helping bring forward new blended, hybrid satellite and terrestrial networks. That being said, the broader satellite world today is still relatively stovepiped. For example, there might be a unique satellite modem for different military satellite constellations and then another system for a commercial constellation. The shift towards the software-defined architectures is enabling the collapse of that and Comtech recognizes that situation could be collapsed further.

Look at Earth observation or geospatial satellites, which have historically been of a different world than communications satellites. We've identified a lot of cases where the same terminal, the same modem, and the same ground infrastructure can be used to support both—creating a truly unique end-to-end solution. By blending different capabilities, we can create new systems that deliver new game changing insights and actionable intelligence.

There is also a critical operational value to be gained in the sense that some of these fast-moving customers don't have the option to carry multiple systems. Now, though, they can access geospatial Earth observation intelligence at the tactical edge without waiting for data to be pulled from a remote location,

sent back to the US, and then sent over that exact same SATCOM link.

At the end of the day, the modern warfighting concept assumes that almost all units are either on the move, or at the very quick halt. Reducing the number of systems that have to be accessible and simplifying the workload is a significant game changer.

Question: Comtech was just awarded a US\$48.6 million contract to deliver Enterprise Digital Intermediate Frequency Multi-Carrier modems in support of US Army SATCOM digitization and modernization programs. Can you provide a bit of detail about the technology and how it will be used to enable warfighters?

Daniel Gizinski: The Enterprise Digital Intermediate Frequency Multi-Carrier (EDIM) program is a core piece of the future DoD architecture and the shift towards all digital SATCOM. What that means is the flexibility built into the system enables both backwards compatibility with those legacy modems out in the field—the legacy terminals that will take a few years to cycle through the upgrade process. It allows operation in modern, high throughput modes, and has the right hooks built in for future enhancements. One of the key parts of this is support digital intermediate frequency, or Digital IF.

Digital IF provides a few key benefits. The first is flexibility to change the way a system is used long after the initial fielding, by separating out key parts of the way the signal is processed. Digital IF architectures are also helpful in reducing the requirements for fragile, expensive RF cabling in place if Ethernet. I'm a big advocate for taking a fragile component out of a system and replacing it with something more resilient and easier to repair.

There is also a huge reduction in the size and weight footprint, which is better than an 8x improvement over the system in the field. Ultimately the shift towards a digital SATCOM architecture is extremely important in promoting flexibility. When you look five years out, it's hard to predict who the significant players in the industry will be and each of them has a very different architecture and a very different approach to building out their systems. The same is true for our military SATCOM systems. You can point to large programs like Advanced Extremely High Frequency (AEHF) shifting over to things like Evolved Strategic SATCOM (ESS) and Protected Tactical Satellite Communications (PTS). All those programs bring large

questions and I think the Army has been thoughtful, leaning forward and saying that they don't know exactly what the future is going to look like. So Comtech is dedicated to building a system that is flexible and has the ability to continuously evolve and adapt to address customer needs in the future.

Question: What do you see as the biggest hurdles for adoption of these new technologies by military and defense customers? What steps is Comtech taking to ease the way?

Daniel Gizinski: As mentioned previously, one of the biggest challenges is the sheer volume of what's in the field. There are tens of thousands of satellite terminals out there and there is an increased emphasis on coalition interoperability. We see this with Combined Joint All Domain Command and Control (CJADC2). It's not just joint service interoperability, you need to be able to interoperate with allies and other coalition partners. Turning over the entire fleet of satellite terminals, not just within the US, but in other locations around the globe is not going to happen overnight. It is going to take time and a significant investment to get there.

Building systems that have the flexibility to adjust to the lowest common denominator is key. Some areas have very modern equipment while other areas do not. The shift towards OTA contracts allows for both the DoD and other coalition partners to keep pace with the rate of change in the commercial industry.

Another area that's very interesting is the emergence of hybrid and highly converged networks in SATCOM. That means using multiple orbits, and multiple constellations, but we are also starting to see a push towards supplementing SATCOM with terrestrial when that is available, as well as using other capabilities like Comtech's troposcatter systems given recent advances we've seen. There are a lot of standards that are being put forward and a lot of innovation in the commercial space which the DoD now has the opportunity to take advantage of and incorporate into future networks.

At Comtech, we are finding ways to harness commercial innovation and add the appropriate security overlays. We are focused on solving our customers' hardest challenges. We've got a bunch of very intelligent men and women throughout our organization who rally around these hard problems. It is certainly clear to us that the DoD and some of their coalition partners have some very difficult challenges ahead of them and we're excited to be part of the team leading the way to solve them. **GMC**



● ● Photo courtesy Comtech



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Mission in motion●●

Mission Microwave Technologies was founded in 2014 with a single ambition: to create the next generation of Solid-State Power Amplifiers (SSPAs) and Block Up Converters (BUCs). The company manufactures a range of Gallium Nitride (GaN) based RF and microwave electronics for antennas built by leading players in the satellite industry for defense and commercial use. We spoke with Mission Microwave and several of their customers to pinpoint how and why Mission's unique cylindrical BUCs are enabling mission-critical applications.

Crispin Littlehales, Executive Editor, Satellite Evolution Group

Who of us does not want to be informed? Whether the information we seek is mundane or life threatening, we want to know what is happening so that we can act accordingly. The more immediate and comprehensive the information is, the better. The challenge is how to collect and disseminate all that data into actionable insight as quickly as possible. Increasingly, we are turning to mobile and tactical satellite-based communications to achieve that goal.

According to research firm, MARKETS AND MARKETS, the Satellite Antenna Market is currently valued at approximately US\$5.8 billion and is expected to reach US\$10.5 billion by 2026. Market expansion has been driven largely by the deployment of low Earth orbit (LEO) satellites and constellations of satellites for communication. The increased demand for Ku- and Ka-band and Communication On The Move (COTM) solutions for platforms such as the expanding fleet of autonomous and connected vehicles for commercial and military use has contributed to industry growth. We are also seeing greater use of flat panel antennas (FPAs) and electronically steered phased antennas (ESPAs).

Lightweight and power efficient

Antennas used for airborne, maritime, vehicular, and tactical applications as well as those antennas that support satellites in LEO and medium Earth orbit (MEO) require rapid and automated pointing and tracking. They must also optimize Size, Weight, and Power (SWaP).

Steve Richeson, Vice President of Sales and Marketing for Mission Microwave Technologies notes, "It is obviously easier to move and track a lightweight antenna system, and mobile applications have limited power and thermal budgets that demand efficient energy utilization. This is true regardless of the shape of the antenna; terminals using flat panels, parabolic antennas, and conformably shaped antennas all need to be efficient in terms of their SWaP footprint."

A portable or mobile satellite terminal consists of the following subsystems: the antenna/pointing mechanism, the baseband equipment, and the Radio Frequency (RF) components. These



●● AvL's 1.6m Tri-Band High Wind Manual Point Terminal

include the Block Up Converter and Power Amplifier (BUC) and Low Noise Block (LNB) Downconverter.

The BUC takes the signal from the modulator and boosts it from under a milliwatt to several watts or several hundreds of watts, thereby changing the frequency of a signal and making it a million times more powerful without distorting it.

Richeson explains, "LNBS do this with receive signals at very low power levels, but receivers in mobile terminals are largely unregulated because they really can't hurt anything else



●● The ThinAir® Ka1717 terminal from ThinKom delivers a market-leading combination of spectral efficiency, size, and drag for regional jets

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if they are poorly implemented. There are a lot of regulations on how to build a transmit terminal to avoid creating interference to the adjacent satellites or frequencies. Higher performing modems require better linearity to support higher order modulation signals schemes. Newer satellite bands, like the 30 GHz Ka-band, need higher frequencies and higher power levels to overcome rain fade."

Enabling customers

Mission Microwave's product line has evolved around the needs of its customers who are, in turn, creating antennas and terminals to be used by people on the front line. That might be in the aftermath of a natural disaster, in an oil field, on an aircraft carrier, in the midst of battle, or in any other scenario where robust and dependable communications are critical.

"We try to provide the products and services to our customers that allow them to offer their end users a high-performance terminal that will survive many of the harsh environments in which they are used—all at a reasonable price," confirms Chris Callow, Director of Sales for Sat-Lite Technologies. Sat-Lite Technologies builds flyaway antennas, vehicle mount driveaway antennas, manpacks, and full motion LEO/MEO tracking antennas used in a variety of applications.

"We were an early adopter of Mission Microwave BUCs," adds Callow. "Their lightweight compact design fits in naturally with many of our smaller manpack and flyaway antennas. They are easy to integrate and don't take up much room for packaging in the transit case. Even their 400W Ku-band BUCs are small and light enough to mount on something as small as our 1.5m vehicle mounted antenna. In the past, it took a heavy custom oversized antenna baseplate to even consider mounting a redundant 400W system. It's amazing how Mission Microwave's products were able to change the game. What is more, they work...and they keep on working."

User feedback and responsive support are vital to product

integration, particularly in a price-sensitive market. Richeson, who is himself an engineer, understands how important it is not only to be there when a customer has specific questions about one of his company's products, but also to provide as much information as possible about competitive products. "When someone is looking at our website, we make it very easy for that person to compare our BUCs with all the other ones in that same class that are available in the marketplace," says Richeson. "We've created a chart that compares all the data sheets from other manufacturers. Our customers are serious players who do their homework, and we want to facilitate comparison shopping. We exist to enable our customers to stay one step ahead by making antennas and terminals that are better than what's currently available. That means understanding the competitive environment on every level."

On the move

When it comes to in-flight connectivity (IFC) reliability is key. It's expensive and time-consuming to replace systems so they need to go the distance and do the job as required. ThinKom, a leading supplier of airborne SATCOM antenna solutions, just passed 40 million operating hours with its systems; its antennas exhibiting greater than 100,000 hours mean time before failure (MTBF).

The company primarily supports the booming commercial aviation inflight connectivity segment, but also delivers systems for various government and military programs, typically for Intelligence, Surveillance, and Reconnaissance (ISR) applications. On the ground, ThinKom's ultra-low profile, network-agnostic, broadband RF antennas are used for high-speed internet back-haul, news gathering, border security, disaster recovery, and more. The company's newest innovations focus on space payload, gateway, and electronic warfare applications.

Denny Lynch, the company's Director of Business Development, works closely with commercial operations as well as various organizations within the US government and the Department of Defense (DoD). His primary responsibility is to understand the unique SATCOM needs of end-users and help provide solutions that meet or exceed the requirements. Although ThinKom uses its own patented VICTS phased-array technology, it does not build high-performance amplifiers (HPAs). That's where Mission Microwave comes in. "We started working with Mission Microwave about five years ago, incorporating various BUCs into our ThinPack and ThinSat COTM terminals," Lynch recalls. "Most recently, Mission Microwave's lightweight 25 Watt Ka-band Stinger BUC was selected as part of the Ka1717 system that was developed for regional jet IFC. Production deliveries for a major US based carrier will commence next year."

When the going gets rough

There has been a dramatic shift in the way battlefield communications are conducted. Recognizing this, the US DoD has called for a comprehensive and collaborative Joint All-Domain Command and Control (JADC2) strategy. This concept to connect sensors and communications from all of the military services—Air Force, Army, Marine Corps, Navy, and Space Force—into a single network has as its goal to ensure that the joint force commander has "the capabilities needed to command the Joint Force across all warfighting domains and throughout the electromagnetic spectrum to deter, and, if necessary, defeat any adversary at any time and in any place around the globe."

This ambitious effort is by no means an easy task. According to a report published in September 2022 by the Center for Strategic and International Studies (CSIS), "The problem set features rapid technological change, the necessity of interoperability with existing systems and with new systems across the services, integration with allies and partners, new and non-traditional contractors, and novel acquisition approaches."



● ● AvL's 2.4m X-Y Auto-Acquire MEO-GEO FlyAway Antenna

Mission Microwave's BUCs are integrated into a number of products that are currently part of the JADC2's communications strategy. Among those suppliers are AvL Technologies and L3 Harris Technologies.

AvL Technologies' core business addresses SATCOM, electronic warfare, and signal intelligence. All systems are networkable into JADC2 applications. Most AvL antennas go into remote, even unmanned, and harsh environments where reliability is paramount.

Dave Provencher, Vice President of New Business Development at AvL explains, "We are constantly advancing competitive new products capable of operating in LEO/MEO/GEO orbits at different frequency bands, and all while remaining lightweight and portable. Keeping up with new constellations requires advanced acquisition and tracking techniques and drive systems with a wide range of antenna gains that can seamlessly transition between the LEOs, MEOs, and GEOs. AvL antennas are easily adaptable to different frequency bands, and uplink/downlink signal characteristics and waveforms thereby eliminating the need for the user to carry multiple antenna terminals. With the incorporation of GaN technology, small SWaP, high efficiency and standardized electrical and user interfaces, Mission Microwave BUCs are ideal for integration into AvL's multi-band, multi-orbit antenna terminals."

L3 Harris has delivered more than 10,000 deployable Very Small Aperture Terminals (VSATs) to the US DoD and its international partners over the last ten years. The majority of those systems shipped with commercial and unprotected modems, "But", notes Jerry Adams, the company's General Manager of SATCOM Programs, "the times are changing." The latest offerings from L3Harris include Panther II manpack and Hawkeye 4 Lite (H4L) flyaway. "As part of our development efforts, we are designing the next-generation Family of Terminals (FoT) for the Hawkeye 4 product line range in apertures from 1.3m to 2.35m axis-symmetric terminals designed around the integration of Mission Microwave solid state BUCs," he adds.

"End users leverage our terminals in multiple ways, ranging from short-term Special Operation Force (SoF) missions to long-term deployments where larger VSATs are used as remote HUBs. Each L3 Harris SATCOM product is easy to set up, tear down, and offers a common user interface platform, which makes them seamless to operate from terminal to terminal and sets them apart in the industry. Modem modularity and the ability



● ● Sat-Lite mounted antenna on Viasat service truck

to adjust to the mission are critical aspects of our equipment," Adams says.

Building the best

If you ask Steve Richeson why so many companies have elected to incorporate Mission Microwave's BUCs into their antennas and terminals, he's quick to say it's not because of the price, but, rather, a fear of being left out. "Our customers want to make a winning product," explains Richeson. "As people started adopting our product, they found that they could make terminals that were better than their competitors. If there's not a Mission Microwave BUC on that product, that manufacturer needs to be able to explain why."

GMC



● ● Sat-Lite antenna on emergency vehicle in Japan



● ● Craig Miller, President of Global Space Networks at Viasat

Providing secure delivery of actionable information to warfighters ●●

What will the next war look like? Based on what's happened so far in Ukraine, it's not just going to be about military might. Secure communications, efficiently disseminated as intelligence to warfighters, regardless of their location, will be key to success on the battlefield. Craig Miller, President of Global Space Networks at Viasat, shares the company's strategy for enabling those on the front lines to maintain the advantage.

Crispin Littlehales, Executive Editor, Satellite Evolution Group

Question: Warfighters on today's battlefield need to be able to move data and share information to maintain an advantage. How is Viasat enabling that?

Craig Miller: The way in which information is gathered, processed, and dispersed to warfighters who need to use it is certainly becoming mission critical.

We have a broad and diverse set of capabilities. Viasat's next-generation satellites are designed to be the pinnacle of what's possible with broadband satellite communications, especially now when combined with Inmarsat's assets. This includes high-capacity beyond line-of-sight communications that are resilient, secure, and available anywhere in the world at any time of day or night. This is vital when you are transferring information in a way that has to be relevant and useful to the warfighter. We also have a suite of tactical edge capabilities such as blue force tracking with Viasat L-band terminals, UHF channel controllers, and other narrowband applications. In addition, we have a product called NetAgility, which is a software-defined Wide Area Network (WAN) or Local Area Network (LAN) that intelligently routes data between a variety of tactical data link networks.

While there are many kinds of tactical data links used by warfighters at the edge, they are not all compatible. We can stitch them together both with gateway products and software-defined networking. This allows warfighters to communicate with each other. We also provide information assurance using Type 1 crypto in everything from small, embedded units to multi 100 gigabit per second cloud crypto.

Question: How will Viasat's next-generation satellites enable successful military missions?

Craig Miller: In addition to bringing substantial capacity and flexibility, our latest satellites are designed to be highly resilient and can detect spacecraft interference and tell you where the culprit is located. Using automation, the satellite can mitigate the interference and change the shape of the beams, thereby providing resistance to subsequent attacks. We also have a unique ground infrastructure—a distributed architecture—that makes it resistant to disruptions on the gateway side so there aren't single points of failure. Plus, there is encryption throughout the system to ensure the privacy and security of the users on the network.

Question: Militaries all over the world are realizing the importance of resilient and flexible communications. How can Viasat keep warfighters one step ahead of adversaries?

Craig Miller: There are a couple of dimensions here. We've already talked about the global network that we operate now with the combined Viasat and Inmarsat assets. That system has all sorts of features to ensure it operates through interference and is resistant to disruption on the gateway network. In addition to that, we already have an advanced cyber defense system, which protects the satellites, their attendant infrastructure, and the users on the network. We also provide additional resilience by creating a network of networks. The existing

GMC
Q&A

Viasat constellation, coupled with Inmarsat's fleet of satellites in orbit (with more slated to deploy over the next several years) means there will be two to three satellites orbiting in view just about anywhere in the world.

We've all become used to that level of resilience in our personal devices and we're going to be bringing that to the warfighters' devices using both our network and assets through partnerships. Our combined fleet gives us additional flexibility and resilience so Governments can access maximum security.

Question: Cybersecurity remains a top concern for militaries. How is Viasat addressing that?

Craig Miller: We do everything to maintain good cyber hygiene that every defense contractor does and then, we offer considerably more. As an Internet Service Provider (ISP) Viasat has many hundreds of thousands of individual users on our network which is spread throughout the US and Europe as well as South and Central America. There are a unique set of challenges because anyone in the world can get on our network.

While some defense networks are isolated with boundaries, we must assume adversaries are always in our network and therefore we've developed ways to identify those adversaries and mitigate their movement—basically maintaining a zero-trust network. We've had this in place for a very long time and therefore have an enormous amount of experience creating the sort of systems and controls that allow you to operate in a zero-trust environment. We've been able to apply those lessons to our defense side of the business.

Because we are an ISP, we are also well-versed in handling an immense volume of data that traverses our network every single day. As we deal with many terabytes of data, we've created analytics tools that process that data and look for threats. These are machine learning based tools that we've trained

against our ISP data, and they are very sophisticated. It's worth noting that it's not the algorithms that make those tools so successful, it's the data that you train them against. Because we have such a rich and varied data set that few others have, our tools are extremely effective at describing indications of compromise and indications of threats on our network. The third pillar of what we do in cybersecurity is our Enhanced Cybersecurity Services Program which allows us to host DHS NSA signatures on an unclassified device and use that for indication of threat and compromise.

Question: What are the main advantages to using space and hybrid networks over the traditional communications networks that militaries have been using?

Craig Miller: Today commercial technology is being considered for military missions. In some cases, a commercial solution may well be better than specialized military technology. There are plenty of examples: use of cell phones as a service; use of the cloud as a service; and the use of satellite communications. Our goal is to smooth that cultural transition from a proprietary military network to a hybrid network that uses commercial solutions alongside what is already in place.

Today's young people are highly connected and used to being able to stream anything anywhere at any time. What if military service personnel are deployed on a ship and they don't have Netflix or email or the ability to text and chat with friends and family back home? With a dual use commercial and military network, Viasat can offer those Morale, Welfare, and Recreational (MWR) capabilities right alongside battleground applications.

Inmarsat, with its expertise in global mobility both in the air and on the sea, adds to what Viasat already has in place and the combined company can provide real time command and



● ● Viasat provides a range of multi-band, flexible SATCOM terminals and electronic warfare (EW) resistant networks that will help achieve resilient, end-to-end communications across domain and missions

control via an array of fixed ground, mobile, maritime and air platforms, ranging from small UAVs to the biggest jets including senior leader aircraft.

Question: What are the challenges you face when trying to convince militaries to uptake and invest in the new technologies that Viasat is enabling?

Craig Miller: As is the case with any large organization, there are elements of it that are early adopters and elements that are resistant to change. There is a cultural aspect to all of this going from “we invented it, we own it, it’s ours” to “we have to depend on you for part of our mission.” That’s a big leap for a military operation. Solving that cultural challenge is, in many cases, as difficult as solving the technical challenge.

We work with early adopters like US Special Operations Command (SOCOM) who are very aggressive at trying new capabilities. We have also had success with senior leader aircraft for multiple countries on our network, including the US. If a technology is good enough for the leader of a country, a lot of the resistance melts away. In addition, Viasat has worked hard to provide agile business models and ways of buying the services.

Progress is being made. The Space Force has been forward looking, creating its own commercial SATCOM office. They are leading the way in using commercial capabilities and leveraging those to make a difference for warfighters.

Question: How do you see battlefield communications evolving over the next 1 to 5 years?

Craig Miller: Everything and every warfighter, along with some of their devices, will be connected. This means that every soldier is a sensor and a shooter. Where there’s literally millions of individuals with millions of devices that are part of the next battlefield, the big question is how do you manage to capture and filter that information into something useful that is quickly routed to where it needs to go?

In this future, Viasat’s role may be to connect sensor, shooter, and everything in between. In some cases, the sensors are the shooters and in other cases the shooters are the sensors. Having the ability to dynamically manage a network like that at scale is going to be key. The entity that can do that will be the one who has mission success. Being able to process the data and to divine intent from that data and then be able to move that intelligence to where it needs to go so that you can act on it, that’s the challenge.

I think that Viasat is capable of supporting warfighters in that challenge with split-second timing and no guesswork.

Question: Is Viasat open to enabling everybody?

Craig Miller: We are a commercial company that sells services worldwide and so we work with a wide variety of countries. We try to be a provider of services to everyone that we can in a fair and legal way. In terms of governments, we work with the US Department of Defense. We work with NATO and other coalition partners.

Of course, as a US company, the law forbids doing business with some nations and then there are others that we choose not to work with for humanitarian or other reasons. **GMC**



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● ● Photo courtesy Integrasys

Integrated capacity management and NewSpace technologies ● ●

In an ever-evolving landscape with more conflicts and high demands imposed by modern military operations, effective communication, data transfer, and coordination are critical to success. The complexities of today's military environments necessitate a sophisticated approach to capacity management, one that seamlessly integrates technology and leverages the boundless possibilities of NewSpace.

Alvaro Sanchez, CEO, INTEGRASYS

At the heart of every military operation lies the critical need for efficient capacity management. Providing connectivity to soldiers on the ground, aircraft, naval vessels, as well as satellites orbiting in space form a complex collection of interconnected platforms, each with its unique communication and data transfer requirements. This intricate tapestry of military assets demands seamless coordination and information flow. However, navigating this presents a multifaceted challenge. The demand for substantial bandwidth to support voice, video, and data transmission is a pressing concern, since bandwidth limitations can hinder communication, particularly in remote or contested areas.

The constant threat of signal interference, jamming, or interception poses significant risks to operational security. Moreover, military operations are inherently dynamic, marked by rapidly changing scenarios that make predicting and allocating capacity effectively a challenging endeavor within any operation. Resource optimization is equally crucial and

necessitates the maximization of available resources, including spectrum allocation and satellite coverage, to achieve operational objectives while managing costs efficiently.

Technology integration: A game-changer in military capacity management

To address these intricate challenges, satellites are becoming more flexible. The defense sector is embracing advanced technologies that offer a holistic approach to capacity management. These innovations are poised to be game changers by effectively tackling the multifaceted issues faced in military operations. Satellite communication, a linchpin of modern defense, is undergoing a transformative evolution with the introduction of new technologies. These innovations bring increased bandwidth and reduced latency, offering improved communication capabilities, especially in remote or challenging terrains. However, these solutions are much more complex to manage.

The integration of capacity management tools with advanced link budget calculation systems has emerged as a critical



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● ● Alvaro Sanchez, CEO, INTEGRASYS

necessity. These integrated solutions serve as the backbone of efficient communication and resource allocation, particularly in the context of NewSpace constellations in Low Earth Orbit (LEO) and Medium Earth Orbit (MEO). By seamlessly combining capacity management and link budget calculation tools, military organizations can share data and allocate resources with agility and precision. This integration empowers decision-makers with real-time insights into resource allocation, ensuring that military communication remains reliable, efficient, and adaptable to the dynamic demands of modern warfare. It also ensures that bandwidth demand can be served regardless of the data consumption if mission requires.

The reporting capabilities offered by integrated capacity management systems, aligned with military standards and operational needs, empower decision-makers with actionable insights, enhancing overall situational awareness and strategic planning. This integrated approach to capacity management not only addresses the complexities of military operations but also propels defense organizations into a new era of efficiency and effectiveness, in a single portal for all communications to the warfighters.

NewSpace ventures: Expanding horizons for defense

The emergence of NewSpace ventures has injected fresh vigor into military capacity management, promising to reshape the future. These commercial endeavors, operating in LEO and beyond, have introduced a wave of innovations that hold tremendous potential for the defense sector.

One of the most significant advantages of NewSpace is the expanded coverage and reduced latency satellites in LEO offer. Positioned closer to Earth, they facilitate near-instantaneous communication, even in remote or challenging terrains. This heightened connectivity has the potential to revolutionize military operations by ensuring that vital information flows seamlessly, regardless of the operational theater with multiple satellites to connect in a multi orbit environment.

Another key attribute of NewSpace ventures is resilience through diversity. Diverse constellations of LEO satellites provide critical redundancy and resilience. In the event of a satellite malfunction or adversary action, data and communication can

“The constant threat of signal interference, jamming, or interception poses significant risks to operational security. Moreover, military operations are inherently dynamic, marked by rapidly changing scenarios that make predicting and allocating capacity effectively a challenging endeavor within any operation. Resource optimization is equally crucial and necessitates the maximization of available resources, including spectrum allocation...”

seamlessly shift to alternative satellites, ensuring operational continuity. This level of redundancy is vital for military organizations, which can ill afford communication breakdowns in high-stakes operations. Constant best path calculation is also a must have in multi orbit network.

The cost-efficiency of NewSpace is a compelling factor for the defense sector. The commercial space industry has played a pivotal role in driving down the cost of satellite technology and launch services. This cost reduction makes it more economically viable for defense organizations to access COMSATCOM NGSO networks and deploy satellites in space, thereby expanding their capacity management options. This cost-effectiveness allows defense organizations to stretch their budgets further, achieving more with less.

Agility and rapid deployment are hallmarks of NewSpace ventures. Smaller, more agile, and intelligent satellites that can communicate and observe in ground and in space can be launched and upgraded swiftly, adapting to changing operational needs with remarkable speed. In an era where agility and flexibility can mean the difference between success and failure, this responsiveness is a tremendous asset for defense organizations.

Perhaps one of the most transformative aspects of the NewSpace race is the opportunity for the defense sector to leverage the innovation and expertise of the private sector. Collaborations with commercial space companies provide military advantage with access to cutting-edge technology and solutions that can accelerate capacity management advancements. This partnership between the public and private sectors ensures that the defense sector remains at the forefront of technological progress, guiding the industry on how cover current and future needs.

Conclusion

In the world of modern military operations, flexible management of enterprise capacity has become the key to success. From the complexities of communication and data transfer to the intricacies of coordination, the challenges are manifold. Yet, with the integration of advanced technologies and the embrace of the NewSpace race, the defense sector is poised to overcome these challenges.

As satellite communication experts within the defense sector, the path ahead is clear. It's about embracing this transformative synergy, where technology integration and NewSpace possibilities converge to enhance military enterprise management. In doing so, defense organizations can ensure that communication remains secure, efficient, and prepared for the challenges of the modern era.

In this era of rapid change, innovation is the key to achieving new heights in defense capabilities. By seamlessly integrating technology, exploring NewSpace, and partnering with the private sector, the future of military capacity management is not just promising, it's revolutionary. The defense sector is on the brink of a new era, where communication and coordination will be sharper, more resilient, and more effective than ever before; and spectrum superiority will be decisive to accomplish any mission.

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