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Dudullu OSB, 1. Cadde 18/1 34775
Ümraniye İstanbul / TURKEY

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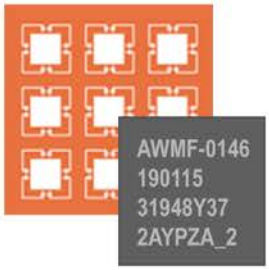

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The 2Gen PRISMA EO System + HydRON Builds Now Underway By Thales Alenia Space + Teams

Thales Alenia Space, the joint venture between Thales (67%) and Leonardo (33%), has signed a contract with the Italian Space Agency (ASI) to conduct a feasibility study for the PRISMA Second Generation (PSG) hyperspectral Earth observation system.

This will be leading a consortium that includes Leonardo, Telespazio (the joint venture between Leonardo (67%) and Thales (33%)), ***e-GEOS*** and ***SITAEL***. Lasting nine months, the feasibility study will take an innovative approach to support the development of applications in both national and international markets, such as improved monitoring of natural and atmospheric resources, while providing the data needed to more effectively manage regional development and environmental risks.

The feasibility study will capitalize on increased interest in hyperspectral imaging by consolidating the technological excellence achieved through the PRISMA demonstration mission. It will deliver higher performance in line with the updated application requirements specified by the European Space Agency (ESA) for the upcoming Copernicus Hyperspectral Imaging Mission for the Environment (CHIME), deployed as part of Europe's vast Copernicus environmental monitoring program.

The main challenge for hyperspectral technology is to capture images with high quality and spatial resolution, with frequent re-visit times and high signal to noise ratio. PRISMA SG will represent a significant step forward over the first-generation PRISMA system, improving spatial resolution via enhanced platform and instrument agility.

Thales Alenia Space in Italy will build the new satellite and take complete responsibility for system design, drawing on its proven experience in Earth Observation (EO) satellites for Copernicus and the first and second-generation COSMO SkyMed satellites. It was also selected by ESA in 2020 to design and build the two CHIME environmental monitoring satellites, with Leonardo contributing to the payload. Leonardo provided the PRISMA hyperspectral instrument, already in orbit, and will also build this payload for PRISMA SG, but offering even higher performance to address the rapidly growing number of government, scientific and industrial applications.

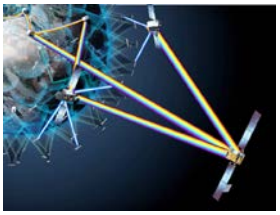
Telespazio will be responsible for designing the PRISMA SG ground segment, while e-GEOS, a joint Telespazio (80%) and ASI (20%) company, will be in charge of market analysis and will also help Leonardo define user requirements.

SITAEL, a space company and a part of Angel Group, capitalizing on the national investments on electric propulsion, will participate in the trade-offs of satellite and platform as well as study the configurations to make PRISMA SG an "all-electric" satellite, thereby ensuring the maneuverability and operational flexibility that only this type of satellites provide. Moreover, thanks to its extensive experience in control electronics, as in the case of the ESA Copernicus

CHIME mission, SITAEL will study the sophisticated control unit of the hyperspectral payload, aiming at the scalability of a cutting-edge and consolidated technology that is able to speed up the development time as well as the implementation costs.

Drawing on more than 40 years of experience and a unique combination of skills, expertise and cultures, Thales Alenia Space delivers cost-effective solutions for telecommunications, navigation, Earth observation, environmental management, exploration, science and orbital infrastructures. Governments and private industry alike count on Thales Alenia Space to design satellite-based systems that provide anytime, anywhere connections and positioning, monitor our planet, enhance management of its resources, and explore the Solar System and beyond. Thales Alenia Space sees space as a new horizon, helping to build a better, more sustainable life on Earth. A joint venture between Thales (67%) and Leonardo (33%), Thales Alenia Space also teams up with Telespazio to form the parent companies' Space Alliance, which offers a complete range of services. Thales Alenia Space posted consolidated revenues of approximately 1.85 billion euros in 2020 and has around 7,700 employees in 10 countries with 17 sites in Europe and a plant in the US.

Additionally, Thales Alenia Space recently kicked-off two projects related to HydRON, being funded by the European Space Agency (ESA). The two contracts will allow Thales Alenia Space, and its partners, to develop its own vision demonstrating the potential of laser-based satellite communication.



Fiber in the sky for connectivity services thanks to laser communications. Image is courtesy of ESA.

The past years have seen a quick expansion of communications infrastructures fueled by the unprecedented rise in the volume of data streams that circle the globe. This demand is also felt in the aerospace sector, where interconnection and integrative network concepts across orbits and across the globe are key to fulfil the demands of the future. Laser-based satellite communication has the potential to bring terrestrial network functionalities to satellite networks in order to help bridge this digital gap for a variety of applications (e.g. virtual private networks, edge computing, 5G/6G services, internet to/from space and airborne assets). This is beyond current satellite capabilities, and ESA's HydRON (High Throughput Optical Network) vision seeks to develop these for European and Canadian industries.

The vision is part of ESA's ARTES Advanced Research in Telecommunications Systems (ARTES) 4.0 Strategic Program Line on "Optical & Quantum Communications" – ScyLight program. It is an Optical Transport Network concept combining extremely high throughput Optical Ground-Space Links, high throughput Optical Inter-Satellite Links and on-orbit routing/ switching capabilities.

The resulting space Optical Transport Network aims at seamless inter-operability with existing high-capacity terrestrial networks – the "internet beyond the cloud(s)." In the frame of the two contracts, Thales Alenia Space led a consortium, including **GMV**, **Telespazio**, **CGI**, CRAT, **Officina Stellare**, **DLR-IKN**, **Kepler Communications**, **Scuola Superiore Sant'Anna** and **Open Fiber**. This consortium will study the implementation of a ***HydRON Demonstration System*** (**Phase A/B1**) as well as develop a ***System Simulator Testbed.*** The ***Telecommunications and Integrated Applications Directorate*** (**TIA**) of ESA is funding both.

The objective of the first contract (HydRON Demonstration System Phase A/B1) is to push the development and validation of the HydRON technology integrated into terrestrial networks at terabit-per-second capacity. It will demonstrate:

- *the end-to-end system, including critical key technologies and a minimum viable service*
- *networking capabilities, including seamless inter-operability with high-capacity terrestrial networks*
- *operational concept, reflecting an expandable HydRON concept*

The Phase A/B1 study will last 18 months to propose an implementation concept to demonstrate the HydRON vision, tentatively composed of two space-based laser communication payloads in LEO and GEO, interconnecting with each other, several optical ground stations and terrestrial fibre optics networks. Their completion will pave the way for a subsequent implementation phase (Phase B2/C/D/E1, launch in 2026), subject to ESA member states decision at ESA's next Council Meeting at ministerial level in November 2022. The objective of the second contract is to develop a HydRON System Simulator Testbed to:

- *consolidate HydRON vision, system functionalities & end-to-end system architecture*
- *support HydRON Demonstration System trade-offs and aseline selection*
- *verify optical communications network solutions and technologies in a representative end-to-end network involving interfaces with high-capacity terrestrial networks evaluate performance of optical satellite networks in scenarios with many degrees of freedom and under a large number of stochastic environment variables*

Rocket Lab Adds Their Second, Electron Launch Pad With Pad B In New Zealand… First Mission Already Scheduled

Rocket Lab's Launch Complex 1, Pad B, New Zealand.

***Rocket Lab USA, Inc*. (Nasdaq: RKLB) has completed their second orbital launch pad at *Launch Complex 1* in New Zealand – the Company's third dedicated pad for its *Electron* rocket – and confirmed the new pad's first mission.**

Pad B is based within Rocket Lab Launch Complex 1, the world's first private orbital launch site, located in Mahia, New Zealand. The new pad is Rocket Lab's third for the Company's Electron launch vehicle and joins the existing Pad A at Launch Complex 1 and a third launch pad at Rocket Lab Launch Complex 2 in Virginia, USA. With two operational pads within the same launch complex, Rocket Lab doubles the launch capacity of its ***Electron*** launch vehicle.

With two launch pads and private range assets at Launch Complex 1, concurrent launch campaigns are now possible from the site. This enables resilient access to space by accommodating tailored customer requirements or late changes to a spacecraft while keeping Rocket Lab's manifest on schedule. Operating two pads also eliminates pad recycle time, ensuring a launch pad is always available for a rapid-response mission. Launching from a private launch complex, Rocket Lab is also able to avoid the lofty range fees and overheads typically associated with shared launch sites, resulting in a cost-effective launch service for satellite operators.

Rocket Lab founder and CEO, ***Peter Beck***, said, "*A reliable launch vehicle is only one part of the puzzle to unlocking space access – operating multiple launch sites so we can launch when and where our customers need to is another crucial factor. We are proud to be delivering responsive space access for our customers, making back-to-back missions possible within hours or days, not weeks or months. Even with just one pad at Launch Complex 1, Electron quickly became the second most-frequently launched U.S. rocket every year. Now, with two pads at Launch Complex 1 and a third in Virginia, imagine what three pads across two continents can do for schedule control, flexibility, and rapid response for satellite operators globally.*"

More than 50 local construction workers and contractors were involved in the development of Launch Complex 1 Pad B, which includes a 66-ton launch platform and 7.6-ton strongback customized to the Electron launch vehicle. With Pad B operational, several roles are available now at Launch Complex 1 to support Rocket Lab's increased launch cadence.

Rocket Lab's Vice President – Launch, ***Shaun D'Mello***, said, "*With Pad B we've kept things efficient. Its systems and layout replicates Pad A and shares much of Pad A's infrastructure including the Electron vehicle integration hangar, runway to the pad, and our own range control facility. With that we've been able to double our operational capacity – all on a concrete area smaller than the average tennis court. I'm hugely proud of what the team has achieved: building and bringing a second pad online, all while continuing to service and operate Pad A for our Electron launches to date, and in the middle of a global pandemic no less.*"

About Launch Complex 1

Located on the Mahia Peninsula in New Zealand, Launch Complex 1 is the world's first and only private orbital launch site. As the launch site for Rocket Lab's Electron rocket, Launch Complex 1 has supported the successful delivery of more than 100 satellites to space across a range of missions for environmental and marine monitoring, Earth observation, science and research, internet connectivity, technology research and development, and national security. An FAA-licensed spaceport, Launch Complex 1 is capable of supporting up to 120 launch opportunities every year. From the site it is possible to reach orbital inclinations from sun-synchronous through to 30 degrees, enabling a wide spectrum of inclinations to service the majority of the satellite industry's missions to low Earth orbit. Located within Launch Complex 1 are Rocket Lab's private range control facilities, three satellite cleanrooms, a launch vehicle assembly hangar which can process multiple Electrons for launch at once, and administrative offices. Operating a private orbital launch site alongside its own range and mission control centers allows Rocket Lab to reduce the overhead costs per mission, resulting in a cost-effective launch service for satellite operators.

Rocket Lab will not be attempting to recover Electron for this mission.

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Kleos Space Receives A Data Evaluation Contract

Kleos Space **has received a data evaluation contract from** ***Advanced Ground Information Systems, Inc.*** **(AGIS).**

AGIS simultaneously processes up to 200,000 real-time sensor reports to provide command and control communication capabilities to U.S. military, government and first responders.

The firm's ***Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance*** (**C5ISR**) system enables data interoperability between U.S. and NATO C5ISR systems to provide a common operational picture.

AGIS' C5ISR system will be using ***Kleos***' ***electronic intelligence*** (**ELINT**) data to complement other intelligence data sources to provide hostile and illegal shipping awareness to its customers with the ability to direct forces.

Under the contract, AGIS will have access to Kleos' ***Guardian Locate*** data product for evaluation purposes. The product delivers processed radio frequency transmissions collected over key areas of interest, irrespective of the presence of positioning systems.

Kleos' Chief Revenue Officer, ***Eric von Eckartsberg***, said, "*AGIS has a long history of providing critical data to those in the field. We're excited for our geolocation sensor data to be integrated into their command-and-control systems, which will help bringing Kleos' products to a wide array of government customers around the world. Kleos' data complements existing datasets and can be used to validate or tip and cue other sources to improve the intelligence, surveillance and reconnaissance capabilities.*"

AGIS' CEO, ***Cap Beyer***, said, *"We are looking forward to working with Kleos, and providing users the ability to integrate Kleos' intelligence information with a mature multinational C5ISR system and other intelligence sources*."

Kleos' radio frequency geolocation data enhances the detection of illegal activity, including piracy, drug and people smuggling, border security challenges and illegal fishing. Its global activity-based data is sold as-a-service to governments and commercial entities, complementing existing commercial datasets.

Kleos currently has eight satellites on-orbit with launches for the company's ***Patrol*** and ***Observer*** Missions scheduled for April and June 2022, respectively.

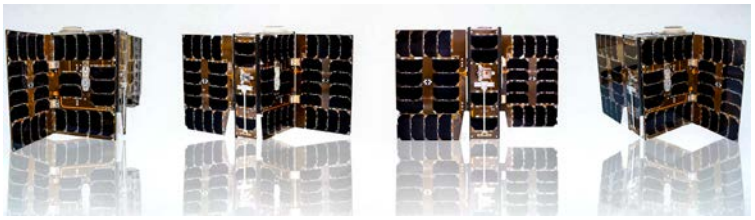

Photo of Kleos Space Patrol Mission smallsats, courtesy of the company.

Mynaric Receives Optical Comms Contract

Mynaric **was been awarded a contract by the** ***European Space Agency*** **(ESA) to analyze, design, build and test on a laboratory model an end-to-end optical communication system that can achieve data transmission speeds of 1 Terabit per second (Tbps) — this project enhances Mynaric's commitment ≠to innovation and its mission to create a truly connected planet.**

Mynaric was awarded the contract through a competitive, open call for proposals. The project, named Pegasus, is allocated within ESA's ScyLight program which supports the research, development, and evolution of optical communication technologies and provides flight opportunities for on-orbit verification. ESA's ***"High Throughput Optical Network" (HydRON) program*** is, additionally, creating a space-enabled, optical network, ensuring that people can connect even in remote locations.

The benefit of establishing terabit speed backhaul in space is that it allows constellations to offer the equivalent ultra-high speeds found in ground-based networks. Moving terabit bandwidth into LEO, MEO and GEO provides an alternative backhaul capacity for industry and commercial applications for whom current speeds are not sufficient.

Offering these speeds in space also ensures these industries and applications are not reliant on ground-based networks susceptible to natural disasters or other ground-based activity that threatens connectivity.

In August 2021, Mynaric launched its new, ultra-fast and scalable optical communications terminal, the CONDOR Mk3 based on customer and market insights. Key to the CONDOR Mk3's entry into the market was its scalability of both speed and production.

With configurable data rate speeds between 100 Mbps and 100 Gbps, the terminal ensures both standardized compatibility and delivers higher speeds for different applications.
Mynaric's CONDOR Mk3 supports link distances >7,500 km with a flexible data rate coverage from 100 Mbps up to 100 Gbps.

"*As part of our product development roadmap, our engineers and product development teams are revolutionizing the industry and realizing the fullest potential of optical communication systems*," said ***Bulent Altan***, CEO of Mynaric. "*We are able to take theory and make it a reality through thorough planning, development and testing. The work we do today to increase data speeds will help drive connectivity for not only Europe, but the entire planet*."

Mynaric's CONDOR Mk3 supports link distances >7,500 km with a flexible data rate coverage from 100 Mbps up to 100 Gbps.

Mynaric (Nasdaq: MYNA; Frankfurt Stock Exchange: M0Y) produces optical communications terminals for air, space and mobile applications. Laser communication networks provide connectivity from the sky, allowing for ultra-high data rates and secure, long-distance data transmission between moving objects for wireless terrestrial, mobility, airborne- and space-based applications. The company is headquartered in Munich, Germany, with additional locations in Los Angeles, California, and Washington, D.C.

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The UK's Spaceport Cornwall Edges Closer To Initial Launch

Set to deliver the first ever launch from UK soil this summer, Spaceport Cornwall is laying the foundations for long-term, responsible, smallsat services from Cornwall Airport Newquay with the build of the Center for Space Technologies.

This state of the art facility is a nationally unique asset where the value of launch from Cornwall will realize its full potential. The Center comprises two main facilities: the Space Systems Integration Facility, where satellites will be integrated into the fairing of the rocket; and the Space Systems Operation Facility, an adjacent R&D work and office space.

The Center for Space Technologies will be home to academic partners, SMEs, multinationals and environmental organizations who will come together and collaborate on responsible launch practices and applications — showcasing how space can help solve some of our greatest challenges on Earth.

The facilities are key to Cornwall's space cluster development and continued growth for cutting-edge practice within the region, and will serve as a catalyst to attract space businesses to work alongside academia in this unique capacity. Businesses from across the UK space sector and beyond, including satellite manufacturer ***D-Orbit***, have already committed to using the center as a base for innovation and advancement.

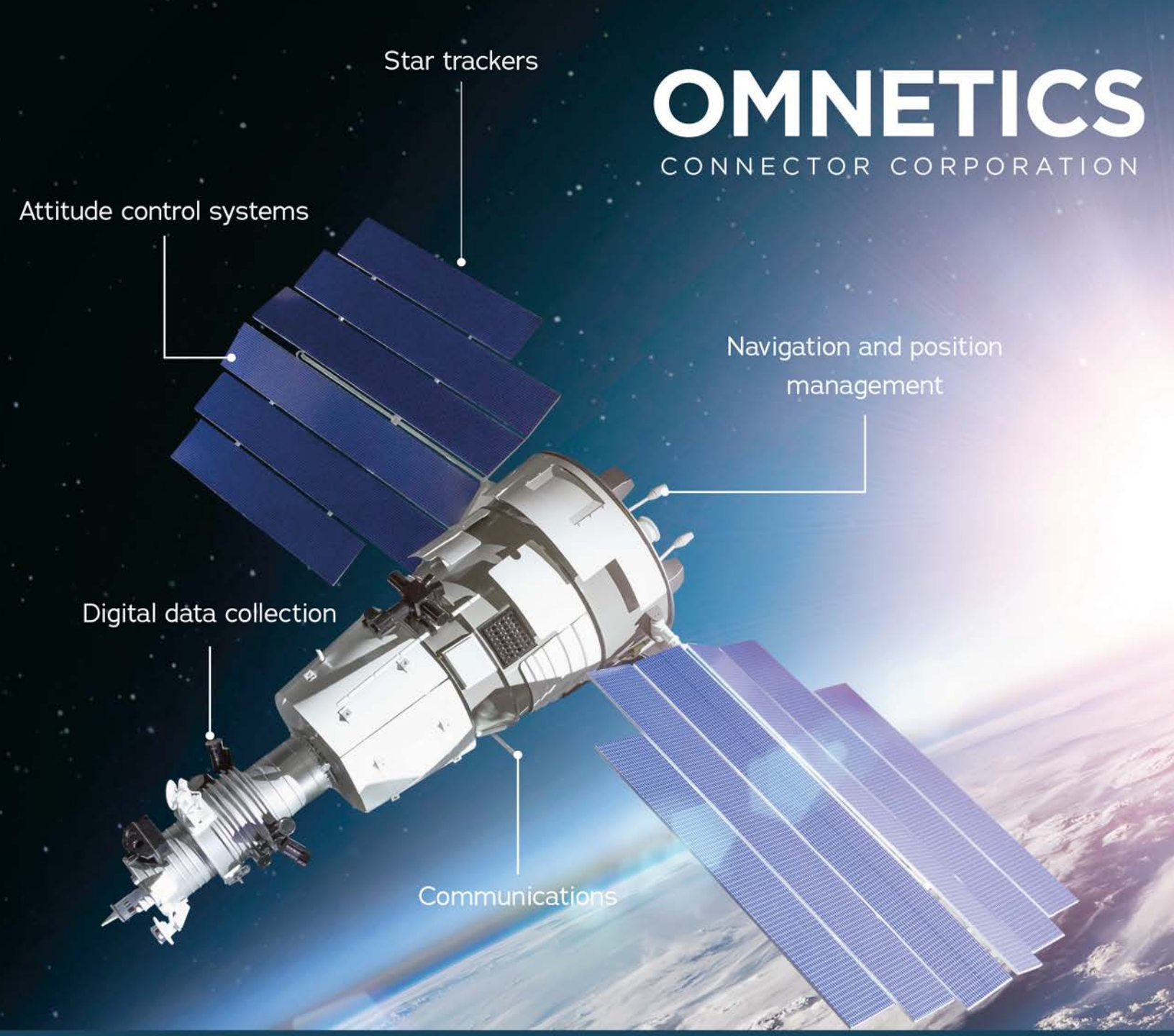
The center will also be the on the ground base for Spaceport Cornwall's mission to take a global lead in responsible launch and their ambition to achieve Net Zero. It will be home to ***Kernow Sat-1*** – a G7 Legacy funded Community Satellite that will be launched to monitor ocean health around the coast of Cornwall – supporting Blue Carbon ambitions. Alongside this, further R&D will focus on Environmental Intelligence and Space.

Business Secretary, ***Kwasi Kwarteng***, said, "*From connecting people with their friends and family, to helping farmers to manage their crops, space is playing an increasingly pivotal role in our daily lives. Not only is this booming £16 billion sector a vital part of the UK economy, but it is also helping to protect British security interests abroad. The Centre for Space Technologies, backed by government funding, will be a hugely exciting asset to both Cornwall, and to the UK's space sector as a whole. The facility will contribute to vital research and development in the field, bringing together industry and academia to exploit space to solve some of humanity's greatest challenges. The Government is delighted to be able to support this fantastic site, which will bring 150 jobs to the local area while boosting Cornwall's burgeoning space cluster.*"

Melissa Thorpe, Head of Spaceport Cornwall, said, "*Spaceport Cornwall is more than just a launch facility. The Centre for Space Technologies is proof of our ambitions to lead the way in a global industry shift. We want to show the key role environmental intelligence can play in solving global climate challenges and the center will be home to vital R & D in this area — fostering collaboration across industry and academia to pioneer the use of space for good.*"

Ian Annett, Deputy CEO of the UK Space Agency, said, "*It's fantastic to see how our investments in UK launch are leading to the development of impressive facilities that will support spaceflight operations, research and collaboration, and create high-skilled jobs. As we countdown to the first launch this summer, we are working closely with Spaceport Cornwall, Virgin Orbit and partners across the country to grow a sustainable new spaceflight industry in the UK.*"

The £5.6 million innovative space has been jointly-funded by **Cornwall Council**, the **European Regional Development Fund** and the **Cornwall and Isles of Scilly Local Enterprise Partnership**, through the Government's **'Getting Building' Fund**. Accelerating UK Space and growing Cornwall's economy Spaceport Cornwall, with the Center for Space Technologies, will deliver 150 direct jobs and £200 million GVA.



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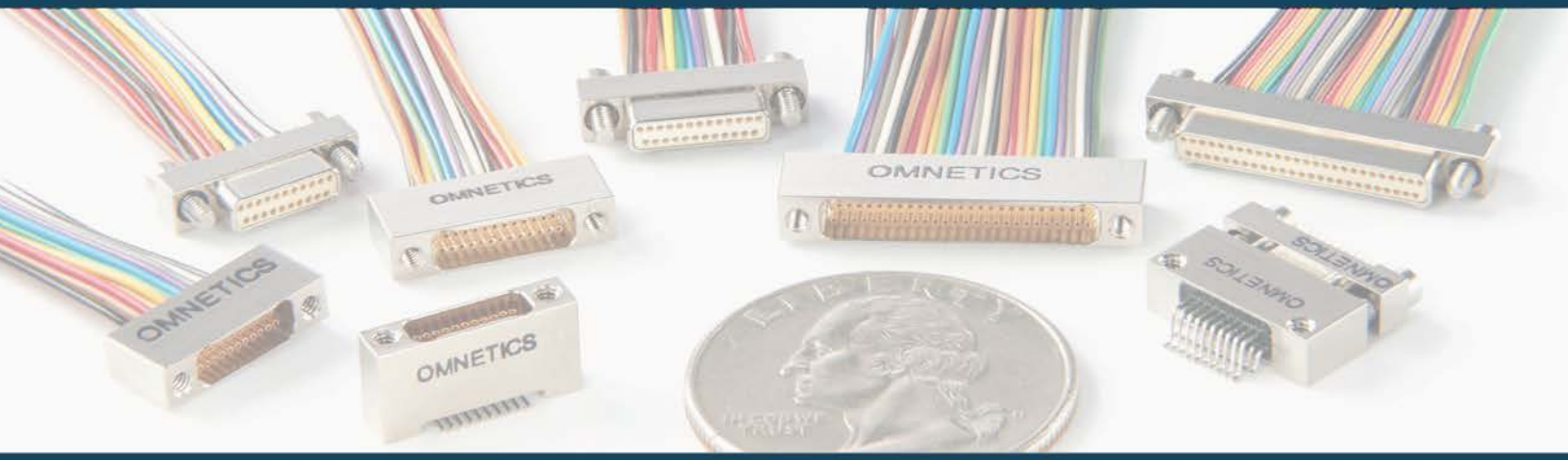

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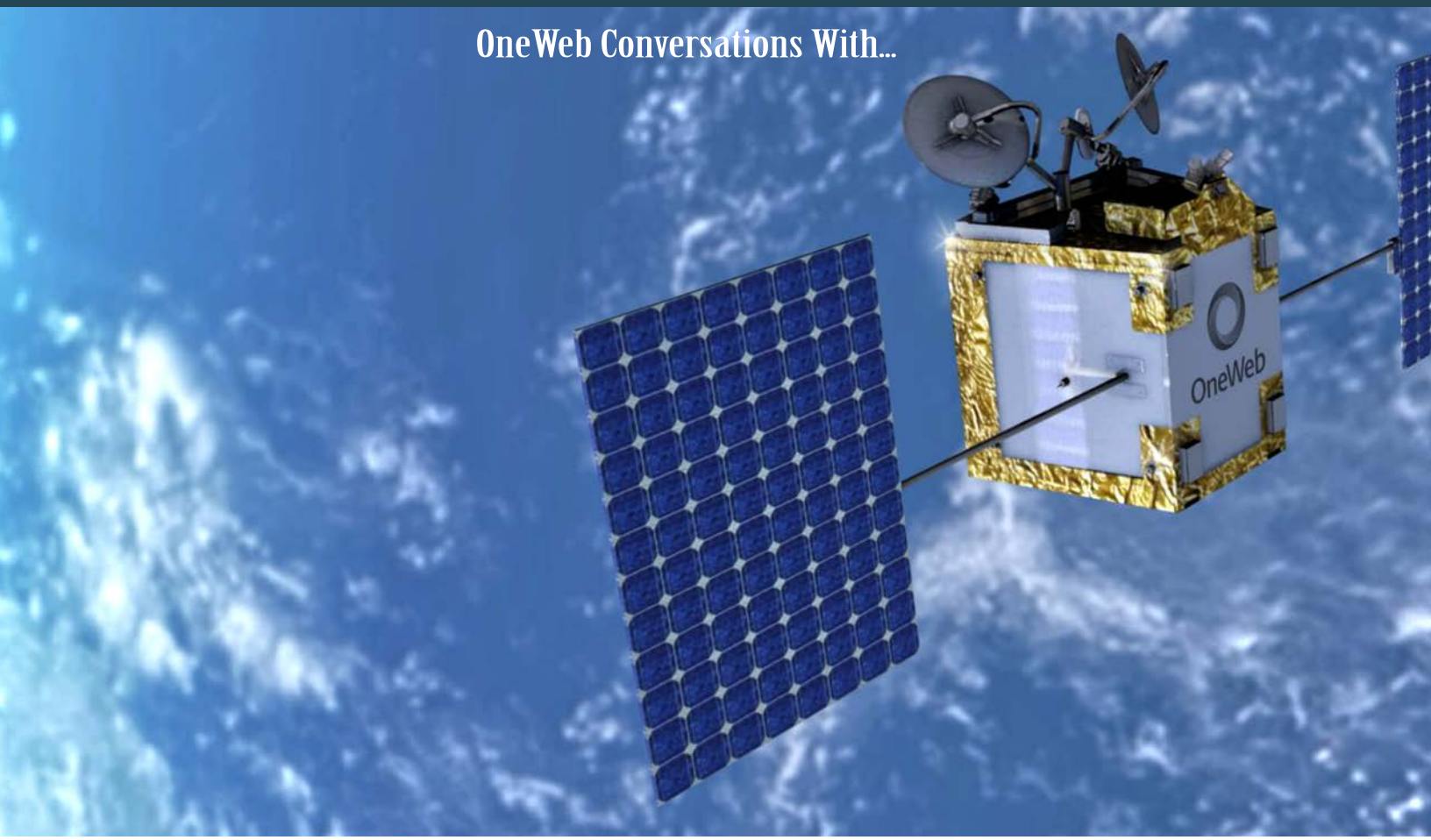

Carole Plessy, Head of Maritime, OneWeb

Dylan Browne, President, Government Business Unit, OneWeb

Ben Griffin, Vice President, Mobility, OneWeb

Eric Gillenwater, Vice President and Business Head of Global Carrier and Enterprise, OneWeb

Four of the leading executives at OneWeb offer their insights into the business cases for their company and discuss the firm's operations for the planned, worldwide, communications connectivity model.

Carole Plessy *is Head of Maritime Commercial Development for OneWeb. Carole joined OneWeb in 2018 with a background in satellite telecommunications and more than 20 years of business leadership and experience working across R&D and complex project management and product integration. Carole has extensive knowledge of the Maritime sector based on her previous role at Inmarsat, where she was Senior Director of Digital Products and, prior to that, Director of Maritime Product Development, responsible for new product delivery from concept to launch.*

Carole Plessy

Ms. Plessy, what is OneWeb's aspirations for connectivity within the maritime industry during the next five years?

Carole Plessy

There is currently a stark digital divide between connectivity on land and at sea which has limited the progress of the maritime industry's digital evolution. Vessels still have vast untapped potential to drive tech-enabled efficiencies and environmental improvements. Nearly 1.7 million seafarers on merchant ships alone, are also unable to reliably and cost-effectively contact home. We have a vision that access to data at sea should be as seamless and simple as it is on land and we are committed to making this a reality in the near term.

In the next few years, we are expecting to see the phase out of outdated, one-size-fits-all services and the establishment of a selection of tailored, customizable broadband channels, allowing vessel operators to access data based on their needs.

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Data speeds will also increase. With a high throughput, low latency global network is bringing terrestrial-like connectivity to operations at sea. For context, from 2023, OneWeb is offering speeds which are up to 10x faster than GEO solutions claims, while providing seamless global coverage including throughout the Arctic. In addition to opening up new trade routes, this enables the use of real-time data to enable remote operations, environmental monitoring especially on sensitive routes, real time video and cloud syncing can be used as standard, even on deep sea vessels.

There is no doubt we will see a complete digital transformation of the maritime industry and improved connectivity will be part of the catalyst. By enabling digitalization to become more accessible and reliable, fleets including container ships, cruise liners and fishing vessels, will have greater capacity to successfully navigate market challenges and become more resilient, responsible and profitable.

We know that access to data won't solve every challenge on its own. But, by improving the communications and information exchange, ship owners and operators will be better equipped to improve their environmental performance, manage crew welfare and social impacts, increase the accuracy of regulatory reporting and support the governance of the oceans.

What current trends are you seeing in the maritime market and what opportunities does this bring?

Carole Plessy
A key trend we have seen come to the fore over the last couple of years, are the challenging circumstances facing seafarers who are at the forefront of global trade. From extended contracts on vessels, the challenges in returning home, and unexpected quarantines, ultimately, seafarers have suffered as unseen front line workers in the pandemic.

One issue being highlighted is the inability to contact home either at all or without paying extortionate fees. In The Mission to Seafarers' Seafarer Happiness Index for 2021, seafarers reported the desire to leave their careers largely due to the impact of lack of connectivity on their mental wellbeing. This situation is still likely to have a negative effect on attracting and retaining essential maritime talent, even when operations fully return to 'business as usual'.

High-speed, low-latency services would enable them to enjoy social media and live video chats and contact friends and loved ones at times they need it. Connectivity has become fundamental to crew welfare whether seafarers are working on a merchant ship or a superyacht, and is increasingly perceived as a basic human right - seafarers should expect the same level of connectivity at sea as they get at home.

Access to data also greatly expands the possibilities for training and personal development at sea. This can help attract and retain the best crew, build loyalty and boost performance. Shipping companies are realizing that connectivity is a key element impacting seafarers, and vessel safety, and with this allows us to empower ship owners and operators to improve crew welfare and safety onboard vessels.

Seafarer wellbeing is just one 'social' aspect of the multiple ESG considerations that the maritime industry is trying to solve. The most significant one being its mandate to improve its environmental footprint, particularly the drive to become net zero by 2050.

Despite the complexity for ship operators of developing sound ESG strategies, there is an active role for data to drive effectiveness and an essential role for connectivity to support it. With better data insights, the industry will be more equipped to improve environmental performance, manage crew welfare, increase the accuracy of regulatory reporting and support the governance of the oceans. Fleets will then have the potential to become a valuable seaborne, carbon neutral data platform that boosts supply chain transparency and assist ESG decision-making amongst customers, financiers and suppliers, as well as becoming a key contributor to the performance of sustainable value chains.

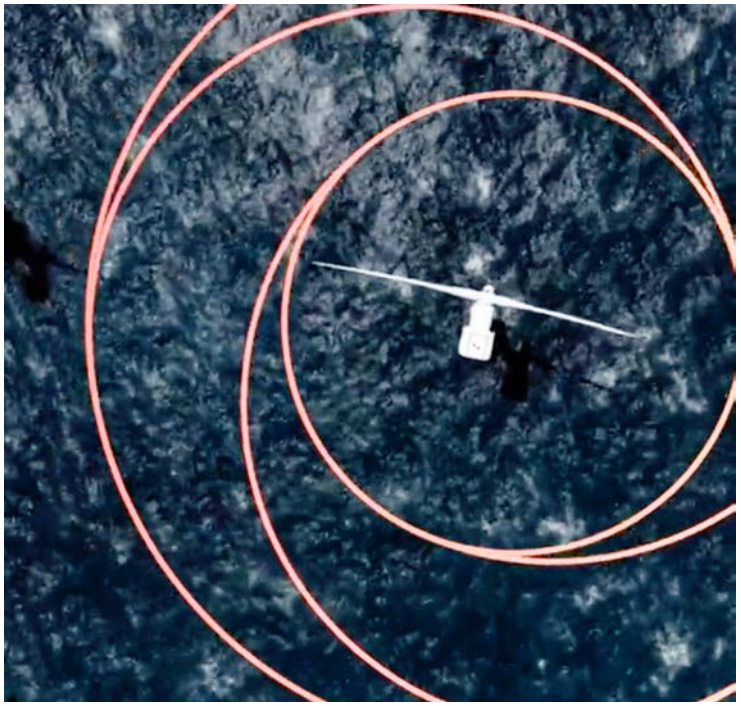
Dylan Browne *brings almost 30 years of experience in military and commercial satellite manufacturing, operations and sales for both satellite communications and Earth Observation (EO) missions. In his prior role as Chief Operating Officer at COMSAT Inc. he was responsible for both the day to day operations and business strategy of COMSAT's U.S. and International Mil/Gov programs and the development of new services for US DoD customers AMC, NAVAIR, SOCOM to include the adaptation of Iridium's Certus constellation based services for NATO, Australian Defence Force and UK MoD. Prior to his role at COMSAT, he was Chief Commercial Officer of the U.S. office of Airbus Defense and Space.*


Dylan Browne

Mr. Browne, how does OneWeb support First Responders?

Dylan Browne
Deployed at short notice into any type of scenario, First Responders must benefit from seamless and resilient connectivity to ensure maximum levels in operational effectiveness.

Whether it be the support of Law Enforcement, Paramedics, Fire Departments or Civil Defence Agencies, OneWeb is ideally positioned to provide First Responders with ubiquitous connectivity, applications and benefits anywhere in the World, at any time.



OneWeb's global constellation of ***Low Earth Orbit*** (**LEO**) satellites, gateways and user terminals ensure resilient voice and data communications, even in the most disadvantaged of areas. First Responders can exploit data throughput at high speeds and latency levels less than 100ms roundtrip, maximizing situational awareness and enabling near real-time command and control.

To that end, OneWeb is partnering with UK-based, ***Excelerate Technology***, a technology partner to First Responders in the UK and globally to enable such things as additional and improved real-time services, improved patient care, and situational awareness. First Responders, Government Organisations through to paramedics on the ground and telemedicine applications can all benefit from seeing additional, resilient connectivity services integrated into their work.

OneWeb's LEO-based satellite communications can be operated as a standalone solution or in working with partners like Excelerate, it can be integrated into their solution to help ensure data is shared in a timely manner between dispatched teams or individual personnel and their headquarters, each other or cooperating agencies to optimize decision-making.

Through the partnership with Excelerate Technology, OneWeb also allows First Responders and health service personnel to fully exploit 5G network connectivity for telemedicine procedures, thereby reducing requirement for unnecessary hospital admissions.

There are many exciting ways that OneWeb's LEO network can play a key role in safety and security and we are looking forward to seeing the impact of our work through our partners.

How does OneWeb support Humanitarian Aid and Disaster Relief operations?

Dylan Browne
Humanitarian Aid/Disaster Relief (HADR) missions typically take place in some of the most disadvantaged and remote areas of the World.

Whether featuring United Nations Disaster Assessment and Coordination (UNDAC), International Committee of the Red Cross or unilateral Government Agencies, OneWeb provides the connectivity required to successfully undertake HADR mission sets anywhere in the World, at any time.

Our truly global constellation of ***Low Earth Orbit*** (**LEO**) satellites, gateways and user terminals, provides Government and Non-Government Agencies with rapidly deployable, consistently available and resilient voice and data communications.

Customers benefit from 99.7% global coverage, including the Arctic; high speed data throughput; and latency rates less than 100ms roundtrip. OneWeb also ensures beyond line of sight connectivity and real-time command and control between forward-deployed teams and headquarters often located hundreds or even thousands of miles away, to maximize chances of mission success.

LEO-based connectivity can also be integrated into ***Primary, Alternative, Contingency and Emergency*** (**PACE**) communications plans.

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Designed with reduced size, weight and power specifications, multi-domain user terminals can be carried by dismounted personnel and integrated on board tactical ground vehicles, surface vessels and manned/unmanned aircraft to support operations in the most inaccessible parts of the globe.

OneWeb stands ready to support some of the most complex operations in the World, saving lives and providing relief to those who need it.

***Ben Griffin** has more than 20 years' experience in IFC, with notable contributions to companies such as ARINC, AeroMobile, Inmarsat and currently OneWeb. Ben's career in IFC has developed alongside the fast-paced change from narrow band to true broadband connectivity and now, at OneWeb, is responsible for delivering terrestrial-like connectivity solutions to aviation customers in all parts of the aircraft, passengers and crew alike. Ben brings a wealth of experience from the IFC service provision perspective, including significant satellite provider insight spanning both GEO and LEO technologies. Now based in the UK, Ben has also enjoyed 13 years in the Middle East giving him a broad experience of business in MEA and APAC regions.*

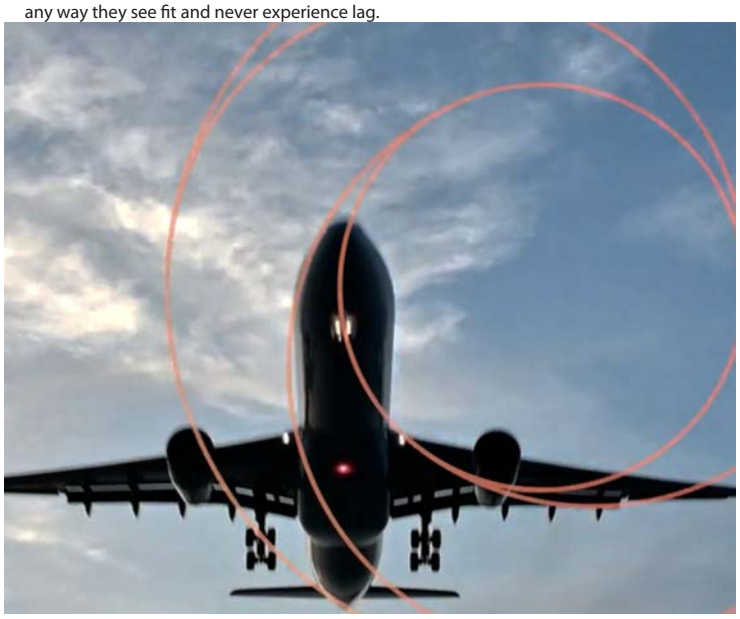
Ben Griffin

Mr. Griffin, how is OneWeb pushing the boundaries of inflight connectivity (IFC)?

Ben Griffin
By 2023, Gen Z will be the largest group of global consumers and research tells us that these guys love to travel. The tech savvy young adults who make up the flying public of tomorrow have never known a life without the internet and most of them (58% according to ***The Center for Generational Kinetics***) get very uncomfortable after just four hours without access to it. Just imagine how important the internet and online experiences will be for the generations coming after them!

With the advent of 5G and connected handheld devices growing more prevalent and more powerful by the day, it's clear that airlines need to make smart connectivity decisions now if they plan to keep up with the technological demands of future travelers.

There's a lot of talk in the airline industry right now about "*managing expectations*" when it comes to passenger connectivity, but at OneWeb we don't think this should be the approach. Instead of managing expectations, we should be fueling imaginations. We're launching a service that's robust enough to enable all passengers on a given aircraft to use internet in any way they see fit and never experience lag.



The inflight connectivity offered over OneWeb's LEO constellation will offer a much richer experience than their GEO cousins. This is key, especially when we take into consideration how demand for bandwidth in the air will evolve as Gen Z fine-tunes its taste for travel. OneWeb's coverage will be truly global a point of real significance for airlines traversing polar and equatorial regions where GEO satellites often struggle to deliver consistent bandwidth. Our recently announced agreement with ***GDC Advanced Technology*** paves the way for development of electronically steered antennas that will maximize throughput on any size fuselage.

All this adds up to a service that will finally allow airlines to deliver the seamless connected experiences onboard that their passengers' increasingly demand. The sheer speed and low-latency of OneWeb's solution will mean that Alex in 32F can stream the football game, Naomi in 15C can snag a last minute hotel room for when she lands, the Instagram star in 1A can 'go live' with her followers, the hardcore gamers at the back of the plane will be able to compete with opponents on the ground, and Ali can seamlessly and consistently access the cloud to work on their presentation… and all this can happen simultaneously. The key differentiator here is the low latency which is ten times faster than that possible through the GEO networks.

Each airline will have a different approach to the business model around our service, depending on their operations, their passenger demographic and connectivity need. But whether they opt for free, paid or sponsored access, they'll also be considering how IFC can benefit crew, maintenance teams, and pilots.

Connectivity even benefits airlines looking to reduce emissions by helping pilots and ATC optimize flight paths in real-time. And that's great news… because aside from being passionate about travel and wanting to say connected on the go, research shows that Gen Z are more likely to choose brands that show love for the planet through sustainability efforts.

***Eric Gillenwater** leads OneWeb's carrier and enterprise business and is responsible for engaging distribution partners which can bring OneWeb's game-changing enterprise-grade connectivity solutions to market. Eric ensures the enterprise market is taking full advantage of OneWeb's LEO network capabilities which will offer unprecedented speed and low latency connectivity to customers. He brings 20+ years of global telecommunications experience to OneWeb, most recently with Airtel for seven years as Vice President and Business Head of Airtel USA.*

Eric Gillenwater

How will OneWeb's LEO network affect rural and remote communities — bringing connectivity to places who have never experienced the benefits?

Eric Gillenwater
Digital infrastructure has become a priority for governments, businesses and communities globally. We think that our global connectivity service brings an incredible opportunity to address the digital divide, and to help close it.

For places where fiber is not feasible, or where existing solutions simply cannot provide the required classes of service, OneWeb is here to fill the void. Reliable, resilient connectivity will support resource and economic development, advance public health and safety, and, we believe, will truly empower people in un-served and underserved communities.

The low latency and high bandwidth of the network enables access to digital services such as remote learning, healthcare, e-commerce, and telework, supporting a range of benefits for many industries. The LEO technology also supports critical business applications in these hard-to-reach areas, opening new opportunities for economic expansion. We are looking forward to working in these communities around the world to make a difference.

How does OneWeb's solution fit into the already existing connectivity ecosystem for enterprises?

Eric Gillenwater
Our solution complements existing technology to bring new and enhanced applications into play. Our model is that of a Distribution Partner arrangement. We want to work with as many existing players as we can — for the benefit of our customers and to the existing providers. We are not here to displace fiber.

We actually want to work with the carriers who can then ultimately best serve their end users. We want to be part of the solution, not a standalone solution. The ability to support low-latency applications opens a whole new world of use cases that are now possible. With improved productivity, health and safety, asset tracking, environmental monitoring, crew scheduling, and employee welfare – working together with our partners, we can have a great impact on many industries.

We believe that our unique network plays a crucial in providing connectivity to drive transformational change.

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AEROSPACELAB RAISES 40 MILLION EUROS IN SERIES B FINANCING ROUND

Belgian satellite manufacturer *Aerospacelab* has accelerated its next stage of growth with a successful raise of 40 million euros. The Series B round is co-led by *Airbus Ventures* and *XAnge*, a leading European investor in early-stage startups. Additional investors in the round include *Octave & Miroslaw Klaba*, *SRIW*, *Noshaq*, *BNP Paribas Private Equity*, *Sambrinvest*, and *Belaero*. Since its inception in 2018, Aerospacelab has raised a total of 60 million euros.

"*With its clear and significant potential to positively impact both European and global markets, Aerospacelab sparked our immediate interest and attention*," said Airbus Ventures Partner ***Mat Costes***. "*They won our support by demonstrating how they can substantially improve decision-making processes across a robust sequence of varied sectors and are uniquely positioned to provide geospatial intelligence to private companies and governments alike. To the entire Aerospacelab team we offer a warm welcome as the newest members of our worldwide system of entrepreneurs spearheading the advance of our fund's portfolio companies across the planetary system.*"

Supported by an ambitious, vertically-integrated approach and dedicated to making geospatial intelligence actionable and affordable, Aerospacelab is powered by proprietary satellite data and enabled by its own satellites. Their constellations provide real-time content for a wide range of applications, ranging from defense and security, to civil sector applications including environmental, commercial insurance, and economic intelligence.

"*2021 was a fantastic year for Aerospacelab, marking the launch of our first satellite and demonstrating the efficacy of our technology in space*," said ***Benoît Deper***, Founder and CEO of Aerospacelab, who presented the company's industrial roadmap during a keynote at the #SpaceSummit, alongside European Space Agency Director General ***Josef Aschbacher***, in Toulouse, with the French Presidency of the European Union and European Commission in attendance.

"*Aerospacelab is a prime example of how European talents can realize important space projects in Europe. I am also glad to see that the work of ESA is contributing to this success. I warmly congratulate Aerospacelab on its successful fundraising*," said ESA Director General *Josef Aschbacher*.

Géraldine Naja, as Director of Commercialization, Industry and Procurement, said, "*We warmly congratulate Aerospacelab on its latest fundraising and fully expect to seek continued inspiration and advice from Benoît and the team as they scale.*"

The company's latest funding will ramp up satellite production capacity, deploy multiple constellations to establish an intra-daily monitoring of the Earth's surface, and implement geospatial data fusion analytics capabilities.

"*With this round, we are eager to continue to deepen our relationship with one of our earliest investors, XAnge, and thrilled to see Airbus Ventures enter our cap table, collectively confirming our ability to impact the space ecosystem and earn even greater opportunities in the European and global markets*," *Deper* said.

Since 2018, Aerospacelab has grown substantially, with two offices and more than 110 full-time employees, rapidly positioning itself as a leader in geospatial intelligence and small satellites platforms.

"*We have followed Aerospacelab since its very first steps. We've confidently believed from the very beginning their serious potential, as we led their first fundraising in 2018*," said ***Guilhem de Vregille***, Partner at XAnge. "*Today, we are especially pleased to be co-leading the second round with Airbus Ventures, and we are happy to continue to support Aerospacelab's bright future.*"

Nicolas Dhaene, Investment Manager at the ***SRIW*** (Regional Investment Company of Wallonia in Belgium), said, "*Aerospacelab is an excellent example of the extent of Wallonia's potential when its talent is matched by entrepreneurial spirit and ambition. As an early-stage investor, we are proud of the company's achievements to date and happy to further support its exciting industrial and technological roadmap within this strategic sector.*"

Resolve Optics Experiences Solid Growth In Delivering Optics For Space Projects

Resolve Optics has reported on growth in the demand experienced for designing and supplying robust optical systems for a range of different space projects during the last 24 months.

Many different types of optical imaging and sensing systems are used to observe and measure the Earth and the universe at large. However, designing optical systems for satellites and spacecraft is challenging, due to the harsh conditions that space places upon components and systems working in this remote environment.

Mark Pontin, Managing Director of Resolve Optics Ltd., said, "*Designing high performance optical systems for confidential space projects is something that we have done for over 20 years. Lenses that are used in space applications have to meet certain basic requirements to survive the harsh environment of space. Lenses must be constructed of specific materials that will not outgas when exposed to the vacuum of space. all significant air spaces should be vented to avoid pressure on the elements and distortion of the lens. All materials right down to glues and greases must be approved and tested for outgasing.*"

Mark added, "*The orbit that our optical systems will be operating in determines how much radiation they will be required to withstand. All optical elements within Resolve Optics radiation tolerant lens designs are made using cerium oxide doped glass or synthetic silica enabling them to withstand radiation doses of up to 100,000,000 rads and temperatures up to 55°C without discoloration or degradation of performance. These non-browning lenses provide high image resolution and minimum geometric distortion from 400 to 750nm.*"

Resolve Optics provides optical systems for surveillance, where the optical system monitors the outside of the spacecraft, looking for any signs of damage caused by space debris or micro meteorites. Inspection, where the optical system is required to view a specific area to aid operation. As part of a vision system that is used to guide and dock payload craft visiting platforms such as the International Space Station. And, remote sensing from satellites where powerful, high resolution lenses enable the Earth to be viewed from space providing valuable data on weather patterns and the impact of climate change.

New, Satellite-Focused Business Lines Debut From Comtech

Comtech Telecommunications Corp. **(NASDAQ: CMTL) has established two business units that are focused on exploiting long-term and growing business opportunities in the satellite ground station market.**

These two new business units, each of which will have its own agile and nimble business structure, will formalize and improve Comtech's ability to serve U.S. and allied governments as a defense contractor and will facilitate the establishment of a major innovation center for Comtech's growing commercial, VSAT platforms.

Daniel Gizinski and Dr. ***Vagan Shakhgildian*** have been appointed Presidents of two, recently created, U.S. and Canadian-based subsidiaries, respectively.

"*Our customers expect Comtech to apply expertise and state-of-the-art technology to address their complex challenges,*" said Comtech Chief Executive Officer and President, ***Michael Porcelain***. "*This is especially the case for satellite and defense-related hardware and government contracts, both in the VSAT arena and more broadly. This organizational shift is the latest example of how Comtech is transforming itself to anticipate and meet the changing needs of our end markets. I congratulate both Daniel and Vagan for taking on these new roles and share a sense of 1 momentum as we move toward a very bright future.*"

Daniel Gizinski

About Comtech Satellite Network Technologies, Inc.
Daniel Gizinski will serve as President of this unit which will be based in the firm's new, state-of-the-art, Chandler, Arizona high-volume manufacturing and technology facility as well as the existing Santa Clara, California facility.

Mr. Gizinski will lead a team focused on providing integrated, satellite-based solutions for government and commercial customers who have a need to rely on technologies developed and manufactured in-house at Comtech's facilities based in the United States

This business unit brings together a full range of Comtech's satellite Earth station products, including EF Data and Radyne branded modem lines and all of Comtech's XICOM branded, solid-state and traveling-tube wave satellite amplifiers.

Daniel Gizinski first joined Comtech in August of 2019 and has served in a variety of senior management positions, including Vice President of Product and Strategy for Comtech Systems Inc., where he oversaw the rollout of the ***Comtech COMET***™, the world's smallest, over-the-horizon (OTH) microwave, troposcatter terminal.

Prior to joining Comtech, Daniel held program management and leadership roles at L3Harris Technologies, Sierra Nevada Corporation and General Electric. Daniel holds a Bachelor's degree in Electrical Engineering from the University of Virginia and a Master's degree from Duke University.

About Comtech Satellite Network Technologies Corp.
Dr. Vagan Shakhgildian will serve as President of this unit which will be based in a new technology center located in Montreal, Quebec.

Dr. Vagan Shakhgildian

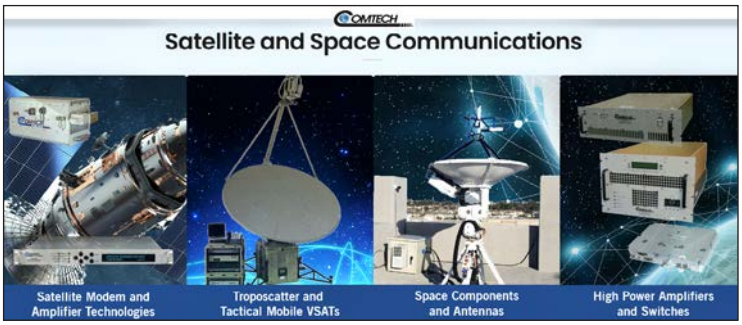
Dr. Shakhgildian will lead a team focused on streamlining, accelerating and capturing commercial networking opportunities for VSAT platforms and building out an innovation center for Comtech's commercial satellite Earth station communications technologies.

This business unit brings together Comtech's VSAT products, including Heights™, UHP and Memotec branded, satellite networking solutions.

Dr. Vagan Shakhgildian first joined Comtech in March of 2021 as part of the acquisition of Canada-based UHP Networks. As the CEO of UHP Networks, he led the company from a virtual start-up to a market leader in high performance VSAT systems.

Prior to that, Dr. Shakhgildian was the President and Chief Operating Officer of Advantech Wireless, Head of Research at Adaptive Broadband and held senior R&D positions with Motorola and Signal Processors. Dr. Shakhgildian holds advanced degrees in mathematics and electronic engineering, as well as an MBA from the London Business School.

Comtech Telecommunications Corp. is a leading global provider of next-generation 911 emergency systems and secure wireless communications technologies to commercial and government customers around the world. Headquartered in Melville, New York, Comtech designs, produces and markets advanced and secure wireless solutions.



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Getting The Most Capability From A LEO SATCOM Network

Author: Barry A. Matsumori, Chief Executive Officer, BridgeComm

While fixed and mobile providers have taken great strides in bringing high-speed broadband service to nearly every corner of the globe in the last decade, the industry is undoubtedly at a tipping point. Investments have dramatically increased in Low Earth Orbit (LEO) satellites as they are — compared to the larger satellites sent into a higher orbit — less expensive per satellite and easier to launch, replenish and update. These smallsats also require less power and have shorter data transmission latency. However, despite the benefits, there are tradeoffs to keeping costs down for the market segment they hope to capture. Individually, LEO satellites cover far less ground than satellites in higher orbit because they are at a low altitude, needing thousands of satellites and numerous ground stations to ensure coverage. As a result, the total system cost is higher than terrestrial counterparts since these are space-based systems.

Key LEO Communication Constellation Capabilities

When providing end-users communication services, there must be value added. Likewise, it is useful to review some desired capabilities from the LEO constellations.

- **Data link speeds**: *The data rates offered must be fast enough to support the breadth of modern services, including video streaming.*
- **Quality of service**: *The quality of service needs to be as close to terrestrial telecom as possible, reaching 99.999 percent of availability. Yet to enable a data link in space, there are two factors, availability during a data session and satellite system availability when initiating a session.*
- **Global coverage**: *A unique facet of LEO constellations is the broad global coverage afforded by the breadth of satellites. However, constellation architectures may limit coverage in higher latitudes unless designed for this coverage.*
- **Very low latency connectivity**: *A unique capability is using space-based routing to minimize the latency of a connection between disparate locations on Earth. Several applications can use extreme low latency services.*
- **Edge computing**: *Just as edge computing considers terrestrial networks, space-based networks can leverage telecom architectural construct.*

All current LEO constellations consider these parameters and translate said requirements into designs they deemed best for their customer base. Nevertheless, it is useful to examine, analyze and further explore value-added capabilities beyond the offerings of terrestrial communications.

One perspective of LEO constellations is that they are just extensions of the terrestrial telecom network. As such, they can use the unique factors of global coverage and low latency to provide advantages beyond terrestrial networks. However, operating like a terrestrial telecom network assumes several factors. Namely, the ability to route to any communications node and the network management capability to optimize things like least latency routing, on-demand data rate management, system capacity management and the management of various system services.

What enables these LEO constellations to have similar functions to terrestrial networks is their capacity to do in-space connectivity between satellites. Inter-satellites have these communication capabilities because of ***Optical Wireless Communications*** (**OWC**) and are called ***optical inter-satellite links*** (**OISL**). On the contrary, the early OISL solutions do not necessarily support the notion of a flexible communications network.

Unique Factors Related To Space-Based Comms Services

The use of a satellite adds constraints to the system design. Likewise, the addition of a communications terminal will influence several aspects of the spacecraft base chassis, normally known as the spacecraft bus. All OISL solutions need to consider the mass of the optical terminal and its relation to overall mass budgets for the satellite. Similarly, the power consumed by the optical terminal is a large factor in sizing satellite buses.

Also, the operational volume of the optical terminal is important as most optical solutions have dynamic envelopes. Meaning that in systems that use mechanical gimbals to steer the optical beam, the telescope must move its direction, creating a larger volume than the static envelopes. The slew rate of steering the beam is a criterion that decides if covering multiple satellites is possible. The possible slew rate of a mechanical gimbal will not support either multiple satellite coverage or the closing rate of satellites moving in cross plane connections.

One of the other factors related to the satellite bus is the control of bus attitude. Due to influences on the satellite bus, adjustments to the bus attitude through various devices must reorient the bus to its designed attitude. Typically, momentum wheels and thrusters control the bus attitude, but the use of these devices comes at a cost in the budgets planned for energy use. Any mechanical device that influences bus attitude will require energy to compensate for the device. And as a result, using a mechanical gimbal to provide coarse beam steering will add to the energy expenditure of a satellite bus.

These considerations contribute to many parameters that an LEO communication constellation will need to meet to support a unique service to end-users.

The Value Of Point-To-Multipoint Optical Communications

Where do optical point-to-multipoint (PtMP) communications fit into this set of requirements for an LEO communications constellation? The short answer is that any communications technology that can operate similarly to RF, the prevailing wireless technology, the better a communications system can function. However, some details provide more insight into how PtMP communications help meet the parameters needed for an LEO constellation.

The most obvious applicability is related to network architecture. To create a mesh network in space, one must consider that the larger number of connectable nodes, the more robust the network can operate. This robustness translates into the following guidelines:

- *More routes help achieve the least latency routing. This process is not just for single users but a multitude. Thus, this is a classic network optimization opportunity.*
- *More routes for capacity planning. The multitude of connectable nodes provides a communication system for routing and loading traffic across the network. There must be a myriad of nodes to select from, or system capacity will decrease - unlike an architecture that supports more operational nodes.*
- *More routes will support coverage diversity. Although an OISL is propagating through space, the connection to end-users is from space to ground. Having more routing options to connect to end-users through a diverse set of nodes will assist in delivering a higher quality of service to the end-user.*

The advantages of PtMP connectivity to a communications network are clear, but are there advantages beyond the network itself? The answer lies in the terminal designed for supporting PtMP connectivity and its implementation.

Realizing An Optical PtMP Terminal

There has been work done in the past on developing an optical PtMP terminal which has largely not manifested in a product. However, the combination of technology advancement, updated methods of optical design, and lessons learned have enabled a functioning PtMP product to get designed by BridgeComm.

There are three key elements in the optical terminal design; the use of a liquid crystal multilayer switch, a unique optical head assembly design and unique firmware that manages the terminal capabilities. This optical terminal design contributes to added benefits to the overall satellite system design. These design points manifest in **MOCA** (***Managed Optical Communications Array***) technology. These benefits are as follow:

- *Smaller operational volume for the optical terminal: Operational volume applies when components dynamically move during the terminal's operation. If it is possible to eliminate a mechanical gimbal, there will be a notable reduction in the volume required for integration into the spacecraft bus. BridgeComm's design supports the coarse beam steering function without needing mechanical components. It also allows for static volume that does not require a dynamic volume envelope.*
- *No added moments of inertia: The satellite bus does not have to accommodate for moments of inertia given the lack of mechanical components needed for coarse beam steering.*
- *No added power: Likewise, because there is no mechanical component necessary for coarse beam steering, there is no added power requirement other than the operation of the based optical terminal.*
- *No added mass: Furthermore, there is no added mass for that component in the MOCA technology-based design.*

Note: there are operational needs for an optical terminal to support PtMP functionality not traditionally required.

- **Bidirectional communication**: *The assumption is that a terminal supports bidirectional communication in all implementations. Point-to-point terminals will support this function, and MOCA technology will also enable this requirement.*
- **Tracking**: *Given that a space-based optical terminal has connections between moving objects, the target transceiver needs to get tracked. Further, this tracking must account for very high speeds as one of the conditions is for cross-plane connectivity where closing rates between satellites are approximately 56,000 km/hr. Such a rate of change in beam direction necessitates agility that will challenge a mechanically-based steering component. MOCA technology can support such a rate as it can perform beam direction changes in a range of microseconds.*
- **Beam steering to multiple target transceivers**: *To support a PtMP function, the change in beam direction does require short periods to use* **TDMA** *(**Time Division Multiple Access**) techniques. True multi-point has all target transceivers receiving different user signals simultaneously, but such a capability comes at the burden of higher costs as it requires multiple terminals. A close implementation is to use TDMA techniques to support multiple users with an acceptable level of latency as the terminal switches between users. MOCA technology will support this function.*
- **Rapid signal acquisition**: *PtMP requires minimal acquisition time to support multiple users. In the case of satellite constellations, ephemeris data is available that allows for a predictable path for satellite movement. The rapid signal acquisition combined with rapid beam steering enables the support of multiple users. In large part, most all-optical terminals can take advantage of satellite ephemeris data to support the signal acquisition.*

Combining all these capabilities into an optical terminal creates a product that can complement existing RF systems and still provides the specific benefits that Optical Wireless Communications (OWC) offers. In applications such as inter-satellite links, it may not need to be complemented by RF as the propagation environment of the vacuum of space is quite suited to OWC. However, where there may be atmospheric conditions that could mitigate the quality of service from an OWC terminal, RF could be a "*backup mode.*" This notion is similar to what already happens in multi-mode mobile phones.

The Future Is Bright For OWC In Space

The LEO communications constellations have recognized that the best medium for inter-satellite communications is OWC. We will see a proliferation of such terminals in the constellations. The next step to expect is expanding the application of OWC to space to the ground, including space to air links. Then, the possibilities for further application expansion are broad, as OWC will complement RF incredibly.

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Barry A. Matsumari

Author Barry A. Matsumori is the Chief Executive Officer of BridgeComm, Inc. His extensive background in the mobile wireless and Space 2.0 sectors spans numerous leadership roles, among them serving as senior vice president of business development and advanced concepts at Virgin Orbit, senior vice president of sales and business development at SpaceX and nearly two decades at Qualcomm, where he was vice president of wireless connectivity. He has also worked with several early-stage technology companies in development and management capacities. Barry holds a bachelor's degree in business from Arizona State University and earned his master's degree in electrical engineering from the University of Arizona.

LEO B'Band Connectivity Coming To India

OneWeb and Hughes Network Systems LLC ("Hughes") have a strategic, six-year, Distribution Partner agreement to provide LEO connectivity services across India.

The arrangement between OneWeb and Hughes Communications India Private Ltd. (HCIPL), a joint venture between Hughes and Bharti Airtel Limited ("Airtel") follows the Memorandum of Understanding (MoU) signed by the companies in September of 2021. HCIPL is well positioned to deliver services to enterprise and government with OneWeb capacity, especially in areas outside the reach of fiber connectivity. OneWeb will connect towns, villages, and local and regional municipalities in those hardest-to-reach areas, playing a critical role in bridging the digital divide.

This agreement expands upon an established relationship between the two companies. Hughes, through its parent company, EchoStar, is a longstanding and supportive OneWeb shareholder. The company is also an ecosystem partner to OneWeb, developing gateway electronics — including for those in Gujarat and Tamil Nadu — and the core module that will power every user terminal for the system.

Hughes is also the prime contractor on an agreement with the ***U.S. Air Force Research Lab*** (**AFRL**) to integrate and demonstrate managed LEO SATCOM using OneWeb capacity in the Arctic region.

In each of its core markets, OneWeb works with carefully selected distribution partners providing new business and expansion opportunities while supporting its goal of bringing improved digital communication services to some of the hardest-to-reach parts of the world. OneWeb's most recent satellite launch on December 27, 2021, brought the firm's total in-orbit satellites to 394 in number, that being 60 percent of the planned 648 LEO satellite fleet.

OneWeb plans to commence global service by the end of 2022 as demand continues from telecommunications providers, aviation and maritime markets, ISPs, and governments worldwide for its low-latency, high-speed connectivity services.

Service offerings under this agreement are subject to all appropriate regulatory approvals and licenses.

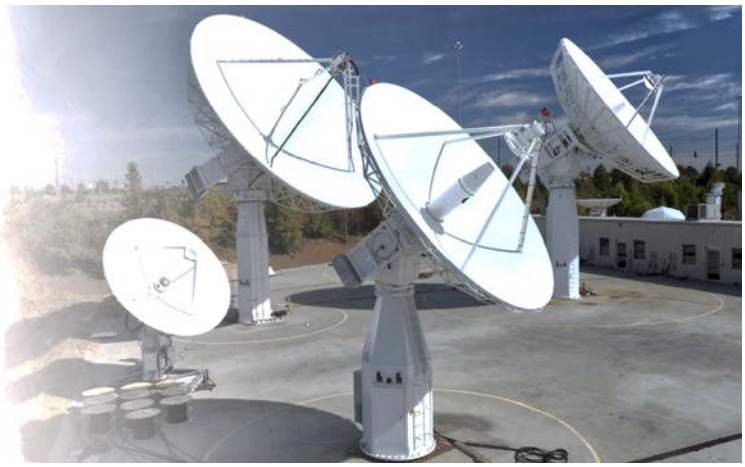
Viasat Advanced, Large Aperture Antennas Debut

Viasat Inc. **(NASDAQ: VSAT) has now made available their most advanced class of large-aperture antennas, one that will be capable of providing the United States and other spacefaring nations with enhanced space-to-ground communications for upcoming Earth Observation (EO) missions, manned and unmanned missions to the Moon, Mars and other deep space as well as Department of Defense (DoD) initiatives.**

The new class of full-motion multi-band antennas, which range from 19.7 to 24.0 meters in diameter, offer revolutionary capability enhancements when compared to other legacy solutions that still use decades old technology. Viasat's key antenna enhancements include:

- ***Full-motion high-dynamic pedestal with precise tracking that will support current and future multi-orbit missions from low earth orbit (LEO) to Lunar and beyond***
- ***An integrated radio frequency (RF) architecture paired with precision reflector surface accuracy to enable enhanced operation from L-band to above Ka-band***
- ***Robust suite of software leveraging 20 years of delivering the highest levels of cyber security standards***
- ***RF designs that support use of extremely high-power amplifiers in multiple bands enabling advanced mission requirements***
- ***Advanced high-rate modems that will support emerging industry standard interfaces and software defined radio (SDR) frameworks to enable future virtualized architectures***

"There is tremendous interest in earth observation, defense-based intelligence, surveillance and reconnaissance (ISR) and deep space/lunar link communications, which our latest class of full-motion large-aperture antennas were built for," said ***Kent Leka***, vice president and general manager, Antenna Systems, Viasat. *"In fact, it only requires a handful of Viasat's large-aperture antennas strategically positioned around the globe to provide constant connectivity, which could bring increased visibility to global space and defense agencies as well as to Ground Station-as-a-Service providers looking to deploy a network of antennas that support upcoming missions with lunar direct-to-earth service and cislunar relay for future missions to the Moon and even Mars."*

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*Source: GovWin IQ Total Federal Market Overview – Top Contractors 2016-2020 – NAICS 517410 Satellite Telecommunications
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Northrop Grumman Sends Israeli Chickpeas To The ISS Aboard Cygnus

Northrop Grumman's Antares rocket liftoff from pad 0A at 12:40 p.m. EST from NASA's Wallops Flight Facility in Virginia. The Cygnus spacecraft, carrying 8,300 pounds of science investigations and cargo. Photo is courtesy of NASA Wallops/Allison Stancil

Israeli chickpea seeds were among the supplies and equipment sent to the International Space Station (ISS) on February 19, 2022, for a series of experiments aimed at controlling growth of crops via technology.

From L to R: Yonatan Winetraub and Elad Sagi, Experiment System Engineer, showing the miniaturized green house containing the chickpeas to NASA and the protective suitcase aimed to reduce vibrations and temperature fluctuations prior to launch. Photo Credit: Getty Images

Contained for optimal growth in a small device called a "*miniature greenhouse*," they will be delivered as part of ***Northrop Grumman's*** 17th commercial resupply services mission to the ISS, aboard its ***Cygnus*** spacecraft. These special greenhouses are also well-suited for travel to the moon, which will be the next step of the mission.

The chickpeas are part of a project called "*Space Hummus*," which will test hydroponic techniques for plant growth in zero gravity. A superfood with high nutritional value, chickpeas grow quickly and easily, making them ideal for space cultivation. Scientists will conduct experiments on the ISS using special LEDs to see how well plant growth can be controlled, remotely observing and controlling root growth through video and still images.

The goal is to maximize productivity and allow efficient management of resources on future space colonies on the moon and Mars. The team believes that perfecting techniques for control, part of a field called synthetic biology, could be essential to growing crops in a space station or on the moon and other planets.

"*We can't let the plans 'grow wild' in future colonies because they will quickly run out of resources*," said Co-Founder of ***SpaceIL***, ***Yonatan Winetraub*** (PhD, biophysics at Stanford University), the visionary behind the experiment. "*Our hope is to use our technology to control the rate of chickpea growth in space with zero gravity and limited resources.*"

Led by Winetraub, scientists and engineers from Israel and Stanford University, VC fund ***Moon2Mars Ventures*** and the ***Desert Mars Analog Ramon Station*** (D-Mars), the experiments will receive additional assistance from ***Yeruham Science Center*** high-school students and be performed, in part, by Israeli astronaut ***Eytan Stibbe*** (RAKIA mission, 2022).

The "Space Hummus" experiment would not have been possible without the support of ***Strauss Group Ltd***., an Israeli F&B company; and ***Haifa Group***, which specializes in advanced technological solutions for precision agriculture and has developed a unique nutrient formula for growing chickpeas in space to ensure high-quality crops per unit area.

"*We don't know if chickpeas can grow in space. This is something that has actually never been done before*," said Winetraub. "*The challenge is not just how to grow as many chickpeas as possible, but how to control the way they are grown – so that we maximize our limited resources. The more we learn to grow food with fewer resources, the more prepared we will be for the challenges that await us on Earth, as well*," he added.

NASA has recently announced that it's looking at ways to provide astronauts with nutrients in a long-lasting, easily absorbed form, such as through freshly grown fruits and vegetables. The agency agrees that the challenge is how to do that in a closed environment without sunlight or Earth's gravity.

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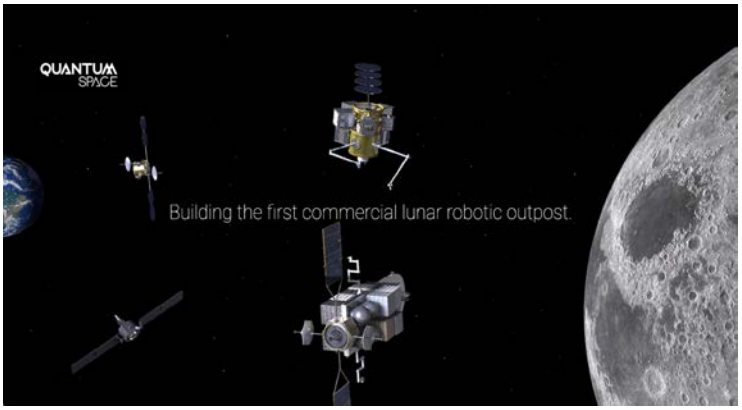
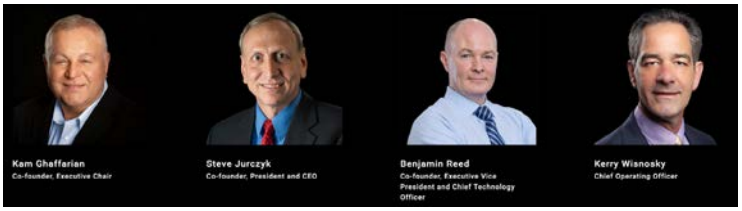
Quantum Space Debuts To Build Evolvable + Scalable Space Platform



With a focus on rapid technological advancement and lowering the cost to access cis-lunar space, a quartet of space veterans are launching Quantum Space, a commercial space infrastructure and services company aimed at disrupting the current norms of the satellite industry.

At the center of the new company is an evolvable and scalable space platform, called a robotic outpost, that will serve multiple users with deploying satellites, hosting payloads and acquisition of data and logistics services via customizable missions from locations in lunar and Earth orbits.

The three co-founders are ***Kam Ghaffarian***, a space and energy entrepreneur whose co-founded many leading new space companies, ***Steve Jurczyk***, the former NASA Acting Administrator, and ***Ben Reed***, former division chief of NASA's Exploration and In-Space Services at Goddard Space Flight Center. They are joined by ***Kerry Wisnosky***, the co-founder and former principal owner of Millennium Engineering and Integration.



Each has more than 30+ years of experience in aerospace developing, launching, and operating complex space systems. The trio saw a need in the market to lower operating costs, drive more rapid innovation and efficiently enable new space capabilities.

Founded in 2021, Quantum Space focuses on hosting and deploying payloads and providing data and logistics services from unique vantage points, such as Earth-Moon Lagrange points, a critical location for economic and national security purposes. The company plans to rapidly expand space services with additional outposts at various orbits. With its modular in-space infrastructure, Quantum Space plans to be a key player in addressing space sustainability with their multi-user, multi-mission model.

The first mission to Earth-Moon Lagrange Point 1 is slated for 2024.

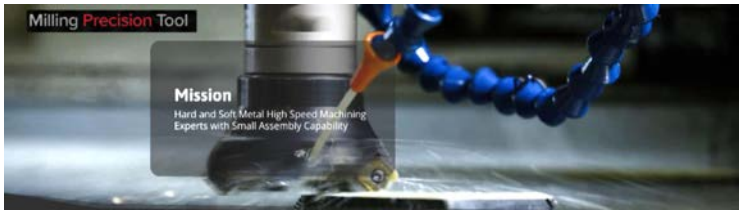
"*We envision a future where innovation and sustainability meet propelling human progress, economic growth and expanding access to space, and its vast ability to improve life on Earth. Quantum Space will be a leader in building this new future by rethinking how we approach spacecraft and space services*," said ***Ghaffarian***, co-founder and Executive Chairman of Quantum Space, who is providing the seed funding for this new space company and has a strong background co-founding and funding successful deep-tech startups such as Axiom Space, building the world's first commercial space station, Intuitive Machines, creating the first American Lunar Lander in 50 years, and X-energy, an advanced nuclear power company.

"*We aim to remove barriers to entry for utilizing space to deliver more science, more data and information, strengthen national security, and accelerate commercial activities. Our business model which allows customers to purchase services on an as needed basis will enable new entrants and markets by reducing costs and allowing more rapid access to strategically important locations*," said ***Steve Jurczyk***, Co-founder and President and CEO of Quantum Space. Jurczyk, who in addition to leading America's space agency, also served as NASA's Associate Administrator and Associate Administrator for the Space Technology Mission Directorate.

United Launch Alliance Contracts For Atlas V Rocket Components

United Launch Alliance has contracted with Milling Precision in Wichita, Kansas, to supply components for the company's Atlas V rocket. The Atlas V rocket has launched 90 times with payloads for the Department of Defense, NASA and commercial customers.

Milling Precision will be adding to ULA's diverse network of suppliers providing fabricated and machined parts. Their talented and committed workforce will add to the company's first in class launch and schedule capability meeting our customers' needs and ULA's best value.



ULA is no stranger to the tremendous aerospace suppliers of the great state of Kansas. Currently, ULA works with 16 suppliers and as our launch demand grows we continue to look for new and talented suppliers to meet our stringent requirements.

"*I had the opportunity to visit Wichita recently and meet with current and potential suppliers*," said ***Tory Bruno***, ULA president and CEO. "*During my time there I was very impressed with the highly skilled workforce and aerospace industry knowledge that already exists. As we continue our support to the nation as its premier launch services provider, we looking forward to working with Milling Precision to deliver those critical missions.*"

With more than a century of combined heritage, ULA is the nation's most experienced and reliable launch service provider. ULA has successfully delivered more than 145 missions to orbit that aid meteorologists in tracking severe weather, unlock the mysteries of our solar system, provide critical capabilities for troops in the field, deliver cutting-edge commercial services and enable GPS navigation.

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Back-Up Systems Now Taking Center Stage

Reliance on connectivity increases

Author: Nabil Ben Soussia, Chief Commercial Officer and President — Asia, Middle East and CIS, IEC Telecom Group

As digitalization becomes the norm across many business sectors, fast-tracked by digital solutions identified during the pandemic, IEC Telecom advises that business continuity is critical to ongoing success.

"*Digital systems need to be capable of operating seamlessly over satcom and back-up solutions. With the amount of data that needs to be recorded and transferred seamlessly, for example between a ship and shore, and often in real-time, it isn't possible to just drop down to email-only mode if the primary network goes down*," said ***Nabil Ben Soussia***, CCO and President — Asia, Middle East & CIS, IEC Telecom Group.

According to a 2021 survey, 95% of operations and IT leaders are revising and implementing business continuity measures as a result of the pandemic. Prior to the global Covid-19 outbreak, only 49% of senior managers said they were continuously improving their ***business continuity management*** (**BCM**) processes (2011 figures), while 18% revealed they did not have a BCM program.

According to ***Gartner***, while the average cost of IT downtime is $5,600 per minute, these can be as much as $540,000 per hour at the higher end of the market. A recent survey of IT decision makers regarding their action plans post-pandemic found that 50% planned to improve their IT infrastructure, 45% aimed to improve IT operational efficiency, and 34% were working to improve their business continuity plan. A further 29% planned to implement edge computing while 43% intended to deploy hybrid solutions.

Mr. Ben Soussia said, "*Back-up systems are essential in today's business environment. The challenge now is to ensure that they are able to be used to their fullest potential to form a crucial part of business operations without adversely impacting critical operations or costs*."

He foresees a greater expansion in the development of specialist applications that enable customization throughout 2022 and beyond. It's an area where IEC Telecom has focused on particularly over the past five years to develop a series of specialist applications which can operate on VSAT and even L-Band. Its comprehensive suite of applications, ***OptiConnect,*** offers a range of communication services optimized for low bandwidth environments. Applications previously only possible via GSM are now available via lower bandwidth systems and back-up services.

Not only are a greater range of users across multiple industry sectors now able to access business tools such as videoconferencing, real-time online maintenance, and remote surveillance, but they are also able to ensure business continuity because the services can continue to operate via back-up systems if the main link goes down.

According to a 2020 ***McKinsey*** survey, organizations that are able to leverage design thinking into their offerings post the Covid-19 crisis have seen significant first-mover advantage. The top economic performers have invested into digitalization, acquired new digital technologies for profitability, and outperformed their competitors in total returns to shareholders.

Moreover, digital solutions are increasingly being used for remote maintenance, resulting in an increase in operational efficiency, optimized capital investment in hardware, and saving the cost and complex logistics involved in sending technicians to far-flung sites.\

OneAssist is the perfect example of a digital solution used for remote collaboration in the utility, oil & gas, and humanitarian sectors. It is easily accessible over a high-resolution display on a rugged head-mounted device that is attached to a helmet. This hands-free approach frees up the time that field workers or technicians spend looking at a paper manual and almost 80% of concerns can be resolved quickly with such remote access.

Such benefits of seamless connectivity have also been extended to first responders, who are now empowered with better situational awareness due to advanced photo and video data transfers. Enabled by special integrated protocols and tools for a low bandwidth environment, interactive solutions by IEC Telecom allow users to quickly share images and video clips from a remote mission in real-time. Decision-makers can then easily select the visual areas of interest to be transferred in high resolution, thereby increasing the efficiency of the bandwidth while maintaining the quality of data transferred.

In the maritime sector, ensuring these cost and time efficiencies as well as the authenticity of data that is transferred is just as crucial, with more than 90% of global trade carried through the sea network. With the increased demand for security in ports and coastal areas, tracking vessels, and protecting them from any hostile attacks, surveillance and tracking systems that are optimized for operations at sea are actively being developed.

"High tech ships are now offices at sea and the associated requirements for managing large volumes of critical data via reliable connectivity are increasing exponentially," said Mr. ***Ben Soussia***. IEC Telecom's multi-layer cyber security package safeguards onboard systems, helps customers cover a large part of the recommendations of the ***International Safety Management (ISM) Code*** — which has been in effect since January 1, 2021 — and supports the business continuity of customer operations by enabling IT personnel to retrieve data following an interruption.

Keeping pace with the rapidly evolving global business environment is critical to staying relevant and meeting customer needs in real-time. Having a back-up system is not a new concept – what is new is the ability to use these systems for important operational functions. Digital solutions that ensure continuous connectivity represent the future.

Author *Nabil Ben Soussia is the Chief Commercial Officer and President — Asia, Middle East and CIS, IEC Telecom Group.*

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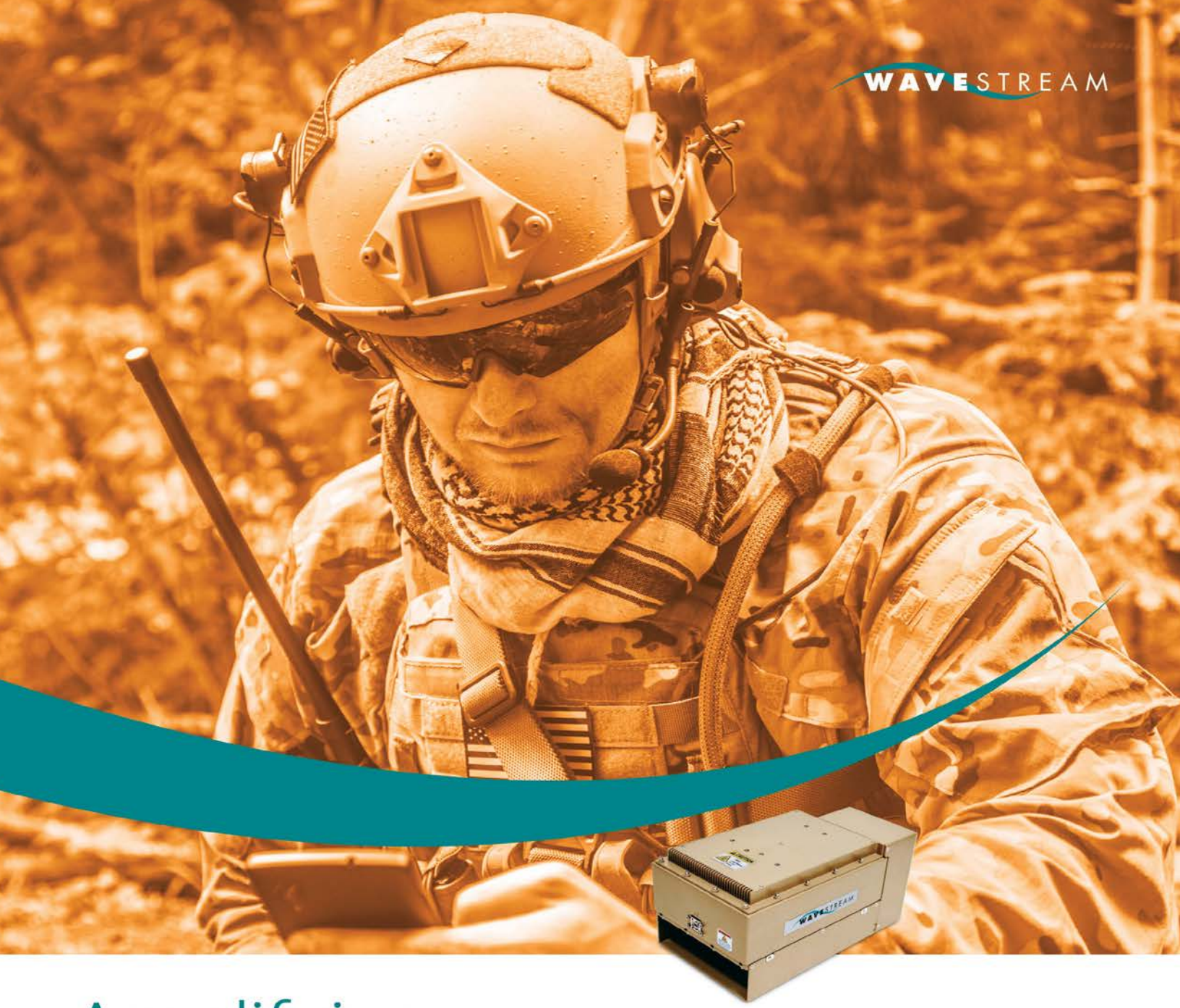
Nabil Ben Soussia

WAVESTREAM



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A PALS Focus...

Presenting a modular Earth Station

Author: Özdemir Öztürk, System Integration Engineer, PALS Elekltronik

With recent advancements in the industry, mobility has became an extremely popular technology demand with end-users as well as with sector professionals in the satellite communication (SATCOM) markets.

PALS Electronics, based in Istanbul, Turkey, has a wealth of experience in design, development and manufacturing state of art satellite antennas and integrates communication systems and has done so since 1995. The company recently developed an ***Earth Station*** (**ES**) with a special structure to comply with the demands for a lightweight, modular solution that incorporates robust components for commercial and military satellite communication (MILSATCOM) purposes. Satellite systems crucially provide connectivity solutions to rural areas where there are no land connection options at all —

PALS' PFA-370 (*pictured to the right*) is a unique solution for building a modular ES in those areas as a highly flexible and mobile solution.

Introducing PFA-370 as an ES antenna that possess all of the features of modularity means that the user can disassemble the antenna and transfer it to any other location they wish to incorporate its capabilities.

All parts of this ES are designed and manufactured from *Carbon-Fiber* to be lightweight — this means that an average person can assemble/disassemble, and most importantly, carry it around. The antenna reflector itself, which is the heaviest part of this unit, is comprised of up of 19 individual segments. Each segment has labels with numbers, making it easy to assemble. All parts are designed to be snapped on — no special tools are required, other than human hands. The PFA-370 antenna system is specifically designed for ease of use and installation, no matter whether the operator is a professional who has experience in satellite communication, or an operator who has just experienced their first encounter with a satellite communication antenna with some training under their belt.

One of the most important features and what makes this system mobile, other than modularity, is how you transport them. Each part of the system has a designated spot in its packing boxes. The whole system can be divided into nine boxes in total. Each box is IATA compliant, which means it is not too heavy for a person to carry, and the box sizes are appropriate for use on commercial or military aircraft. These types of products are called "***Fly-Away***" with the carrying boxes part of the antenna mount, called a pedestal (*see the image to the right)*. There is also secure housing for antenna systems' motors and driver controllers. Users don't have to worry about where to put all the boxes after the parts have been removed.

In addition to the unit's distinctive physical features, PFA-370 also allows the selection of different feed options and can operate in C-, X-, Ku-, Ka-, and DBS bands and in various configurations. Feed options can be **Rx**, **Tx/Rx**, **2-ports**, or **multiple ports,** and polarization can be circular or linear. Customized design and different feed arm options are possible to provide interchangeable feed structures. Thanks to the unit's mechanical design, it ensures the best RF performance. The PFA-370 also possesses superb RF characteristics, low insertion loss, great VSWR, high cross-polar isolation, as well as a highly reliable G/T ratio.

For extremely cold environments that are subject to frequent, heavy snowfalls, the PFA-370 antenna system offers a half and full ***De-Icing*** option (*see image to the right)* and it is highly recommended. This low power consumption system makes sure its operation won't be interrupted under any weather condition.

PALS De-Icing system can be controlled by an independent controller or ***PALS Antenna Control Unit, PAC-550***. Both controllers are undergoing military tests according to **MIL-STD-810G**. and make certain the system can be operated at -30 C and can be stored at -40 C.

RF CHARACTERISTIC		
Frequency (GHz)	Tx 13.75 - 14.50 GHz	Rx 10.70 - 12.75 GHz
Antenna Gain (±0.2 dBi)	Tx 52.6 dBi @ Midband	Rx 51 dBi @Midband
Polarization	Linear (optional circular)	
Feed Insertion Loss	Tx 0.8 dB	Rx 0.3 dB
Waveguide Interface	WR - 75	
VSWR	1.3:1	
Cross Polar Isolation	35 dB	
G / T	28.5 dB/K	

PFA-370 environmental characteristics.

PFA-370 is compatible with the PALS PAC-550 antenna control system. For PAC-550 many options are available on demand. It stands out among its rivals with a spontaneous DVB-S/S2 receiver and/or beacon tracking receiver feature. As mentioned earlier, it has a De-Ice module too.

There is a military version of this antenna control system, as well. PAC-550-MIL is designed, developed, and manufactured according to MIL-STD-810 and MIL-STD-461 for the defense market and the unit has passed all of the necessary military standards tests,

PAC-550-MIL antenna controller uses state of the art auto-pointing algorithm — the auto pointing performance has been approved ***EUTELSAT*** according to the ***ESOG120*** standard. The algorithm also makes certain the antenna did not point to side-lobes of the satellite signal but was pointed directly to the boresight of the satellite beam.

A Beacon and/or DVB-S/S2 receiver can be embedded PFA-370 antenna and its PAC-550 antenna controller. This means a beacon receiver can be used for antenna processes, such as auto pointing, tracking, and so on, as well as a DVB-S/S2 receiver in the same box without the necessity of making any physical changes.

This feature makes the system superior. PAC-550 and PAC-550-MIL contain **HPA/BUC** muting features. The main idea behind this is muting the BUC or HPA until the antenna control system automatically or manually acquires a satellite signal. The ES operator will not be able to accidentally send any signal using BUC or HPA and cause disruption of services.

All PALS products have a military version — the company conducts sector defining U.S. ***Department of Defense*** (**DoD**) standard MIL-STD-810G and its method applied to the PFA-370-MIL antenna system and its subcomponents which is the military version of PFA-370. It has the same RF characteristics and complies with ***MIL-STD-188-164A / ITU-RS-580 / ITU-R S.465-6*** criteria.

Obtain additional information about PALS Electronics and its products by emailing the firm ***at this direct link.***

Author Özdemir Öztürk graduated from Electrical, Electronics and Communications Engineering of Haliç University in 2011. He completed a master of science degree at Haliç University, Turkey. He has been working with Pals Electronics since 2014.

Özdemir Öztürk

Predications For The Year Ahead

From the Hughes Leadership

If "what's past is prologue," then we are in for an interesting year! Leaders from across Hughes were asked to share their learnings from 2021 and offer their insights on the trends and opportunities to watch for in 2022.

North American Enterprise Market

According to ***Mike Tippets***, vice president, Enterprise Marketing, organizations continue to "*enhance and improve their ability to support remote work, with many different people across many different locations. But true innovation happens when people can get together in person. While we learned over the last two years that we can all work remotely, a hybrid arrangement is better. Time together is better.*"

Looking ahead, Mr. Tippets said, "*We now understand the impact of artificial intelligence and machine learning. It's been talked about for a long while. Now it's time to start using it. For the enterprise, it requires finding the repetitive tasks, setting up and teaching the models, using AI/ML for automation. It's a lot like factory automation. I don't need an employee to stand there all day pulling a drill bit down; I would rather use them to do something that requires creative, critical thinking. We've started implementing AI/ML in our own field service installations with great success, and that's just the tip of the iceberg.*"

International Markets

Dave Rehbehn, vice president, International Division, offered his perspective: "*One industry takeaway from 2021 is how the geostationary high throughput satellite (GEO HTS) segment rebounded so strongly, with particular demand for digital divide projects. Looking ahead to 2022, we expect to see a significant increase in 'flexible' or software-defined HTS orders from the GEO industry. Software-defined GEO HTS can change frequency bands, coverage areas, power allocation and architecture on-demand and at any point, to enable operators to tap new markets, address new applications and rebalance for demand.*

Defense Markets

Rick Lober, vice president, Hughes Defense, spoke of the significance of LEO satellite demonstrations for the sector in 2021, noting that, "*LEO will become a major element of all future defense programs. This includes commercial and purpose-built systems for the U.S. Department of Defense. In addition to providing low latency service, one of the great strengths of LEO systems is that they enable connectivity in the polar regions – with are strategically important to the military.*"

From the perspective of the defense industry, Mr. Lober added, "*In 2022, we will move to larger managed service programs, either as the prime or a subcontractor, and expand to other transports such as LEO and 5G, providing increased options and capabilities for military SATCOM networks.*"

Government Markets

James Clevenger, director of government sales and business development, offered his reflection on the last year. "*Government agencies spent much of their time the past year transitioning and updating their network technologies from the old NETWORX contract to the Enterprise Infrastructure Solutions (EIS) contract. They now have more options and network providers to choose from, including Hughes.*"

Looking ahead to 2022, he said, "*LEO satellites will become the reality, as we start to see deployment of LEO solutions and services. It's exciting stuff. Everyone at the state and Federal level wants to know more. They won't rip out their existing technologies, but they are eager to see proof of concept networks.*"

Mr. ***Clevenger*** added his prediction that, "*Along with LEO, we'll see more digital signage and digital media deployments, because these solutions provide capabilities that government agencies everywhere need to better engage employees and constituents – especially as contactless services continue.*"

Regulatory + Space Sustainability

Jennifer Manner, senior vice president, Regulatory Affairs, agrees that "*Non-geostationary orbit satellites, like those at LEO, are an increasingly important solution for broadband connectivity, and multi-orbit strategies are essential to meet all user demands.*"

The last year was also notable, Ms. Manner said, because of, "*The creation of the first truly global satellite trade organization with the evolution of the European Satellite Operators Association (ESOA) to the Global Satellite Operators Association (GSOA). The industry is well poised to address upcoming policy issues, including access to spectrum and space sustainability. For the future, with the increasing number and size of satellite constellations, spectrum management and space sustainability will be critical to the industry's long-term success.*"

All of the Hughes leaders agreed: if the past is any predictor, the steep rise in demand for broadband connectivity will continue across all sectors and in all settings—urban, suburban and rural — further strengthening the need for continued Hughes engineering and innovation.

The Forrester Report: CABSAT —— Part One

Time to catch up

Author: Chris Forrester, Senior Columnist

The CabSat trade event in Dubai is still a few weeks away (May 17-19) and has returned to its usual timing after two years of COVID--based delays. This is the opportunity for the local industry to re-assemble and re-assess the challenges that face broadcasters, satellite operators and content creators.

Unfortunately, the past year or so has seen some significant changes. For example, ***Arabsat*** lost their well-regarded CEO, ***Khaled Balkheyour***, in August 2021). He was replaced temporarily by Dr. ***Badr bin Nasser Al-Suwaidan*** — the search continues for a new CEO and an appointment to this position is likely during Q1 of 2022. Sources at the Saudi Arabian-based Arabsat admit that trading is "*tough*."

Arabsat's main satellite rival is Cairo-based ***Nilesat*** — that company has also seen margins squeezed and profits affected commensurately. Nilesat is involved in a limited partnership with Paris-based ***Eutelsat***, and this long-running leasing and channel wholesaling arrangement was renewed — although on a reduced basis — on October 28, 2021. The local consensus is that the Nilesat renewal covered about half of the previous contract.

Eutelsat says it now has "*Multiple agreements*" including multi-year, multi-transponders contracts with the UAE's ***Du***, the important ***Jordan Media City*** and ***Abu Dhabi Media***. Eutelsat and Nilesat's 7/8 degrees West video hotspot represents the most powerful, widespread and dense footprint in the Middle East and North Africa, reaching 90% of TV homes in the region. It is one of the most dynamic neighborhoods in the global satellite TV market with more than 60 million homes and 1,000 channels.

However, revenues and profits are being poorly realized at Nilesat — the company reported nearly $200 million in annual revenue in 2014, but since then, its revenues have steadily declined. Nilesat is quoted on the Cairo stock exchange, making the firm's painful fall in income easy to examine.

Nilesat logged net profits of $20.3 million in the first nine months of 2021, a drop of 22% year-on-year from $26.07 million. The company generated $86.66 million in revenue in the January-September period, down from $93.89 million in the year-ago period, according to a bourse disclosure.

Nilesat revenues	
Q3/2021	$27.18 million
9 months 2021	$86.67 million
Q3/2020	$30.11 million
9 months 2021	$93.9 million

Both Arabsat and Nilesat accurately utter much the same grumbles in terms of market sentiment, and this reflects the fact that the MENA region is still probably the world's largest market for ***Free-to-Air*** (**FTA**) viewing. From the major broadcasters, such as Dubai-based ***Middle East Broadcasting*** (**MBC**) and its impressive portfolio of high-quality channels to the most niche of services, they are almost all free-to-view.

While MBC fully supports high-definition transmissions — and has even backed some 4K productions — the sad fact is that hundreds of other channels are still in near-primitive (*by modern standards*) ***'standard definition'*** transmissions. Their transmission rates are miserable and the video quality is poor. Moreover, the rate of conversion from SD to HD is at a snail's pace. Consequently, the opportunity to levy higher prices for HDTV transmission is slow to be materialized.

Nevertheless, Nilesat has ordered a new, 4-ton satellite (***Nilesat 301)*** from ***Thales Alenia*** for a likely launch later in 2022. The contract was signed by NileSat CEO ***Ahmed Anis*** and SVP at Thales Alenia Space, ***Martin Van Schaik***. The new satellite will replace ***NileSat 201***, which ends its design life in 2028. Importantly, 301 will add Ka-band capacity over the MENA region.

Nilesat 301 has a design life — likely to be well exceeded — of 15 years. NileSat 301 will also cover countries in the south of Africa and along the Nile basin. SpaceX will launch this new satellite to 7 degrees West.

Arabsat and Nilesat have plenty of available capacity, but so does ***Es'hailSat*** which broadcasts from ***Qatar***. The past few years had seen a bitter territorial dispute between Qatar and its near-neighbors in Saudi Arabia, Kuwait, Bahrain, Egypt and the UAE. The basis for the squabble was television piracy of signals coming out of Qatar of the ***beIN SPORTS*** channels **HD1**, **HD2**, **HD3**, **HD4**, **HD2 MAX** and **HD3 MAX** as well as **HD5**, **HD6**, **HD7**, **HD8** and **HD9**.

BeIN SPORTS held the exclusive TV rights for many of Europe's leading football channels and these were blatantly pirated by a Saudi-based operation. Thankfully, the spat was formally ended in 2021, and in good time for this year's massively popular ***FIFA World Cup*** transmitting out of Qatar from November 21st to December 18 this year. The organizers say that transmissions will be in ***Ultra HD (4k)*** and that will help promote sales of higher-end TV televisions in the region and beyond.

Mr. ***Hamad Al Mannai,*** VP/Commercial at Es'hailSat, admits that the MENA broadcasting industry, and the COVID pandemic, has impacted the entire, local entertainment and media industry. "*PwC's report, 'Perspectives from the Global Entertainment & Media Outlook 2020–2024' projected a contraction of 5.6% in 2020 across the industry. However, it is believed that the industry will bounce-back once the situation normalizes later in 2022 and will continue show a growth trend beyond that.*"

Es'hailSat shares an orbital slot with Arabsat at 25.5/26 degrees East similar to that of Nilesat and Eutelsat's 7/8 degrees West slots. Es'hailSat 1 is slotted at 25.5 degrees East, while Es'hailSat 2 is at 26 degrees East, which is where Arabsat's Badr fleet orbits.

Satellite broadcasting remains one of the important pillars in delivering high quality video to millions of homes across this vast region of the world, especially one that is spread out in sparsely populated pockets. Strategically positioned, Es'hailSat's 25.5E/26E hotspot serves millions of households across the MENA region. Despite the emergence of alternative viewing methods, such as ***over-the-top*** (**OTT**) and ***digital terrestrial television*** (**DTT**), it is forecast that satellite broadcasting will add more than 1% CAGR across five years (*2020-2025*) in TV household across the globe.

In addition, data consolidated by Es'hailSat in collaboration with [research company] ***Northern Sky Research***, reveals that Television is the most popular viewing device for watching video and will remain that way for at least the next five years. This includes viewing of satellite and OTT content.

"*Considering potential bottleneck in existing terrestrial infrastructures, it is likely the future viewing will be a hybrid model, with a combination of multiple sources and devices, i.e., satellite TV and IP delivered content*," said ***Al Mannai***.

Part Two of Chris' report will be published in the April issue of SatMagazine.

Author Chris Forrester is a well-known broadcasting journalist, industry consultant and Senior Columnist for SatNews Publishers. He reports on all aspects of broadcasting with special emphasis on content, the business of television and emerging applications. He founded Rapid TV News and has edited Interspace and its successor Inside Satellite TV since 1996. He also files for Advanced-Television.com. In November of 1998, Chris was appointed an Associate (professor) of the prestigious Adham Center for Television Journalism, part of the American University in Cairo (AUC), in recognition of his extensive coverage of the Arab media market.

Satellite TV dishes on the rooftops in Cairo.

Chris Forrester

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Software Defined Radios For Smart Grid Technologies + Policy

Author: Kaue Morcelles, Electrical Engineer, and Brendon McHugh, Field Application Engineer, Per Vices

The Smart Grid: Why Now?

Consequences of climate change are already affecting many areas of our society. This includes one crucial system that many people take for granted: the power distribution network.

Take recent events in Texas. During winter, exceptional storms (as the ones reported in 2011 and 2021) had caused blackouts and interruptions in the energy supply, while the heat waves during summer had caused power overloads due to the increase in the use of air conditioners and other cooling devices. In more extreme cases, such as the recent wildfires in Australia and California, the grid infrastructure had been seriously damaged or even destroyed, interrupting energy supply in several places, including networks far away from the incident.

These issues are significantly aggravated by the type of grid distribution model currently in use today. The most popular distribution paradigm consists of centralized power plants supplying large networks of transmission lines, substations and transformers (***Figure 1***). Such a centralization of power distribution makes the network extremely vulnerable to localized issues. Therefore, with the ever-growing increase in destructive weather phenomena, the current network paradigm must be replaced by a smarter and more robust grid, capable of overcoming or at least minimizing the effects of climate change on power distribution.

Are Smart Grids The Solution? — Overview

As the name suggests, a smart grid is a more intelligent approach to power distribution. It is able to monitor the state of the grid in real-time, including load demand, power flow, voltage levels and line integrity. Moreover, it applies robust communication systems (such as 4G/5G, IP based protocols, WLAN and ***Power Line Communication*** (**PLC**) to transmit this information to several points of the network. Thus, smart grids can sense issues and report them through the whole system. However, this information is pointless if the system cannot solve them, so the grid should also provide actuation mechanisms that can be triggered automatically or remotely.

For example, ***Volt/VAR Optimization*** (**VVO**) can be applied to minimize peak demand and power losses by automatically adjusting the grid configuration, while management automation provides grid self-recovery in the event of outages, by detecting the location of the outage and rerouting the network to restore power. Moreover, the grid can provide real-time pricing to customers, that can adapt their consuming profile to reduce costs and, consequently, optimize their power demand. Decentralized monitoring and control provide much more resilience to localized issues within the network, while also allowing multi-point generation from green energy sources and active consumers (***Figure 1***).

Advantages

The automatic and self-repairing structure of smart grids significantly reduces maintenance and operation costs, which results in a smaller power cost for the consumer. More efficient power transmission and generation, obtained through real-time monitoring of the load demand and power flow, further decreases the power price, while also reducing the ecologic impact and carbon footprint.

As well, power decentralization and real-time monitoring provides better integration between large-scale energy systems and small-scale renewable generation (such as solar panels and wind turbines) from active consumers. Finally, smart grids are more resilient to network failures, as they can immediately detect the location of outages, contain the problem to prevent large-scale blackouts and immediately reroute the transmission lines to restore electricity strategically (for instance, prioritizing vital services and minimizing blackouts).

The Bottle Neck

Compared to conventional transmission networks, smart grids are significantly more expensive, as they require modern control devices, high-resolution and real time sensors, and reliable communication systems to function properly. Moreover, there is a lack of interest and therefore funding from both the government and private utility companies.

This lack of interest stems from both government and private utilities suffering serious financial strain after climate disasters destroy the power grid infrastructure as well as smart grid renewables like wind turbines which require hefty investment in infrastructure such as heaters in winter that often stay idle until winter or climate crisis (for example, snow storms in Texas).

Finally, the software required to run the smart grid is significantly complex, as it should handle, process and integrate a large amount of same data in several parallel processing units at the same time. The software should also implement state-of-the-art encryption and cyber-security features, as the risk of potential invasions to steal data and control the grid is a major concern of the government, power companies and consumers.

A Test Site For Smart Grid Tech

Although there is significant reluctance to fund the transition from conventional power systems to smart grids, one place is trying to be a pioneer in the technology: *Sault Ste. Marie*, Ontario. This city is known to be the North American capital of renewable energy since 2008, investing an immense amount in the construction of wind farms and hydroelectric plants.

Most recently, to extract the best from the green energy generation system, the city plans to implement a complete smart grid by 2022. The designed grid will apply an ***advanced metering infrastructure*** (**AMI**) consisting of smart meters, communication networks and data management, enabling bidirectional communication between customers and power utility providers.

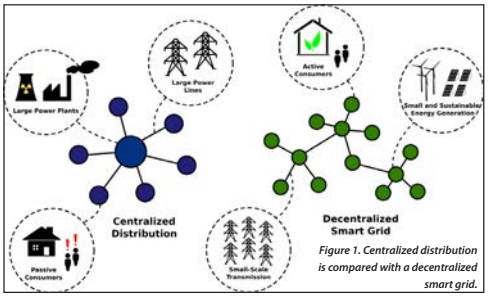


Figure 1. Centralized distribution is compared with a decentralized smart grid.

This is a huge project, especially for the communication and data processing system, as

more than 33000 commercial and residential consumers will be connected to the grid. When finished, the Sault Ste. Marie project will show the world the many benefits and challenges of smart grids, which can be a great opportunity for innovators to develop new technologies and solutions to design smarter and more sustainable transmission networks.

SDRs For Smart Grids — Overview

Software Defined Radios (**SDRs**) are becoming the dominant technology in high-speed radio communications. As the name suggests, an SDR is a radio-frequency device that performs all essential signal processing in the digital world. It uses a minimal amount of analog hardware as possible.

An SDR contains a radio front-end for signal pre-amplification, filtering, downconverting/upconverting with the overall goal of frequency tuning for transmission (Tx) and receiving (Rx). Powerful analog-to-digital and digital-to-analog converters (ADCs and DACs) are used to provide an interface between the analog and digital domains. The digital backend, consisting of FPGAs and DSP technology, is responsible for signal processing and computation.

The backend is the heart and brain of the SDR, as high-speed, multichannel powerful computations must be performed while also providing flexibility and robustness. Considering the great amount of data flow and data in a smart grid, as well as the need for integration with big data analytics, artificial intelligence and machine learning, SDRs are the best option for the main communication system of a smart grid.

SDRs For Proof Of Concept

Despite the many benefits of smart grids over conventional approaches, there is still a lack of trust and resources to implement it in large networks, which hinders the development of novel technologies. Moreover, new equipment cannot be directly tested in the actual grid, as any malfunction has the potential to cause great harm to power transmission.

In this scenario, grid simulation is fundamental to test and validate smart technology before implementation. SDRs are able to provide real-time digital simulation for control, security and data flow before actually being integrated into the grid. The reconfigurable FPGA gives flexibility for prototyping and implementing new protocols and algorithms, without any hardware modification. The smart use of the spectrum through cognitive radio can also be implemented using SDRs, increasing the communication adaptability.

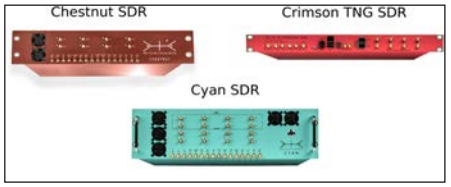
Finally, grid simulators can be used to test cyber-security algorithms and encryption, preventing potential cyber-attacks.

Why Use SDR For Smart Grids?

The flexibility provided by SDRs is fundamental to support different physical layers, including the ones defined by the ***IEEE 802.15.4g*** standards, LTE, 4G/5G, WLAN and possible upgrades. This flexibility also increases the interoperability of the communication system, since the software can be designed to support the older AMI networks. SDRs can also be designed to deal with high data throughput, which is crucial to handle efficiently the amount of data in a smart grid. A state-of-the-art SDR can obtain large bandwidth operation with several parallel channels, allowing multiple bidirectional data flow.

For instance, the ***Cyan SDR***, from ***Per Vices*** (*Figure 2*), provides 16 parallel radio channels capable of working from DC to 18 GHz. It comes with extended channels and higher bandwidth models, fitting different requirements in only one product. Cyan is the best SDR available in the market, which makes it perfect to act as a communication unit in a smart grid. However, performance may not be the only requirement, especially at the consumer side, where size and cost play a significant role.

For smaller units, the ***Chestnut*** and the ***Crimson TNG*** models from Per Vices may be more adequate, as they provide 4 channels, high throughput and several GHz of bandwidth with reduced cost and volume.



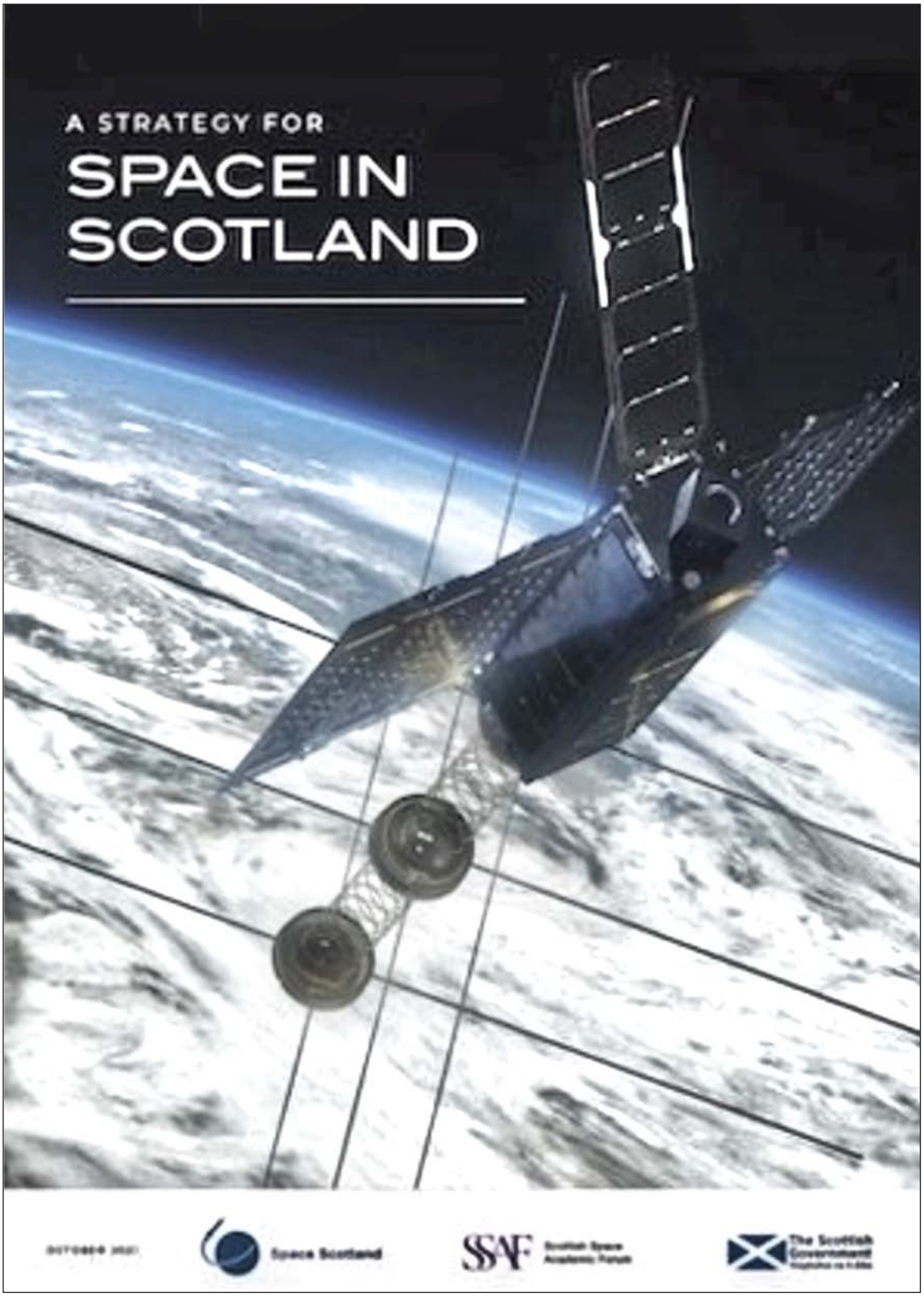
Nonetheless, independent of the device selected, any smart grid will profit from implementing SDRs in the communication system.

www.pervices.com

Per Vices Corporation

Author Kaue Morcelles is an electrical engineer, with emphasis on electronic design and instrumentation. He currently works with biomedical research, developing instrumentation devices for tissue engineering. Learning and writing about cutting-edge technologies is one of his passions.

Scottish Space Sector Charts Path To A Sustainable Future



A specialist working group of *Space Scotland* is contributing to the development of a sustainable space sector by collaborating on a roadmap that will focus on environmental issues in one of Scotland's fastest-growing industries.

On behalf of the Space Scotland's *Environmental Task Force*, **AstroAgency** and **Optimat** will work with Scottish companies, international collaborators and the public sector to develop this latest step in the country's journey towards a future formalized sustainable space strategy and has the full backing of the Scottish Government.

The sustainability roadmap for space – a world first – will involve wide-ranging research, consultations with world-leading space sustainability experts and case studies from other sectors for the space industry to learn from. It will highlight priority actions required by industry, academia and government to support wider net zero ambitions and cover a variety of economic, legal and environmental issues to evaluate how access to space can be used to meet current and future global challenges.

It aims to ensure Scotland's developing spaceports and launch vehicles minimize their impact on the environment, as well as promoting the environmental and societal benefits that can come from UK-launched small satellites.

In addition, the roadmap will highlight the need for LEO to be safeguarded alongside the planet's marine and land environments, while also exploring peripheral space activities that may cause an indirect impact on carbon emissions. Once drafted, the roadmap will be shared with industry-led group Space Scotland and wider sectoral stakeholders for endorsement and approval, before being published later this year.

"*From greener rocket propellants to using satellites to help restore local peatlands and track typhoons, Scottish space companies and Universities are making great strides towards enabling a more sustainable future. This roadmap is an opportunity to unite these activities and identify where we can collaborate more effectively*," said ***Kristina Tamane***, Co-Chair of Space Scotland's Environmental Task Force and Space Sector Lead at University of Edinburgh.

The space sector remains one of Scotland's best kept secrets. In a short time, Scotland has developed world-class capability in smallsat manufacturing, with a cluster of companies in Glasgow producing more small satellites than any other city in Europe. Edinburgh, on the other hand, hosts the largest center for informatics in Europe and is home to more than 170 data science companies.

Along Scotland's rugged edges and in airports such as **Prestwick** and **Macrihanish**, spaceports are making great progress toward launching both Scottish-made and international smallsats, many designed with environmental goals in mind. The applications of satellite data range from monitoring deforestation and illegal mining to helping predict natural disasters such as landslides or the spread of forest fires, with Scottish companies such as **Earth Blox**, **Astrosat**, **GSI**, **Omanos Analytics**, **Ecometrica**, **Spire Global** and **Space Intelligence** leading the way.

The rapid growth of the Scottish space activities comes with a concomitant requirement to minimize the environmental impact of space activities. The Scottish Space Strategy published on the international stage at Expo Dubai in October last year identified sustainability as a key theme of Scotland's approach to space.

"*As we build on the sector's strengths we must also focus on sustainability*," said First Minister ***Nicola Sturgeon*** during the Sustainable Space Summit organized by industry-led group Space Scotland last year. "*Space technologies will have an increasingly important role in the fight against climate change, but the sector must continue to reduce its own environmental impact*."

The roadmap is set to promote a comprehensive approach to space sustainability that consists of more than reducing emissions, extending to the activities of satellites in orbit. It will therefore contain information on space "junk" and debris mitigation and highlight the effect that satellites have on astronomical observations, with a view to acting as a catalyst for meaningful international action in such areas.

AstroAgency's Founder ***Daniel Smith*** said, "*We want to leave no stone unturned. This is an important opportunity for Scotland to lead by example in developing the space sector of tomorrow, both on the ground and in orbit.*"

How Intelsat Casts A Wider Net For Connectivity

With commercial fishing vessels

Author: Shane Rossbacker, Director of Maritime, Intelsat

If the COVID-19 pandemic has taught us anything, it is the importance of technology to keep us connected. In our hyper-connected world, there are few places that are off the grid, with no access to cellular. But ask a commercial fisherman, who can spend months at a time at sea, and they'll tell you that connectivity can be hard to come by on open waters yet remaining connected is critical.

A lack of connectivity can limit a fishing vessels' operations in a number of ways, from hindering navigation, maintenance and reporting systems, to decreased seafarer satisfaction as crew is disconnected from their onshore lives for long periods of time.

The benefits of satellite connectivity are clear: Connected vessels are able to track their onshore deliveries in real time, conduct remote diagnostics, assess the latest weather data to calculate the best route, optimize fuel consumption, and improve product traceability. Connected vessels also improve crew member health, safety, and happiness by enabling them to remain connected with friends, family, and social applications, while ensuring the application of safety regulatory measures and a reliable connection for emergency communications. In an industry known for above average turnover rates — with 24% of fishers leaving a job after one year and 59% in ***four years or less***, broadband connectivity could be used to support crew welfare and increase employee retention.

The Adoption of Vessel Monitoring Systems For Safety and Compliance

A ubiquitous, scalable connectivity solution at sea is increasingly becoming a necessity as more countries require ***Vessel Monitoring Systems*** (**VMS**). These systems require "*always on*" connectivity to provide fishery authorities accurate reporting of the position, date, time and course of vessels. The demands on the fishing industry are also clear: The ***Food and Agriculture Organization*** (**FAO**) estimates that of the approximately 179 million tons of fish caught globally each year, 20% is unreported and unregulated (IUU) fishing, representing an annual cost of $23 billion. VMS are increasingly being required both for safety and to combat this illegal fishing, yet today only a small percentage of vessels have ***such systems enabled***.

In addition to compliance, connectivity empowers vessel owners and crew with accurate information of ports, weather, markets and more. Seamless access to this information lets fishers know exactly where the catch is, helping crew optimize their voyage, and cut down time at sea. In this highly price-sensitive industry, access to real-time pricing of fish stocks in nearby ports allows crew to prioritize a catch by predicting nearby market demand.

To stay competitive in an increasingly digitized and global industry, fishing vessel owners and operators are looking to incorporate dependable connectivity solutions. According to ***Harbor Research***, there are more than 84,000 large fishing vessels (24 meters or larger) globally. However, today only the largest vessels in this segment have adopted ***Very Small Aperture Terminals*** (**VSAT**) communications as these solutions have traditionally been expensive and rather large — typically one meter in size and often weighing hundreds of kilograms. For smaller to mid-size boats, even down to a size of 12 meters, finding a satellite communications system that provides the right balance of affordable equipment, service performance and coverage has been a major barrier for fishing operators.

Intelsat: The Captains of Connectivity

As the foundational architects of satellite technology, Intelsat operates the world's largest integrated satellite and terrestrial network, with a global, multi-layered footprint of high throughput (HTS) and wide-beam geostationary satellites.

Intelsat FlexMaritime, a global, secure, fully managed connectivity solution, removes the complexity of dealing with bandwidth availability, configuration and management of network infrastructure. It delivers speed and throughput where and when users need it. This award-winning, high-performance design provides consistent, "*always on*" service anywhere in the world with proven network uptime.

Since launching its FlexMaritime service in 2017, Intelsat has become the top provider of broadband connectivity for maritime passengers and crew and powers the largest share of maritime VSATs. Intelsat delivers high-throughput capacity that helps fishing companies enhance crew welfare and ship operations while supporting growth opportunities and new, data-hungry business applications. With more than 8,600 ships on the FlexMaritime network, all seamlessly swapping beams in the unforgiving environment of the world's oceans, Intelsat has proven its ability to streamline internet access worldwide.

Satellite Made Simple: Intelsat FlexMaritime Connects Ships of all Sizes

Intelsat and its partners are on a mission to seamlessly connect fishers and fishing vessels worldwide. Enhancing connectivity at sea is not just about the network, it's about lowering the barrier of entry for fishing vessels of all sizes and making procurement of services simple and affordable. With FlexMaritime, both installation and service models are simplified.

FlexMaritime introduced support of ultra-compact antennas from ***KNS*** and ***Intellian***, measuring just 45 centimeters and weighing less than 27 kilograms. These antennas are small enough to carry aboard by hand and easy to install, allowing fishing vessels to avoid the lengthy and expensive installation of larger antennas. Users will experience unmatched performance with ubiquitous coverage and the high-throughput capabilities of Intelsat's global network, even along the most congested maritime routes.

Delivered to end-customers exclusively through Intelsat's network of diverse and highly experienced Solutions Partners, FlexMaritime is offered in simple, month-to-month or annual service agreements. Wholesale, end-terminal packages come with a choice of gigabyte volume-based plans minus any long-term usage commitments. This flexibility allows for a lower barrier of entry and plans that meet all requirements.

Ideal for smaller fishing boats, ***the new 45cm antenna solution*** provides a perfect balance of cost, performance and coverage. Additionally, FlexMaritime has the widest variety of terminal options with services offered on more than 30 qualified antennas of various sizes, including 1m, 60cm, and 37cm terminals.

Additional information is available at this direct Intelsat infosite...

www.intelsat.com

Shane Rossbacker

Mr. Rossbacher joined Intelsat in 2018, bringing more than 25 years of maritime satellite communications experience to his role. He is responsible for Intelsat's Maritime portfolio, including the award-winning Flex Maritime platform which uses Intelsat EpicNG satellites to power high-throughput broadband communications services to all maritime market segments including merchant, cruise, passenger, offshore, fishing, superyacht and leisure. Prior to joining Intelsat, he held leadership roles at Inmarsat, Globe Wireless and Rydex. As Vice President of Business Development for Inmarsat Maritime, Mr. Rossbacher led a team responsible for all maritime product and service offerings and was then promoted to Vice President, Portfolio Management, where he had wider responsibility for Inmarsat's maritime, enterprise and government business units.

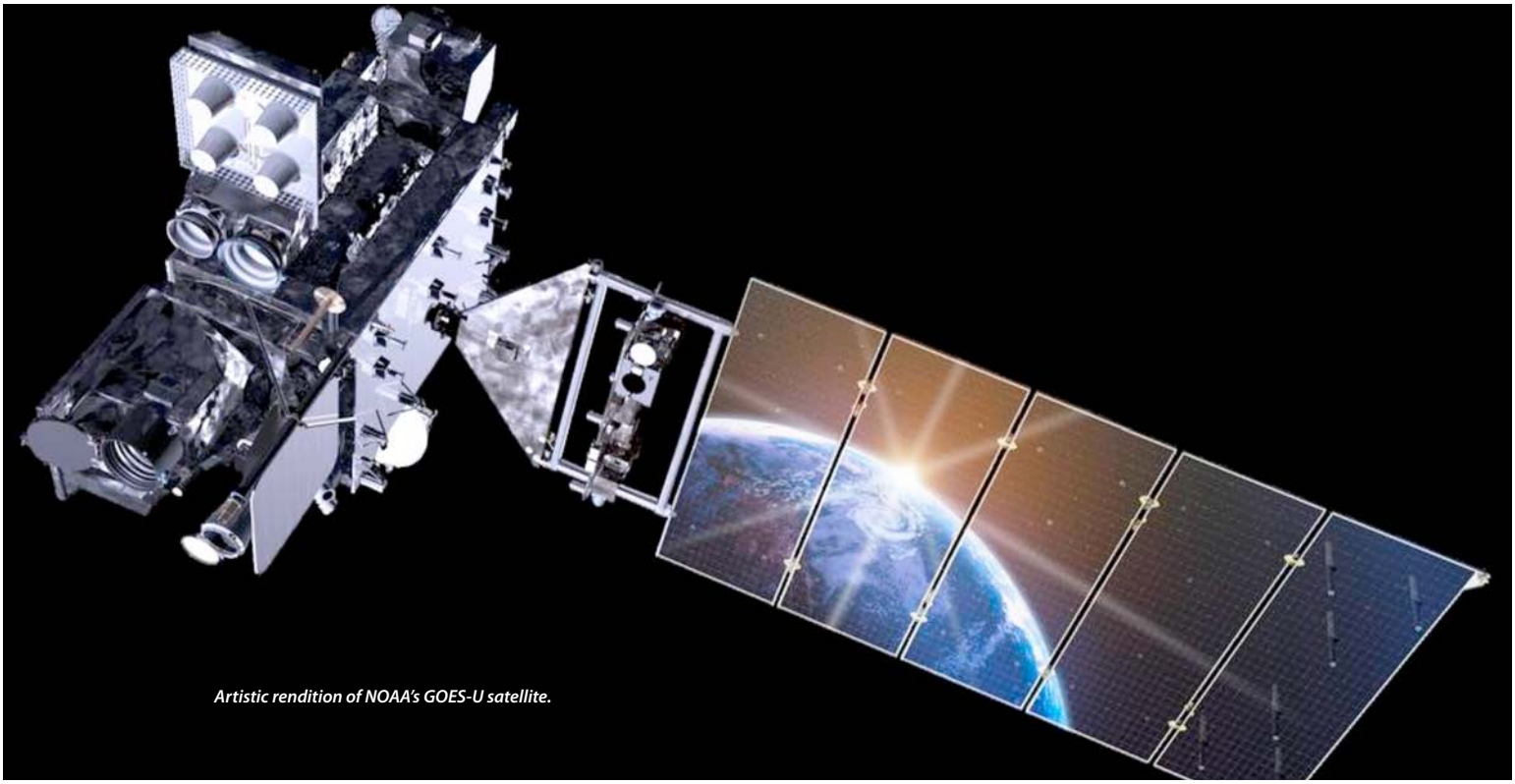
Imager Integration For NOAA's GOES-U Completed By L3Harris

The fourth Advanced Baseline Imager (ABI) (*see photo above***) built by *L3Harris Technologies* (NYSE:LHX) has been successfully integrated into *NOAA*'s *Geostationary Operational Environmental Satellite-U* (GOES-U), completing the series of advanced weather sensors for the GOES program, slated to launch in 2024.**

t
The ABIs onboard the GOES series of satellites provide revolutionary technology by advancing weather observation and environmental monitoring services, and also by providing more advanced notice of fires, hurricanes, tornadoes and floods.

The ABI provides high-resolution video of weather and environmental systems using 16 spectral bands delivering three times the amount of spectral coverage, four times the resolution and five times faster than the previous generation of GOES satellites.

The third ABI is onboard NOAA's GOES-T satellite, scheduled to launch March 1, 2022. GOES satellites are under command and control of the L3Harris-built enterprise ground system.



Artistic rendition of NOAA's GOES-U satellite.

Why Are MNOs Increasingly Selecting Satellite As A Viable Backhaul Option?

Author: Doreet Oren, Senior Director, Product and Solution Marketing, Gilat Satellite Networks

The market for satellite-based cellular backhaul (CBH) is growing in an unprecedented manner. While the reasons are many, the COVID-19 pandemic has certainly brought to the forefront the compelling need for ubiquitous connectivity around the world. The last 2+ years have shown the urgency of providing communication services to everyone, including remote and rural communities that have, until now, lived with insufficient or even no access to communication.

How big is this problem? Billions worth. Even today, almost half of the Earth's inhabitants do not have access to the Internet. This means that about 3.7 billion people are still offline. Most of these people live in developing countries and most of them are women. For the lucky ones, the wealth of information made available today through cellular backhaul connectivity was once unimaginable. From finance to education to real-time crop management…access to information has been proven to improve quality of life. And the simplicity of using a cellphone also means connectivity is made more affordable and convenient — and more importantly – accessible.

Key Growth Drivers Of Cellular Backhaul Over Satellite

There are 5 key trends which are driving the increased use of satellite for cellular backhaul.

1. **Awareness**: *Increasing governmental and social awareness of the global digital divide and the need to close it, regardless of location or geographic terrain.*
2. **Government Mandates**: *We are seeing an increase in government mandates for Universal Service Obligation or USO. A recent UN report cautions that the digital divide will become the new face of inequality. The UN has also included an effort to bridge the digital divide as part of their Sustainable Development Goals.*
3. **Increasing Demand**: *Demand for internet connectivity increased exponentially during the pandemic, allowing those of us reading now to have the ability to continue working, socializing and learning. As a direct result of restrictions caused by Covid-19, China saw a 30% increase in the number of hours per device spent on mobile data usage. In Italy the figure was 11%. And it's not just internet access that has seen these increases. The use of voice services has also increased considerably, as people strive to keep in touch with loved ones and friends during the periods of lockdown that have been enforced around the world. In the U.S., Verizon reports that the average number of daily voice calls is currently more than double the number of calls made on Mothers' Day, normally one of the busiest days of the year. There has also been an increase in the use of broadband data so people can see each other and not just hear each other: think Zoom for both business and pleasure. In the US during the 1st quarter of 2020, at the start of the pandemic, average broadband consumption rose by 47%.*
4. **Climate Change**: *Climate change is causing more natural disasters, such as floods, hurricanes, wildfires, earthquakes, and tsunamis. These events often render terrestrial infrastructure non-functional and mobile networks go down. Unfortunately, this happens exactly when communication is needed the most to secure adequate emergency response and organize life-saving missions. We are also seeing increased need in major cities to rely on satellite backhauling as a BACKUP system when the terrestrial network collapses.*
5. **5G**: *Satellite is an integral part of delivering the promises of 5G. This is because satellite technology has the scale and scope to provide ubiquitous connectivity. We are also seeing IoT applications grow as 5G begins to roll out that call for connecting billions of devices everywhere.*

It is clearer than ever that connectivity is critical to everyone, everywhere, anytime. Satellite backhauling of cellular networks not only extends reach to the most remote regions, but also provides reliable, continuous communication when terrestrial connectivity is not available.

Shattering Myths

In the past, CBH over satellite was often used only as a solution for hard-to-reach rural and remote areas such as islands, mountains, and deserts, where terrestrial infrastructure such as fiber, next-generation copper, or microwave was either too expensive or unfeasible. However, today more and more MNOs are adopting satellite backhauling to easily extend connectivity to rural sites and integrates seamlessly with their terrestrial networks, as they are looking for a reliable solution which can provide enhanced Quality of Service (QoS) and Quality of Experience (QoE). In addition, we are seeing the increased use of satellite communication in cases of disaster recovery and emergency response when terrestrial lines are not working or just not available. Using satellite communication guarantees that governments and businesses can continue to operate their global communications systems and first responders have a reliable means to coordinate life-saving operations.

The economics as well as the ability to overcome technical challenges have brought LTE satellite backhauling to the forefront not only in the developing world but also in more established markets. There are, however, several myths surrounding the use satellite backhauling that are 'fake news":

Myth #1: Performance requirements cannot be met with satellite backhaul — With the large amounts of required data communication, MNOs raise concerns that VSATs are not able to deliver the required LTE performance to the handset and will not be able to support the high throughput required for 5G network architecture. In addition, as satellite communication has an inherent delay, a concern is raised that this will result in poor backhaul performance and consequentially a poor user experience.

Reality: Acceleration technology and high-performance modems mitigate latency effects — The inherent satellite delay can be mitigated by using acceleration technology that addresses latency effects. This makes it possible to achieve high throughput which requires high performance modems to accommodate the traffic and provide the required high-quality user-experience. Such a solution is especially critical when high bandwidth is required, like in 4G/5G deployments. Gilat's solution is based on patented technology and high performance VSATs that provide the required user experience.

Myth #2: Satellite Connectivity is Expensive — In the past, the cost of satellite bandwidth capacity often caused satellite-based communications to be prohibitively expensive for providers of broadband services and MNOs.

Reality: Satellite Capacity Pricing at Times Rivals Terrestrial Bandwidth Costs — With the continued launch of ***High Throughput Satellites*** (**HTS**) and ***Very HTS*** (**VHTS**) satellites, as well as NGSO constellations, we are seeing a further decline in bandwidth prices due to the abundance of satellite capacity, propelling satellite solutions into the mainstream. Based on these trends, it is expected that the cost for satellite backhaul networks will compete with those of terrestrial backhaul networks for many use cases, particularly when the Total Cost of Ownership is considered.

Myth #3: Satellite Connectivity is Too Complex — A third common misperception is that satellite technology is too complex to implement. MNOs already have their hands full with their rapidly evolving mobile networks, and the last thing they want is added complexity for backhaul

Reality: Complexity can be mitigated in a number of ways

A: Accelerated Layer-2 Support Facilitates Satellite Network Integration — A factor contributing to satellite backhaul complexity relates to the OSI network layer, at which the integration of the satellite and terrestrial cellular networks takes place. Satellite networks traditionally operate at Layer-3 (network layer) to be able to accelerate the user data, while MNO networks in some cases operate at Layer-2 (data link layer). Gilat's solution has the advantage of supporting accelerated data while operating at a carrier-grade Layer-2, thus easing MNOs satellite integration while extending traditional terrestrial networks.

B: Global Network Management Reduces Complexity — Another way to reduce satellite backhaul complexity is to use a sophisticated global network management system (NMS). Gilat's TotalNMS enables full provisioning, configuration, control and monitoring of all satellite hub elements, as well as remote terminals, regardless of their physical location. This is crucial for streamlining management, allowing MNOs to easily and cost-effectively scale to support any network size, enabling them to start small and add sites as needed.

C: Managed Service Reduces Costs — Significant savings in cost can be achieved by regarding satellite backhaul as a managed service. The MNO specifies the requirements, the SLA and key performance indicators, as well as the required site locations and the schedule. Considering the managed service as a black box and giving end-to-end responsibility to Gilat, enables the MNO to focus on their core competency and promote their business.

With strong growth drivers and dispelled myths, it is no wonder that satellite backhauling is now mainstream. In fact, satellite backhauling is an important element of MNO operations and is no longer a niche play. As proof, when world economies slowed down during the first year of the pandemic and the SATCOM industry took a hit, satellite backhauling stayed relatively strong, due to the uncompromising need to bridge the digital divide.

CBH From Gilat

Cellular backhaul has, in recent years, been identified as one of the fastest-growing satellite application sectors, prompting satellite operators and service providers everywhere to expand their awareness and capabilities in these areas.

Not only does satellite enable connecting remote locations, it strengthens the resiliency of communications networks, and directly contributes to saving lives. Gilat has proven its superior satellite backhauling technology worldwide and is diligently at work for next generation solutions to meet the challenges still ahead. For more information, ***please visit this direct Gilat infolink..***

Doreet Oren has been with Gilat since 2012 and is responsible for defining product positioning, solution messaging, go-to-market strategies, market research, and analyst relations. Ms.Oren has over 20 years of industry experience, and has held management positions in R&D, Product Management, Product Marketing and Solution Marketing for international high-tech companies. In this capacity Ms. Oren contributed to product and solution definitions and was responsible for delivering the company's vision to the media and analyst community. Oren has published thought leadership articles in renowned international journals and has spoken at numerous industry conferences worldwide. Oren received a BSc in Computer Science from George Washington University and graduated from the Modern Marketing Program at the Recanati Graduate School of Business Administration, Tel Aviv University.

Doreet Oren

mu Space Now Announces The Price Of The mu-B200 Smallsat

Another year for opportunities as 2022 gets underway — *mu Space Corp*, a satellite manufacturer, and satellite internet service provider, continues to grow as a business.

The past year has seen the company open two new factories, scale the team to more than 100 members and, most importantly, the firm has now unveiled their first satellite. The ***mu-B200*** LEO satellite was unveiled to the public late last year by the company's Chief Executive Officer and Chief Technical Officer, ***James Yenbamroong***.

The satellite — produced entirely by mu Space Corp's leading engineers — is the first of its kind manufactured in Southeast Asia. Equipped with cutting-edge technology and incorporating nanotechnology, the mu-B200 will be able to deliver high performance for any required demand.

As mentioned above, mu Space opened two new space factories last year, in addition to the first factory being built in 2020. ***Factory 0***, the first factory, was mostly used for prototyping in the company's early days and has now also incorporated a 3D printer for additive manufacturing. This facility was also responsible for the early production of the mu-B200, as much of the prototyping and planning occurred here.

The second factory, known as ***Factory 1***, opened at the start of last year and is responsible for the production of mu Space satellites. This factory incorporates many different facilities that include, but not limited to, a robots sector, satellite sector, battery sector, and a heavy machinery sector.

This factory can house the production of 10 satellites and has a state-of-the-art cleanroom where the engineers work on developing nanotechnologies that are to be incorporated into mu Space products.

Factory 2, the latest factory, was launched in October of last year and will be able to handle the production of 100 satellites, ten times more than Factory 1. The factory was built with the intention of rapidly increasing the rate of production.

At mu Space, the business strategy is to work with vertical integration — where everything from the components to the final structure is built in-house by the engineers. This allows the company to control quality each step of the way and, on top of that, it allows the firm's customers to tailor the product to their needs.

Vertical integration also helps shorten the supply chain — customers can expect to receive their products on time. When mu Space publicized the mu-B200 at the unveiling event in October of 2021, the satellite checked every, expected box in terms of its structure. The size was optimal for it to function as a LEO satellite, something that had been intended since the initial satellite planning stages.

The mu-B200 is a smallsat and, as a LEO satellite, functions in an orbit close to Earth. As LEO satellites are heavily used for communication as they provide the closest range of frequency between space and Earth. LEO satellites proximity to the Earth also brings forward a range of other applications for the structure.

The mu-B200, once set on its mission, will be able to accomplish various Earth Observations (EO) including carbon footprints, weather observations, water quality observations, navigation, and communications.

The satellite weighs 200 kilograms and incorporates a 1.2 kW high power system that focuses on delivering high power and high performance through the use of advanced nanotechnologies and, as mentioned earlier, a vertically integrated strategy in the manufacturing process.

The mu-B200 satellite features krypton thrusters for orbit correction, a cutting-edge reaction wheel, a phased array antenna, and a unique TRL-9 flight-proven high-power bus system. The Reaction Wheel is ready to be sold in the market as an individual component and features a maximum torque of 190 mN/m. Other components listed above will also be sold individually and will roll out as they are ready to enter the market.

mu Space looks forward to 2022 and the company has now announced the pre-sale price of the mu-B200 — the satellite is priced at $4 million, almost half the price of similar products in the market today. The expected delivery time is 12 months post-order placement.

Test launches are planned for later this year and the company plans employ 300 members by the close of 2022.

PLD Space Secures The Next Steps...

for the MIURA launches

Author: Pablo Gallego Sanmiguel, Senior Vice President, PLD Space

***PLD Space** is a European company with the goal of becoming the European Microlauncher Company, a reference within the sector with reusable rockets dedicated to the launch of smallsats. For this, PLD Space is developing two, reusable launch vehicles named MIURA 1 and MIURA 5.*

MIURA 1 was conceived as a one-stage suborbital sounding rocket that uses a liquid propulsion system fully designed and built by PLD Space — ***MIURA 5*** is a two-stages launch vehicle for smallsats with that incorporates in-house propulsion, structures and avionics development. The company has also developed its own engine, ***TEPTREL-B***, which, in 2021, became the first ***KeroLOX*** rocket engine developed in Europe qualified for space flight. Founded in 2011, the firm recently achieved a new milestone with the official presentation of MIURA 1, which was exhibited fully assembled for the first time in the ***National Museum of Natural Science*** in Madrid. More than 10,000 people could see the rocket and learn about the work at PLD Space during a entire weekend late last year.

Next steps before MIURA 1 launch

MIURA 1 has returned to the PLD Space base at ***Teruel Airport*** to carry out combined qualification testing at stage level, including full-mission duration hot test of the complete stage. After these tests, the stage will be shipped to the launch base to perform a combined test campaign with all the ground segment and ground infrastructure before launch.

MIURA 1 is propelled by a single regeneratively cooled TEPREL-B liquid engine powered by liquid oxygen and kerosene. The recovery system on board MIURA 1 can safely return the whole launch vehicle to ground, enabling the payloads to be returned to the customers and the complete rocket to be used again. After re-entry, two parachutes are deployed consecutively. The Payload Bay of the MIURA 1 launch vehicle is composed of up to four, standardized, payload compartments which are situated directly underneath the nosecone. Each payload compartment can hold a payload mass of up to 25 kg.

Launch From Spain

The MIURA 1 launch is expected to occur during the second half of 2022, which will be the first launch mission of a European rocket in history, designed to reach a maximum altitude of 150 km. and with the capacity to carry a payload of up to 100 kg. This maiden flight is set to take place from the historical Spanish launch site "***El Arenosillo***" (Huelva) in the south-west of Spain. From there, the rocket will fly into a south-westerly direction and after a flight time of about 12.5 minutes, splash down about 70 km. off the coast in the Gulf of Cádiz in the Atlantic Ocean. In this first test flight, MIURA 1 will carry several payloads. Half of the total available payload capacity will be used by PLD Space. A variety of sensors will be integrated into the rocket with the intention to quantify the flight environment. The other half of the available payload mass has been opened for the scientific community and will house several scientific experiments.

The PLD Space team.

The Ultimate Goal

With the MIURA 1 launch vehicle, PLD Space will serve the suborbital market by providing frequent flight access and serves as a technology demonstrator for MIURA 5. In fact, the company is already working on its first MIURA 5 reusable orbital rocket, which is expected to be ready to carry out its first mission in July of 2024, and which will mark the start of the firm's commercial satellite launches.

MIURA 5 maiden flight will have a capacity of 450 kg. of payload mass to LEO orbit from ***Guiana Space Center,*** CSG, Europe´s Spaceport in French Guiana. The first launch vehicle to fly will be ***MIURA 5 block 1.0***, a fully expendable version that will make the first two launches. After those flights, the company will introduce a reusable version for subsequent flights, paving the way for a commercial reusable booster in Europe. This stage will implement all of the lessons learned from ***ESA´s Future Launchers Preparatory Program*** (**FLPP**) contracts, called ***Liquid Propulsion Stage Recovery*** (LPSR) ***1*** and ***LPSR2***.

Two drop tests have been performed successfully to verify the parachute design and recovery operations. The first drop test was performed in Eloy, Arizona, in February of 2019. A mass dummy was equipped with the MIURA 1 parachute system and dropped from an airplane. The test successfully verified the proper functioning of the drogue and main parachute, but also the design of the parachute canister, proper hatch ejection and correct functioning of parachute deployment triggers.

A second drop test was performed in April of 2019 from INTA´s "***El Arenosillo***" launch site in Spain, in the framework of ESA´s FLPP Program. A mock-up of the first stage of the MIURA 5 was dropped from a Chinook-CH47 helicopter into the Atlantic Ocean. Even though the used parachute system was scaled for MIURA 5, the subsystems controlling the deployment are identical to the ones used on MIURA 1. This drop test was also used to test parts of the ground segment that is used for the MIURA 1 launches. Additionally, it provided PLD Space with an excellent opportunity to understand and train the procedures for the MIURA 1 sea recovery.

Following the successful results of the drop test of the first stage of the MIURA 5, ESA awarded a new contract in 2021 to PLD Space. The project by PLD Space and the European Space Agency (LPSR2) is a continuation of the previous contract awarded by ESA to PLD Space in 2017 and executed between 2017 to 2019. This contract is part of ESA's Future Launchers Program and focuses on the study of re-entry trajectories and configurations for the safe descent of stage one of MIURA 5.

A Growing Company

The firm is based in Elche (Alicante, Spain) and has technical facilities in Teruel, Huelva and French Guiana. The headquarters also houses the rocket factory, where MIURA 1 and MIURA 5 are being manufactured. More than 80 people are currently working on the ambitious mission of providing access to space using reusable launch vehicles, but the team is growing and growing. In fact, the firm expects to increase its workforce up to 200 employees in 2022 and triple its size in the next three years. This sustainable growth is possible thanks to the support of PLD Space investors. Last December, the company closed a Series B Funding round of $28 million, which brings the total capital raised to more than $50 million. The company, based in Elche (Alicante), has maintained the interest of both private investors and public institutions. With this level of follow-on, PLD Space financial viability is guaranteed to undertake their next milestones such as the first commercial launch of MIURA 5, the internalization of a good part of the rocket production processes and the demonstration flights of MIURA 1.

www.pldspace.com

Pablo Gallego Sanmiguel is PLD Space Senior Vice President, Sales & Customers. Before joining PLD Space in 2019, he developed his professional career from California (United States) working as Mission Manager of Launching Services with SpaceX as well as providing aerospace consulting services. Previously, Pablo had participated actively in several other rocket launch operations, such as Ariane 4, Ariane 5, Soyuz, Dnepr, Vega, Falcon 9 and Falcon Heavy. Currently, Pablo coordinates his activities in PLD Space between the United States and Europe where he directly addresses the needs of customers.

Pablo Gallego Sanmiguel

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Global Connectivity Becoming A Reality

with the help of new, high density, power solutions

Author: Rob Russell, Vice President, Satellite Solutions, Vicor

As demand for internet bandwidth continues to soar, terrestrial broadband has been slow to respond; in part because it is economically impractical to service nearly half the world's population. However, it is an important endeavor, and making broadband widely accessible to underserved segments of society reduces poverty, improves standards of living and is a core enabler of economic growth.[a]

Where terrestrial broadband falls short, SATCOM is poised to solve this problem. Satellite communications providers and OEMs are striving to develop products to take advantage of this explosive growth opportunity. The efforts of companies such as ***Boeing***, which is providing satellites to European service provider ***SES*** for their aptly named ***O3b*** (other 3 billion) constellation, and ***SpaceX***, with their rapidly growing ***Starlink*** constellation, are leading the way to leveling the playing field for billions of people. In order to realize both the societal and market opportunity, satellite communications providers and OEMs are planning to deploy enough capacity to increase overall bandwidth by at least 20x over the next five years.[***b***] Boeing, OneWeb, Viasat, SpaceX and others are projected to add over 100,000 satellites in the next 10 years,[**c**] all looking to stake their claim in the new space race. To accomplish this, the industry is undergoing a massive paradigm shift in how they design satellite systems, creating significant churn, but also significant opportunity for innovative approaches and new companies to participate in the growth.

A key element in solving the overall problem is solving the power problem. NewSpace satellite communication solutions demand high-performance processing, which in turn, requires more power. Limited space and weight budgets therefore put a premium on advanced power solutions with high density and high efficiency to enable these advanced communications systems.

Keys to competing for NewSpace satellite OEMs and service providers

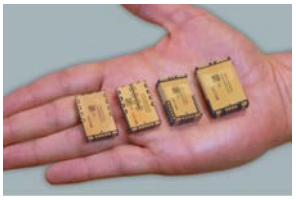
To compete with terrestrial solutions and capture the expected share of internet bandwidth growth over the next five to 10 years, space-based solutions must compete on capacity, coverage, latency and overall cost compared to terrestrial solutions. To be competitive the key strategy that NewSpace companies have converged on is to deploy large numbers of smaller, connected satellites in ***Low Earth Orbit*** (**LEO**) and ***Medium Earth Orbit*** (**MEO**) constellations.

Deploying hundreds or thousands of satellites in lower orbits creates some significant challenges for system architects and developers. The cost for a satellite, including the launch cost, has to be reduced by at least an order of magnitude compared to geostationary (GEO) and deep space satellites to make this solution economically viable.[**c**] To achieve the cost reduction they need to increase throughput per satellite and reduce both size and weight. At the same time, the number of satellites that can be deployed is finite and restricted by international governmental allocation, so there is an even stronger incentive to maximize the throughput capability of each satellite. These diametrically opposing requirements—shrinking the size and cost of the satellites while increasing their performance—along with the reduced radiation exposure of lower orbits, create several design drivers that differ from classic space applications.

NewSpace design drivers and requirements

One way developers are tackling this design problem is to use increasingly sophisticated onboard processing capabilities. The use of the latest ***ultra-deep-submicron*** **FPGAs** and ***ASICs*** that have demanding, low-voltage and high-current power requirements is becoming more commonplace as a way to maximize performance in the smallest possible space.[**d**] The need for more advanced solutions also drives the mission length, because as technology improves, companies will need to refresh the satellites quicker to take advantage of the latest-and-greatest offerings. The typical LEO mission duration and optimal time to upgrade the technology is three to seven years. This can be an expensive proposition, and since they will only have approval for so many satellites, companies will have to replace them instead of add to them. The shortened mission length also requires a different mindset when it comes to the ***time-to-market*** (**TTM**), cutting the typical seven- to 10-year development and production cycle times by half or more. The good news is that the lower orbits inside the Van Allen belt, along the with the shorter mission profile, significantly reduce the amount of radiation hardening needed. This in turn allows for use of more sophisticated, less expensive COTS-type products with lower levels of radiation tolerance required for the mission.

The TTM requirements drive further change. Developers are looking to develop with modular, COTS-type components to increase reliability, to reduce qualification and test time and to allow for much faster and more predictable design cycles. TTM requirements coupled with the sheer volume of satellites that OEMs need to produce put a greater burden on manufacturing capacity and capability. Modular components are typically built-in modern manufacturing environments and are robust and scalable on a commercial level, which contrasts with legacy space-grade components that are typically handcrafted in small batches for missions requiring a smaller number of satellites with a higher degree of radiation hardness.



Vicor rad-tolerant power modules provide are a 3 – 5x power-density improvement over the current best-in-class solutions, and a 50% reduction in power losses for 100V bus applications.

The improved power delivery networks (PDNs) for NewSpace

Similar to other satellite system elements, most existing space-grade isolated and non-isolated DC-DC solutions were developed for deeper space missions and have a high degree of reliability and radiation tolerance. As such, they do not meet the density and efficiency needs for NewSpace applications. The manufacturing requirements for these fully radiation-hardened solutions necessitate hermetically sealed packages and small-batch production with extremely long cycle times driven by a high percentage of manual labor and extensive testing. A different type of PDN solution is needed to meet the performance requirements of NewSpace applications, while still providing adequate radiation tolerance.

To enable the improvements in size, weight and cost afforded by the utilization of advanced communications processors, as well as improve TTM, an advanced PDN capable of delivering high currents at low voltages using dense, efficient, modular components is a must-have. Compact modular power components will significantly reduce the size and weight of the overall PDN in three ways:[**e**]

1. *They are more power dense.*
2. *They reduce the PDN footprint and increase the efficiency, which decreases the copper-heavy PCB area required.*
3. *They reduce the need for additional filtering.*[**d**]

In general, improving the efficiency and density of the PDN leaves more size and weight budget for the payloads and satellite subsystems.

Delivering faster time-to-market, top performance and reduced risk and cost

Vicor radiation tolerant power modules enable the ideal PDN for today's LEO and MEO satellites, providing high efficiency, high density, low noise voltage conversion to power advanced network communication ASICs and processors. Reliability is enhanced with a dual power train topology, which, along with extensive qualification testing, enables our modules to meet mission TID and SEE radiation requirements.

Vicor modular solutions convert power from the source to the load, allowing developers to reduce TTM, risk, and cost, while maximizing board space utilization. The present Vicor product is capable of powering a 0.8V/150A and 3.3V/50A processor load from a standard 100V bus at efficiencies of up to 81 percent. Next-generation modules are in development and will improve end-to-end efficiencies and offer alternate bus solutions.

Some of the differentiated benefits that the new Vicor rad-tolerant power modules provide are a 3 — 5x power-density improvement over the current best-in-class solutions, and a 50 percent reduction in power losses for 100V bus applications. Implementing a Vicor rad-tolerant solution will substantially reduce the overall board space and weight required by the PDN through best-in-class density, efficiency and noise signature.

Leveraging a longstanding heritage in both the COTS aerospace and high-performance computing markets, Vicor is equipped to deliver on the demands of NewSpace. Vicor uses advanced packaging and automated, high-volume ***SM-ChiP***™ assembly techniques. All of Vicor's parts are manufactured in a US-based factory delivering a robust, scalable capability that is ideal for today's high-volume LEO and MEO challenges.[**f**]

End notes

*[a] https://**omdia.tech.informa.com/-/media/tech/omdia/marketing/commissioned-research/pdfs/delivering-on-the-promise-of-broadband.pdf***
*[b] **https://news.satnews.com/2020/07/22/morgan-stanley-analysis-leo-satellites-possibilities-and-obstacles/***
*[c] **https://astronomy.com/news/2021/06/the-future-of-satellites-lies-in-giant-constellations***
*[d] **https://www.edn.com/dc-dcs-meet-power-distribution-needs-of-newspace-applications/***
*[e] **https://www.vicorpower.com/documents/case_studies/defense_aerospace/Def_Sat_Com_Voice_Data_Comm.pdf***
*[f] **https://www.vicorpower.com/resource-library/articles/innovating-power-module-packaging***

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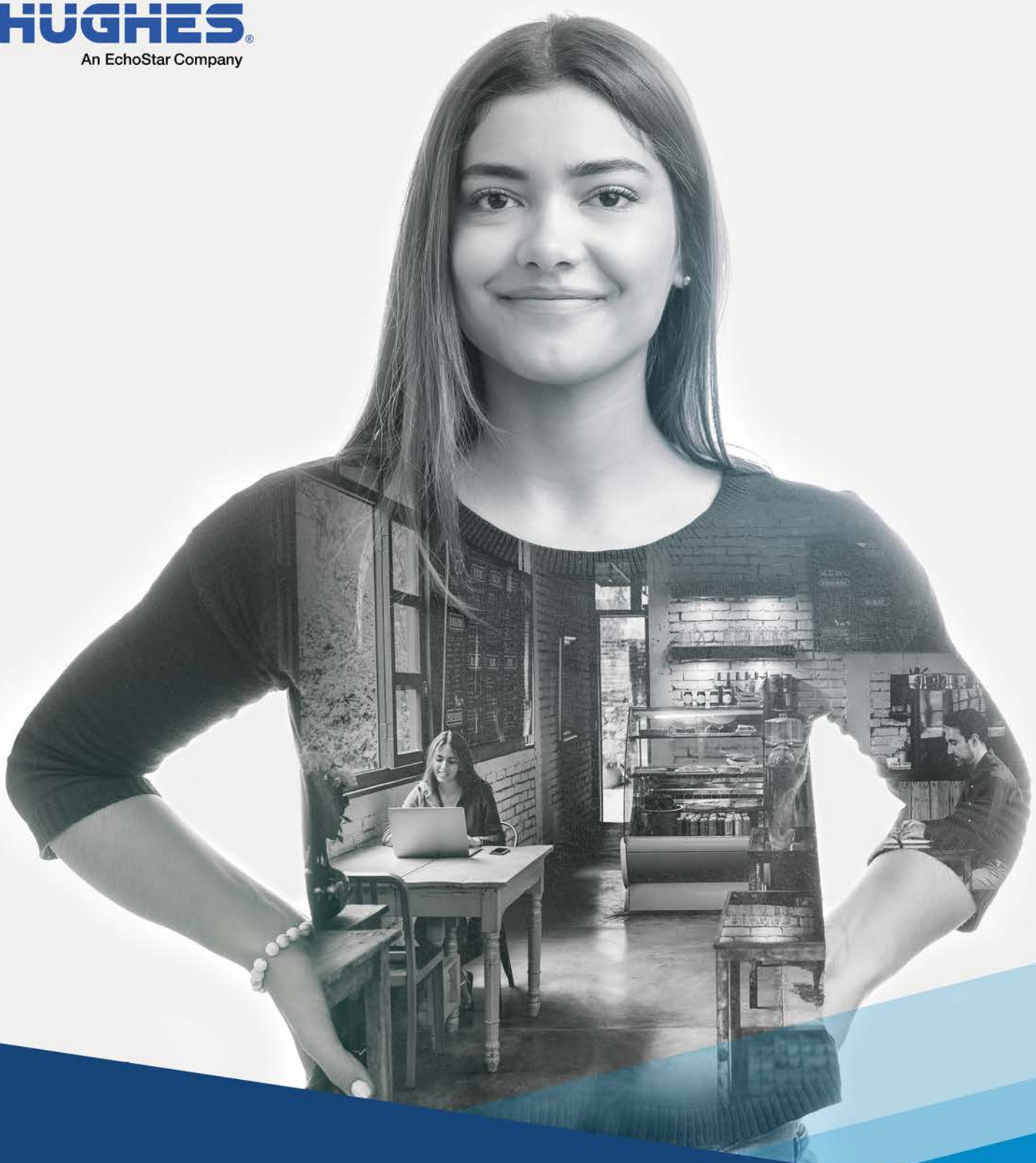

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A CONSTELLATIONS CONVERSATION WITH…

Software-Defined Satellites, New Business Cases and Massive Growth Opportunities

John Gilroy, Host, Constellations
Welcome to Constellations, the podcast from Kratos. Our guest is Dallas Kasaboski, consultant with Northern Sky Research, co-author of the recent NSR report "Software Defined Satellites." To start, Dallas, please clarify what it means for satellites to be software-defined?

Dallas Kasaboski
We hear the term a lot and the simplest definition is a satellite that can be changed or adapted driven by software. Most satellites that go up have a mission, and some flexibility in their capabilities. But for a satellite to be software-defined, it must be able to upload new software and have it completely change its operation. So, to be able to change your satellite's mission using new software means is why its referred to as software-defined.


Dallas Kasaboski

Data centers like Microsoft and Amazon do updates remotely all the time. So, this doesn't seem a groundbreaking concept, although it does seem new in the satellite world. Is a software-defined satellite just applying what's worked consistently on earth to different types of hardware? And, what demand are we seeing for software-defined satellites in GEO and non-GEO?

Dallas Kasaboski
Making those changes in space is challenging. You're not there, and there's lots of other considerations. So, yes, in one way, this is satellites catching up to the terrestrial space. In the communication space, for example, there are specific requirements for a satellite to be software-defined. Communication satellites in GEO are usually fixed, they have wide or spot beams that are focusing on one area of the earth. One aspect of software-defined satellites is that they can steer those beams. They also have a digital channelizer, an ability to cut the beam up, reprioritize it, refocus it in a different way. And the third is that they have some ability to change their onboard power or spectrum.

This goes to the question about demand. GEO satellites are just beginning to engage in software-defined satellite architectures, mostly for the additional levels of flexibility they provide. A common use case might be that you've been selling video services through satellite for years, but with that market shifting or decreasing you want the ability to shift to another type of application in the future. So, we're seeing that as a growing use case. GEO is roughly split 50/50 between traditional bent pipe, non software-defined which is not that flexible, versus something that has flexibility, whether steerable beams all the way down to power and spectrum configuration, digital channelization, and so on.

In non-GEO, the story is very different. Being able to steer beams is almost 100% a requirement. Depending on your network configuration, you may be able to get by without steering beams, but it's really inefficient. These satellites are moving very quickly, they need to coordinate, they need to change their look angle depending on the horizon. So, steerable beams is almost a prerequisite, which means that most non-GEO satellites are some level software-defined by definition.

There's only a few players that are really going full flexible, but it's growing. As we see it about 95% of all satellites that are going to be ordered in the next decade, will have some level of flexibility.

Is video the one application that'll benefit the most from these new types of satellites?

Dallas Kasaboski
Yes, that's one that a lot of GEO operators quote, is the potential need to shift from video to another application. Video has brought a lot of revenue generation in GEO over the years, but that market is changing and many are moving toward a more data-centric focus. So that ability to pivot is the use case.

Another use case, which could work for many applications, including broadband, backhaul, and mobility, is this ability to not only steer beams, but reconfigure them. So, you might have a GEO satellite in one area, but you see that your traffic patterns are changing seasonally or even daily. And if you had a more software-defined satellite, you might be able to redistribute the spectrum to make the most use of it so you're not blanketing an area that doesn't need it. So, there's great need in these cases for flexibility and different efficiencies, whether it's cost or performance.

How will these new software-defined satellite capabilities impact the ground segment?

Dallas Kasaboski
A lot. We often call the ground segment the forgotten link of the satellite network, because often everyone is so excited about manufacturing hardware, different funding and investment, that the ground often lags behind. That is changing. We're seeing a push-pull trade off. On the one hand, satellites are becoming more flexible and capable, with greater flexibility within their network management. But on the other hand, managing that network on the ground is more complicated. The satellite is smarter, more flexible, but more complex, which requires more effort on both the hardware and software side.

Talk about 5G. What role will that play in these software-defined satellites?

Dallas Kasaboski
Yes, 5G is going to affect every part of the system. In general, 5G is both hardware and a network protocol that needs to be considered. So, if you want your satellites to be compatible with 5G, then they have to speak that protocol and potentially be 5G enabled or have compatible hardware onboard. So any software-defined satellite for applications like backhaul, broadband, mobility, should be paying attention to 5G in terms of how to better integrate it. If the goal with software-defined satellites is to be more flexible and capable, those new capabilities will mean less if they're not interoperable or integrated into other networks like terrestrial and cellular. You can stand on your own as a software-defined satellite, but 5G is a way to bring these networks together. That's where we see the impact.

Operators, the ground network, the manufacturers, they're all working more closely together to make systems that are capable of communicating efficiently with each other and reconfigure at the same pace. And that's how 5G is going to impact software-defined satellites and vice versa.

How do software-defined capabilities affect pricing and performance?

Dallas Kasaboski
In short, hardware costs are going down, and software costs are going up. The strategy of manufacturers is to create a more software capable satellite, and one of the ways of doing that is by standardizing the hardware, shifting the complexity of the satellite from the hardware to the software. And in some cases, the hardware costs have gone down, and as I said, the software costs have gone up. But in terms of the overall satellite, software-defined satellites can be cheaper in many cases.

There are other factors. Basically, if you go from a completely bent pipe traditional satellite to a software-defined satellite, there's usually a price increase because it's a more capable system, and it's a newer architecture. Once you look at the difference between partial and full flexibility, we've seen cases where fully flexible satellites have come out cheaper than partially flexible satellites. That's a result of a lot of different factors, but mostly through standardization of the hardware and the growing but not outpacing costs of the software.

Who are the early adopters and how are they using it?

Dallas Kasaboski
The familiar ones are the operators, like SES. SES-17 is a very flexible satellite constructed by Boeing. Intelsat has ordered software-defined satellites. Some GEO players are really jumping on board early. And we've seen some from Eutelsat and Inmarsat as well, as they all see the need for flexibility in space.

Maybe you don't handle that on the satellite itself, maybe you handle that on the ground, or you do it through 5G protocols or something. But generally speaking, the capability is growing in satellites, and some of these operators are either taking risks or they're trying to mitigate risks by having some bridging solution like we talked about earlier.

How is this looking regionally?

Dallas Kasaboski
Regionally, it's probably no surprise we're seeing a lot of interest from North America, and more orders from Europe and Asia. Those three areas dominate. And we're seeing more orders coming from those areas for different levels of flexibility. Those regions have operators who may be ready to invest in another generation of satellites or maybe they have networks that are more complicated that need bridging, or maybe they have the funding to be able to afford it. But it goes back to greater need for flexibility.

Some operators in middle east or in Latin America, for example, are satisfied with a traditional bent pipe solution. They're generally cheaper and they work very well. And maybe their needs for flexibility aren't substantial. One operator in Asia who was considering a software defined satellite decided to go with bent pipe because the technology wasn't quite there yet, and they believed that they could get a bent pipe satellite manufactured more quickly than a software defined one. So the reasons come down to technology or requirement, timing, and business strategy.

Can you project eight to 10 years ahead and how the satellite industry will have changed because of these new capabilities?

Dallas Kasaboski
Looking ahead is always a balance between what has been done and innovation. We look to what the markets have been ordering and how certain markets have adapted to new technology, their adoption, their willingness to switch, the cost of adoption, and how disruptive or innovative that technology will be, how easy is it to adopt. We've talked about the great capabilities of software-defined satellites, but there's a reason that it's still 50/50 in GEO, in terms of who's ordering bent pipe versus who's ordering software-defined. And the reason is because its expensive and it is challenging to integrate these new capabilities into your system. It's not always plug and play.

Going forward, we see GEO shifting toward software-defined, but not fully. Most of the orders we predict, will be in the partially defined, which means that they have one, but not all of those capabilities I mentioned earlier. Steerable beams, for example, is the low hanging fruit of software-defined satellites.

An operator who wishes to maybe be able to change the direction of their spectrum based on different market changes, they might go for a bent pipe plus steerable beams that have a slightly partial satellite. In non-GEO, we also see partial flexibility as the key. And the reason is that a lot of players don't need full flexibility, especially for a constellation that they're going to have to replenish in five or seven or 10 years.

So, what they do is they make them as sophisticated as possible without going over the top because they know they're going to have to spend that CapEx in another five or seven years. So partial flexibility is where we see the market shifting to, and the majority of orders we see over the next 10 years to be placed there.

Dallas, thank you articulating what can be abstract concepts, and explaining software-defined satellites.

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An Apogee Semiconductor Insight: Changing The Economics Of Space

Author: Anton Quiroz, Chief Executive Officer, Apogee Semiconductor

The economics of space has changed significantly over the past decade. We've seen amazing reductions in launch costs that have paved the way for innovative satellite constellations with real world benefits that can be monetized. Applications such as Earth observation, providing world-wide internet and asset tracking can improve our lives in many ways, while generating significant revenue streams.

Along with the significant reduction in launch costs over the decade, the standardization of the cube-sat platform has also played a large role in the changing space economy. Now many vendors are developing components for the cube-sat platform that can be easily integrated into functioning and useful satellites, opening the sector to many groups who would have been unable to participate in the past. This new frontier of science advancements promises to unlock technologies we have yet to achieve.

While there is much positive change in the industry, there is one aspect that has not kept up with the fast pace of the rest of the sector: the integrated circuit (IC).

The Integrated Circuit

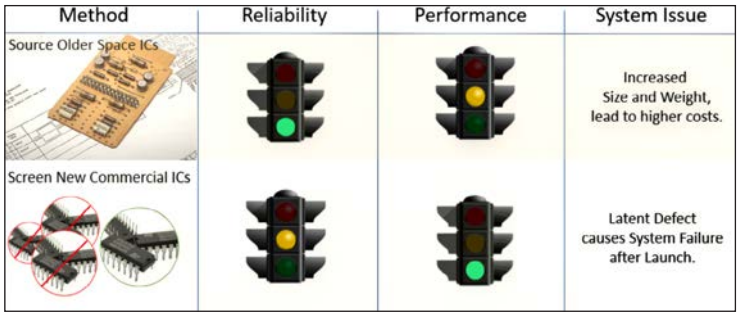
The importance of the integrated circuit to any modern technology cannot be overstated. Our connected lifestyle, transportation and entertainment are all possible because the ICs have become smaller, faster, and cheaper. The nursery of the IC was the aerospace industry, but over time the devices became commercial commodities, and the industry that raised the IC to prominence, now must pay dearly to obtain even outdated technology that can meet the requirements of space travel.

In the early years of the smallsat industry, many manufacturers were leveraging these commercially available components for their cost advantage and modern technology, taking risks to avoid using expensive and hard to source radiation hardened ICs, in specialized packaging. These space grade devices can meet the environmental requirements, but lag technology state-of-the art by over a decade and can have manufacturing lead times that could be in years.

This risk may be acceptable for short duration, very low earth orbit missions, using redundancy and sheer luck to succeed. The facts are that these components will start to fail once the radiation environment becomes more hostile.

Now that these satellites are being used in on-going business endeavors, they must work, and must achieve a return on investment. Satellite manufacturers differ in their awareness and approach toward the radiation and reliability issues.

Some manufacturers take the "ostrich" approach, they use commercial components, knowingly waiving off any radiation concerns. Others recognize that radiation effects on electronics cannot be ignored and actively seek out radiation tolerant components or "up-screen" commercial components to make sure they work under radiation environments.



Todays methods of radiation protection

The cost of ownership in both cases make the business model uncertain in a best-case scenario and leave the satellite developers in a dilemma. The challenges of the traditional space grade ICs make it almost impossible to close the business cases for proposed constellation and the use of commercial components translates into assured destruction of some of the units, but how many and how often?

There are manufacturers also taking a "middle of the road" approach. They utilize commercial components and balance those devices with radiation tolerant components to ensure that no radiation effects have corrupted the functionality of the circuit.

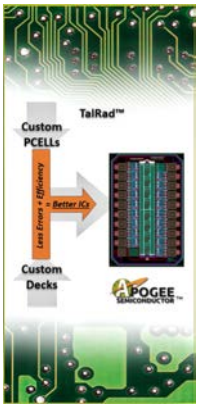
An example of this approach is to use a radiation tolerant voter device to ensure that a flipped bit in a memory does not turn on a device when it should not be on, but the cost and sourcing of such a device is still an agonizing process.

If we truly want to unlock the potential of the space economy, we must solve the rad-hard IC problem.

Solving The IC Problem

As with all growing sectors, when there is a problem, firms will use their innovation and ideation to create solutions. Implementing a patented semiconductor process, in the manufacture of common components, has caused a disruptive evolution in the radiation hardened semiconductor marketplace.

In the above voter scenario, there is now a solution, Apogee Semiconductor's **AP54RHC301** logic voter. The decision makers in all scenarios now have a new option in their solutions tool kit. Implementing a rad hard process in commercial semiconductor foundries, using standard plastic packaging, and proven commercial production flows, Apogee Semiconductor has been able to greatly improve the radiation performance of standard silicon devices to meet the needs of space travel, but also reduce the cost of radiation hardened components to enable satellite manufacturers to close on their business case, without the risks of commercial components.



Apogee Semiconductor first partnered with TSI Semiconductors, a silicon foundry from Roseville, CA, to develop a radiation hardened process delivery kit (PDK) that integrates into TSI's 180nm commercial high voltage process. With only minor changes introduced to a commercial process, it is possible to reduce impacts on cost while keeping the reliability high. Apogee Semiconductor's TalRad™ process accomplishes this while improving the radiation performance by over ten times compared to the commercial components.

Unlike the protype, test, protype, test…iterations typically seen in hardware, this is not possible with silicon. Silicon mask sets can cost millions of dollars and fabrication cycle time can be 2-4 month. This makes the iterative engineering approach not practical for IC design. Instead, IC designers rely on CAD tools and run constant simulations to verify and iterate their designs. Without integration of rad-hard components into these tools, the cost and time required for a rad-hard design can be over three times what is seen commercially. The TalRad™ kit seamlessly integrates the rad-hard components into these tools and solves the design cost and time-to-market problem with developing rad-hard ICs.

What About Packaging + Test?

Making rad-hard design more efficient solves a big part of the problem but we also need to address the cost of assembly and test. Traditionally, space ICs are packaged in expensive hermetic packages that are large and reduce the performance of the IC. The space industry has started to accept plastic packages and New Space customers are using them almost exclusively. There are ongoing efforts to develop standards for traditional space customers to fly plastic ICs, which is a step in the right direction.

While standardization is a positive step, the industry does have to be careful to avoid unnecessary screening costs that do not measurably improve reliability. Testing and screening cost can be over 80% of the cost-of-goods-sold of space ICs. Care must be taken to achieve the optimal balance of reliability and cost. From its beginnings, Apogee Semiconductor has focused on releasing space products in plastic packages with optimized test flows optimized for large constellations.

To truly change the economics of space, we have to make rad-hard ICs more capable and affordable. Continuing to use non-rad hard commercial-off-the-shelf ICs is a reliability risk the industry needs be concerned about. Malfunctioning satellites can cause orbital debris if they crash or become "***zombie***" satellites causing interference as they blast the Earth with unwanted radio signals.

apogeesemi.com

Author Anton Quiroz is the Chief Executive Officer of Apogee Semiconductor

Anton Quiroz

Apogee Semiconductor's mission is to change the economics of space by bridging the gap between rad tolerant and commercial ICs to enable mega-constellations. We need more of these amazing constellations to be able to close their business cases, reliably.

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Are Regulators Doing Enough?

Author: Helen Weedon, Managing Director, Satcoms Innovation Group (SIG)

As a geographically wide-reaching, resilient, and highly used segment of RF spectrum, the decision to hand over swathes of C-band from SATCOM to 5G was controversial. Some satellite operators welcomed the news, while others voiced concerns at the decision's impact on services being provided by SATCOM, especially within broadcast where its resilience is often relied upon.

After many long discussions, the decision was reaffirmed — the licensed use of 3.7-3.98 GHz was assigned and auctioned off for telecom's use. In response, the satcom industry readjusted its services and looked to create mitigation tools and products to prevent RF interference. There were concerns around the impact of 5G cells on the satcom ground segment. ***Would there be an increase in cases of RFI? Would it be possible to identify the cause?***

In recent years, SATCOM's management of RFI has grown in sophistication, with monitoring and identification tools available to quickly identify issues and resolve them appropriately. Additionally, filtering products have been developed to mitigate the impact of 5G signals on satcom's use of C-band; not only to prevent the loss of services caused by the lack of spectrum, but also to reduce the detrimental impact on the remaining services which operators are still able to deliver.

Anecdotally, there have been early instances of 5G causing issues with RF signals for neighboring users. This isn't exclusive to 5G having an impact on satcom; there have been instances in which 5G has caused interference within the telecom industry, with mobile operators impacting on each other's services.

Much of this interference seems to be location based; C-band users within Europe have shared many instances of RF interference in regions where 5G rollout has started. For many, instances of RF interference between the industries are unsurprising. RFI is a very familiar issue within satcom, and many have raised attention to the challenges surrounding its management across communications industries.

With many suggesting that the running of this should be managed by regulators, is the current regulatory situation thorough enough to cope with the increasing rollout?

Managing spectrum

Regulatory bodies across the world have taken different approaches when managing the sharing of spectrum. In many countries, a 'negotiate and agree' type system has been instated which has resulted in interference cases being solved by the communications operators themselves. Unfortunately, this method is not effective and is leaving many decisions to good will and best practice.

One of the more successful approaches has been that of the US's FCC. The FCC has defined how to determine whether satcom is being impacted negatively by 5G and there is a clear procedure to follow if a fault is found. In the U.S., the mobile operator is required to solve any issues highlighted by RF users in SATCOM.

By providing the mobile operator with details, such as which tower or signal levels are causing RFI, the telecom provider must mitigate the effects.

Additionally, the ***FCC*** has taken an active role in managing the handover of spectrum to the mobile industry. It facilitated the auction of spectrum and, with the money gained from the sales, established a project to provide ground segment equipment to SATCOM users within areas of 5G.

Not only is FCC compensating the incumbent satellite operator spectrum rights holders for expediting their efforts to hand over spectrum to mobile operators, but they are also reimbursed the actual cost of doing so, and reconciling all remaining C-band services in grandfathered earth stations.

This seems to be having a good impact on the number of RFI instances being recorded; the FCC's active role is helping to upgrade networks without passing down the associated costs to the ground segment.

Unfortunately, this proactive approach to spectrum management is not common. Each country has its own regulator, and no other is providing the same amount of regulation and support as the FCC. Could this be why we are hearing of many RFI instances caused by 5G in Europe?

We know that the coverage of 5G is going to be wide, and therefore it is hugely important that the rollout is handled correctly. There are huge benefits in regulators taking an active approach to spectrum management; without legislation and regulation, the process of managing incidents is left to operators themselves.

This is not an efficient method of dealing with such instances; ***what happens when operators disagree on the cause of the RFI? Will the region regulator have the capacity to review and oversee each case?***

Another important question to ask is whether regulators are supporting satcom users to adjust to working alongside the telecom industry. A coordinated approach would prevent issues associated with RFI, and in turn reduce the number of incidents requiring attention.

Ultimately, the focus of communications is to deliver seamless connectivity to users. It is in no industry's interest for its services to be disrupted. Small steps could be taken by regulators to mitigate these problems and it is frustrating to see many stalling on the matter.

A Coordinated Approach To Spectrum

At SIG, we have highlighted the need for a coordinated approach to spectrum for years. Spectrum is finite and we must respect that we are not its only users; poor use of RF can have a severe impact on neighboring users.

SATCOM has developed many solutions for identifying, monitoring, and mitigating RFI and is technologically prepared to identify RF issues being delivered by a new source. However, this is not enough to manage the cohesive use of spectrum. It is imperative that regulators take on an active role in spectrum management; it is not good enough to manage C-band auctions and simply move on once the spectrum has been sold.

The challenge has already been made difficult due to how spectrum has been assigned; in terms of spectrum, there are now two industries working very closely aside one another with very different technical characteristics and power levels. Managing industries with separate needs and expectations from their use of spectrum is going to take coordination; there must be clear regulation in place to dictate who is responsible to mitigate instances of RF interference.

As we progress with the rollout of 5G, it is clear that its benefits will bring a range of opportunities for users. However, it is important that we harness our knowledge in RF management to ensure that there are suitable regulatory systems in place to allow users of RF to have confidence in implementing RF technology into their networks

satig.space

Satcoms Innovation Group

Author Helen Weedon is the Managing Director of the Satellite Innovation Group.

Helen Weedon

The Rules Of The Road

Identifying responsible behaviors in space

Author: Daniel Oltrogge, Founder and Administrator of the Space Safety Coalition and Director of Integrated Operations and Research for COMSPOC Corporation

The year is 1863 at Gettysburg, Pennsylvania, a fierce American battle that turned the tide of the American Civil War. In the aftermath, the battlefield was impossible to clean up and largely unusable. Farming families found it too challenging to operate there and many were forced to move away, some permanently and others until the passage of time, natural decay, and difficult work rendered the area usable once again. The Gettysburg aftermath strikingly parallels the degrading effect of last month's Russian ASAT test (https://comspoc.com/News/Default.aspx) on our fragile space environment.

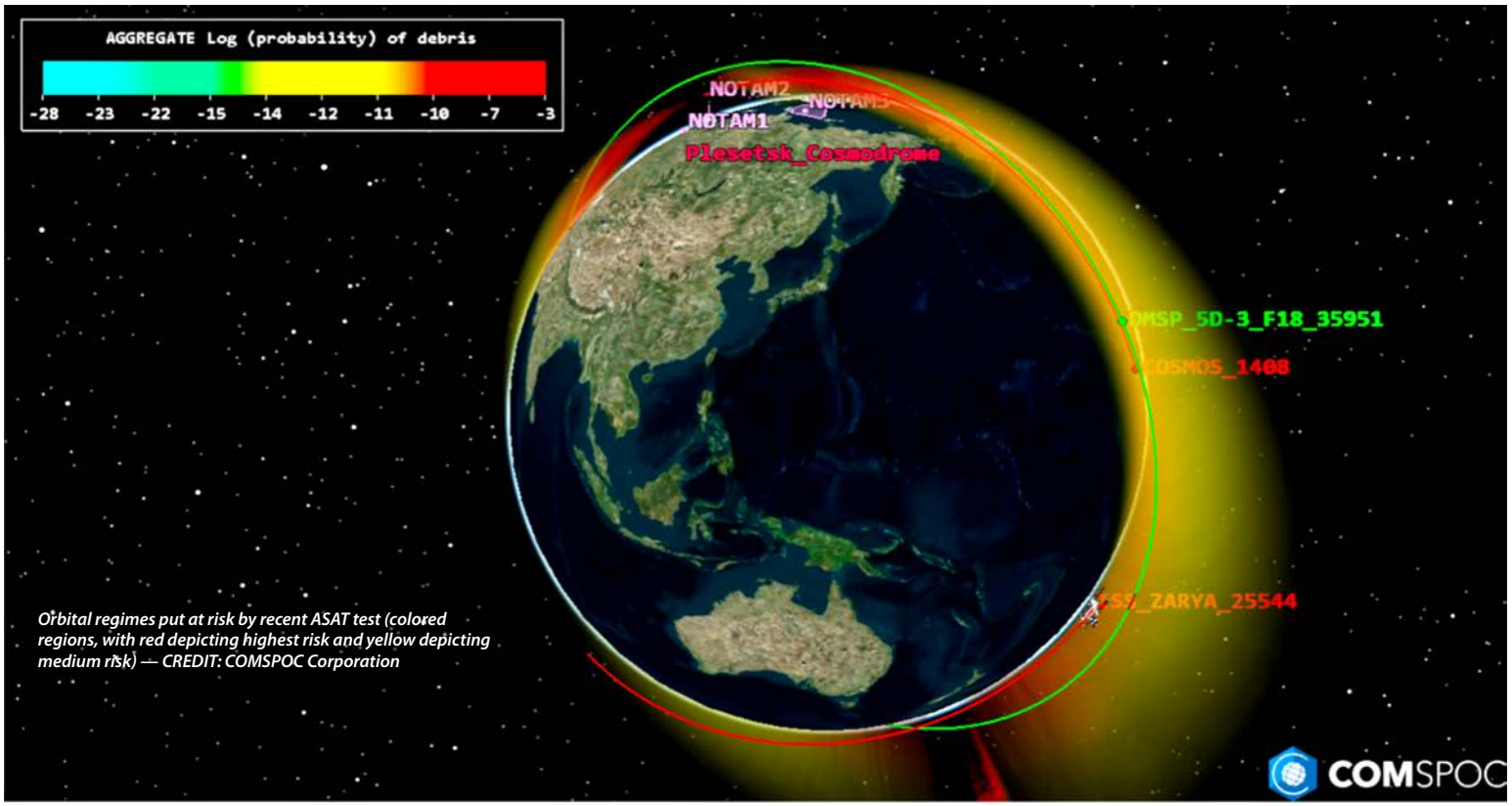
Regrettably, countries have increasingly weaponized space. Though less severe than the Chinese ASAT test of 2007, the recent Russian ASAT test introduced over a thousand debris fragments. Such tests can challenge space operations for years, until — as with the Gettysburg battle — the passage of time, natural decay, and hard work (*i.e.*, active debris removal) gradually cleanses the space environment. Unfortunately, natural decay for space can range from years to centuries to eons. In the meantime, space weapons testing and posturing continue, putting at risk both humans and vital satellite functions critical for humanity including Earth observation, weather monitoring, disaster recovery, security, and communications.

It is time to prioritize both space safety and sustainability, making this adage especially relevant today: we need to say what we mean and mean what we say.

The Space Safety Coalition (SSC), founded in 2019, provides invaluable best practices for space operations (***https://spacesafety.org/best-practices***). These best practices are unique in embracing and adopting tenets of the ***United Nations*** (**UN**), ***Inter-Agency Debris Coordination Committee*** (**IADC**), ***International Organization for Standardization*** (**ISO**), and ***Consultative Committee for Space Data Systems*** (**CCSDS**). These have been augmented by an additional 42 industry best practices endorsed by over 50 space companies and non-governmental organizations from a dozen countries. Many spacecraft operators are keenly aware of what is an acceptable practice and what is not, and the SSC provides an important conduit for voicing and building consensus on responsible behaviors.

Interestingly, the November 2021 ASAT test directly violated one of Russia's own space safety policies, putting at risk hundreds of spacecraft and satellites including the International Space Station. Any spacecraft transiting the colored regions in the above figure will experience a risk of collision with the post-ASAT debris fragments, ranging from lower risk (green) to medium risk (yellow) and highest relative risk (red). The ISS ranks among the top 20 of spacecraft, with other critical space assets needlessly placed in harm's way (Russian ASAT test (***https://comspoc.com/News/Default.aspx***). Spacecraft operators are now at heightened alert and will have to exercise increased vigilance, care, and collision avoidance maneuvering for several years.

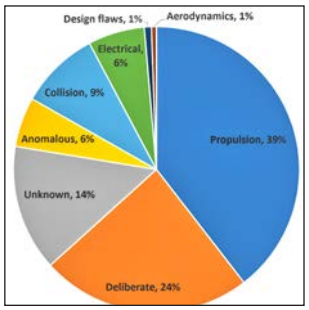
Intentional fragmentation is not the only space safety policy being violated. Other central tenets of our global space sustainability plan are repeatedly ignored, including limiting our post-mission orbit lifetime to less than 25 years, effectively passivating spacecraft, limiting the release of debris (ideally a net-zero operation), and ensuring that spacecraft are effectively disposed at least 90% of the time.



Orbital regimes put at risk by recent ASAT test (colored regions, with red depicting highest risk and yellow depicting medium risk) — CREDIT: COMSPOC Corporation

We need to leave space in a habitable, operable state, but that is not the trajectory that the global space community is currently on.

I am often asked, "*Why focus on the development of space industry best practices when minimum consensus UN, IADC, ISO, and CCSDS treaties, guidelines, and standards are not fully complied with*?" The obvious answer is, "***Why not***?"



Sources of Space Debris — CREDIT: Derived from European Space Agency characterization, © ESA / UNOOSA

All too often, people get stuck in binary thinking mode, asking questions like, "*What is the single most important way we can ensure the sustainability of space operations*?", or "*Is top-down national regulation more important than bottom-up aspirational space industry best practices*?" As shown in the figure below, there are many causes of space debris, and we need the entire space community to address each of the root causes of space debris to achieve space sustainability. Having such a binary mindset on what steps to take is both biased and risky because no single discipline, entity, research area, or regulatory framework can, by itself, address space safety and sustainability. Let's stop kidding ourselves that it can. Addressing the challenge requires a multifaceted space community effort that includes NGOs, military, civil, commercial, academia, and amateur elements.

Space sustainability demands a holistic, leave-no-stone-unturned approach, one that pursues all aspects of space safety and sustainability. That is not to say that all avenues should be resourced or pursued with equal priority, but they should be pursued, nonetheless. Our global space community is a vast enterprise. The elements that comprise it can all do their part without interfering with another element's ability to do so, so that we can collectively up our game. Are we forced to prioritize between academic research, commercial research and innovation, improved Space Situational Awareness, Active Debris Removal, government regulations, commercial best practices, UN and IADC guidelines, or NGOs? No. All these elements are key components of the virtuous cycle that constitutes our space governance and sustainability framework.

The SSC continues to gain momentum with more countries and organizations endorsing its best practices document, which continues to evolve to include critical refinements and enhancements to maintain these best practices. Banning intentional fragmentation, enhanced cyber security, and root cause anomaly investigation and mitigation are paramount, as are rules of the road (RotR).

RotR is a critical ongoing discussion, but so far, there has been no meaningful consensus on its definition, let alone any aspirational or normative content. Some advocate that actual rules - in the form of regulations - be established, while others suggest industry best practices are sufficient. Establishing expectations is a critical first step in this process. Some point to air traffic rules or maritime "give way" procedures as base frameworks for space RotR. It is critical, however, to remember that space travel is fundamentally different from air and sea travel. Any accident or intentional fragmentation in space leaves long-lived debris that doesn't immediately fall out of the sky or sink to the seabed. Instead, it continues to complicate future use of that orbital regime. We also do not yet have in space the air travel concepts of flight levels that serve to automatically deconflict flight paths, or requirements that specific flight plans be filed. Unlike maritime law, spacecraft operators often don't have the innate observability and access to accurate and timely SSA information to know whether another operator has maneuvered their spacecraft, and if so, whether they have performed an avoidance maneuver. In any case, RotR is just one aspect of overall best practices which the SSC is interested in.

In addition to the SSC's continuing development of RotR and sustainability best practices, SSC participants actively serve as lead editors, thought leaders, and strategic contributors to the development of critical international space standards that the SSC can embrace and incorporate. These include interoperability through the establishment of space data standards for orbit, attitude, conjunction, reentry, tracking, fragmentation, and launch data messages in CCSDS, and sustainability best practices for orbital debris mitigation, passivation, orbit lifetime estimation, on-orbit and launch conjunction assessment, ***Space Traffic Coordination*** (**STC**), and the operation of ***Large Constellations*** (**LCs**) through ISO.

Sustainability initiatives are gaining momentum internationally and domestically. In the ***United Nations Committee for the Peaceful Use of Outer Space*** (**UN COPUOS**), the *Long-Term Sustainability of Outer Space Activities Working Group* is assembling to advance its 21 LTS guidelines and focus on ways to implement them. UN COPUOS is also developing a work plan for a new working group focused on legal models for space resource utilization.

Domestically, the ***U.S. National Space Council*** and the ***Department of Commerce*** are re-energizing discussions about what constitutes safe and appropriate behavior in space. The White House has unveiled the ***Space Priorities Framework***. Meeting attendees vigorously discussed that framework, RotR, and norms of behavior in space. These positive developments demonstrate a global sense of urgency of executing robust space safety measures and systems.

International cooperation is critical to protecting the expanding space environment. With this growth comes a global responsibility to identify and abide by appropriate behaviors in space. We can't afford to wait.

Daniel Oltrogge is the Founder and Administrator of the Space Safety Coalition and Director of Integrated Operations and Research for COMSPOC Corporation.

Daniel Oltrogge

A Chorus Of Aurora —The Chase Is On By NASA

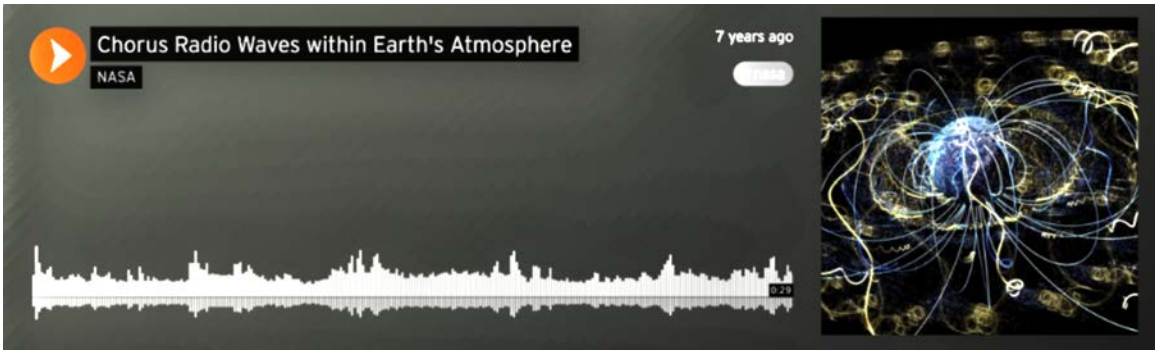
A new *NASA* sounding rocket mission will soon take to the Alaskan skies — the LAMP mission, short for *Loss through Auroral Microburst Pulsations*, will fly above an often-overlooked kind of northern lights to test a theory on what causes them.

Turning observations into information from the center of the Earth to the center of the sun
Geophysical Institute
Poker Flat Research Range

The aurora borealis, or northern lights, is a familiar treat to those who call northern latitudes home. Auroras come in different shapes and colors, waving their ribbons of vibrant green, red and purple across the sky. However, one variety of aurora displays a peculiar behavior: it pulsates.

Like all aurora, pulsating aurora are set alight by electrons (and occasionally protons) from near-Earth space. These electrons plunge into our atmosphere and collide with atoms and molecules, causing them to glow in their distinctive colors – red and green by oxygen, blue by nitrogen – as they release their excess energy.

But what sets those electrons into motion in the first place? For pulsating aurora, the going theory points to chorus waves, so named because they were first detected as audio signals in radio receivers during World War I.



A type of plasma wave known as chorus as heard by the EMFISIS instrument aboard NASA's Van Allen Probes as it passed around Earth. Credits: NASA/University of Iowa Download "Chorus Plasma Waves" (MP3)

But chorus waves are not sound waves – instead, they move through plasma, the electrified gas that makes up over 99% of the observable matter in space. They ripple through the particles trapped within Earth's magnetic environment, shaking some loose to fall into our atmosphere.

"*It's sort of hypnotic, pulsating every few seconds*," said Dr. ***Alexa Halford***, space scientist at NASA's **Goddard Space Flight Center** in Greenbelt, Maryland, and principal investigator for the mission. "*The blobs and colors remind me of a lava lamp, where you can just sit and stare at it for hours. "Pulsating aurora and microbursts seem to happen at similar times, even though they're different energy ranges. So, the big question is, are they the same events? Are they being driven by the same processes in the magnetosphere*?"

"*Chorus waves occur at exactly the right frequency to 'resonate' with the electrons that create pulsating aurora, similar to how you pump your feet at just the right time to get a swing to go higher and higher*," said Dr. ***Allison Jaynes***, space physicist at the University of Iowa in Iowa City and co-investigator for the mission. Eventually, some of these electrons "jump off" the swing — and shoot into our atmosphere.

Chorus waves can launch both low and high-energy electrons, which may explain some puzzling coincidences. Pulsating aurora are caused by fairly low-energy electrons, but they're often observed alongside flashes of X-ray light known as microbursts, which come from higher-energy electrons.

The NASA LAMP payload is rolled out of the payload assembly building at Poker Flat Research Range for testing before heading for the launch pad. Credits: NASA/Terry Zaperach

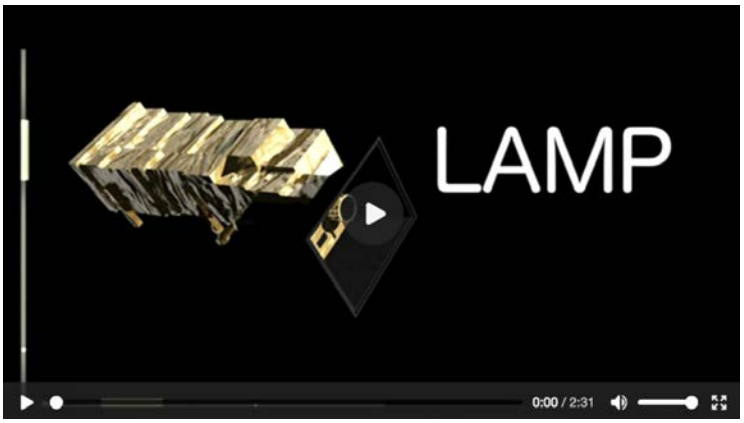
That's what LAMP hopes to find out.

The LAMP instrument will fly aboard a sounding rocket, a small rocket launched into space for a targeted few minutes of measurements before falling back to Earth. Watching ground-based cameras at the Poker Flat Research Range and at a downrange site called Venetie, the team will wait until they see auroras start to pulsate. Then it's go time. Three men rolling out a rocket payload across the snow.

The rocket will fly above the pulsating aurora, measuring the low-energy particles that cause them as well as the medium- and high-energy electrons that should also come from a chorus wave. On the ground, a riometer will provide an independent measure of high-energy electrons, so the rocket team can confirm their measurements. The only thing they won't measure is the chorus wave itself, though the team is hoping for a chance flyby of a satellite that could potentially provide those observations.

"We have all but one piece of the puzzle that we're hoping to catch simultaneously…but any of it is going to provide us new information and hopefully help us test that theory that it's the chorus waves behind it all," Halford said.

The LAMP mission is an international collaboration with contributions from NASA's Goddard Space Flight Center, Dartmouth College, University of New Hampshire, and University of Iowa, and Japan Aerospace Exploration Agency (JAXA), Tohoku University, Nagoya University, and Kyutech in Japan.



Learn more about the LAMP instrument in this video. Goddard Media Studios.

***Story by** Miles Hatfield*
NASA's** Goddard Space Flight Center**, Greenbelt, Maryland.

Inmarsat + Hughes Support ITU Disaster Relief Efforts With $1.3 Million In Donations

Inmarsat **and** ***Hughes Network Systems, LLC*** **(HUGHES) have donated mobile satellite communications technology and services to the** ***International Telecommunication Union*** **(ITU) for use in developing nations facing natural and man-made disasters.**

The donation includes 30 ***Broadband Global Area Network*** (**BGAN**) terminals, manufactured by ***Hughes***, and $1.2 million worth of satellite airtime from ***Inmarsat***, leveraging the ***ELERA*** network. Hughes and Inmarsat will also provide technical training to ITU personnel so they can deliver a turn-key communications solution for humanitarian aid workers responding to emergencies anywhere in the world.

Within the first hours of a disaster or conflict, the ITU will lend the mobile satellite terminals to relief teams that can use the rugged, portable devices and Inmarsat satellite capacity to set up voice and data connectivity where it's needed most for rescue and relief efforts.

With access to global satellite capacity and 30 terminals, the ITU will be able to deploy satellite connectivity to support multiple communities in need at any one time.

Houlin Zhao, Secretary-General, ITU, said, "*We rely enormously on donations from our members to deliver critical technologies and disaster mitigation to countries in need. This donation from Inmarsat and Hughes will help in preparing for disasters before they strike, and in the immediate aftermath, by restoring vital communication links between first responders and communities, and by helping teams on the ground coordinate life-saving rescue and relief activities. The scale of our work simply wouldn't be possible without such donations.*"

Rajeev Suri, CEO, Inmarsat, said, "*Satellite communications are a lifeline in the aftermath of disasters, ensuring that relief efforts can be deployed rapidly, even when terrestrial communications have been knocked-out. We have immense gratitude for the vital work the ITU and their partner organisations do around the world to help communities facing disaster and conflict. We look forward to continuing this partnership, to help more communities and humanitarian workers in their hour of need.*"

Pradman Kaul, president of Hughes, said, "*We are proud to join Inmarsat in donating these crucial technologies to support the life-saving work of the ITU. Connecting communities struck by disaster – and the emergency workers supporting them – is best accomplished with satellite connectivity.*"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