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# SATELLITE EVOLUTION GLOBAL

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April 2022

## How satellite operators manage to be both – an ISP and a TV broadcaster

**Plus:**

Revolutionizing the way to space
Executive movers and shakers
Q&A Airbus Defence & Space
Digitizing gateways for NewSpace
Shaping a cloud-native future for 5G
Reducing interference issues
Q&A ETL Systems

*Front cover photo courtesy Bruce Rolff/Shutterstock*

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Reducing interference issues - page 38...

*Crispin Littlehales, Global Contributing Editor*

# Cosmic setback

Thanks to images taken by Maxar's WorldView satellites, we saw the Russian's invasion of Ukraine almost before it happened. What was not so immediately apparent was the impact that action would have on our industry and how we would deal with it.

In the weeks that followed Russia's savage attack on its non-threatening neighbour, the collaborative and productive relationship that the multi-national satellite and space segment has had with Russia for more than two decades disintegrated into threats, non-cooperation, and sanctions.

In addition to loss of life and destruction of businesses and housing in Ukraine, the fallout from the invasion has caused serious disruptions affecting global finance, energy production, and supply chains—all vital to the growth of the satellite and space industry.

Just as bison form a multilayer circle of protection around their young when faced with predators, many players in our industry have acted in solidarity, providing humanitarian support to Ukraine, while striving to preserve cooperation with Roscosmos and the International Space Station (ISS).

SpaceX not only provided additional Starlink terminals to Ukraine, but also made cyber security a priority. Canadian space company, MDA Corp. provided radar satellite imagery to help Ukraine defend itself against Russian attacks. Jared Isaacman, who is heading up the Polaris Program, made sure that St. Jude Children's Research partners in Ukraine and Poland were equipped with mission critical internet connectivity to support their patients. Then, on March 30, Mark Vande Hei returned safely to Earth from the ISS in a Russian Soyuz rocket, accompanied by two cosmonauts.

Albert Einstein once said, "The world is a dangerous place to live; not because of the people who are evil, but because of the people who don't do anything about it." I believe if Einstein could see what our industry has done in the last month, he would be pleased.

Our April issue of Satellite Evolution Global is filled with reports of technological advances and forward motion. Laurence Russell sits down with Stéphane Estable, Project Coordinator and System Architect for Airbus Defence & Space for a progress report on the PERASPERA In-Orbit Demonstration (PERIOD) project. He also catches up with ETL Sales and Marketing Director, Andrew Bond, to learn about how the company deals with current connectivity challenges.

Dr. Andreas Voigt, Director of the Satcoms Innovation Group, writes about how satellite operators need to be both an ISP and a TV broadcaster. Brooke Frischemeier, Senior Director of Product Management for Robin.io, explains how Kubernetes are used to leverage cloud-native solutions to drive the massive scaling of services and applications for 5G while Ben Snow, Field Sales Engineer for Filtronic, enlightens us on the topic of mitigating interference issues between 5G and C-band satellite communications. Jonathan Baker, Chief Technology Officer for Kratos Antenna Solutions shares his thoughts on digitizing gateways for NewSpace and Moog's Katie Gibas and Shae Williams walk us through their company's involvement with less toxic propellants.

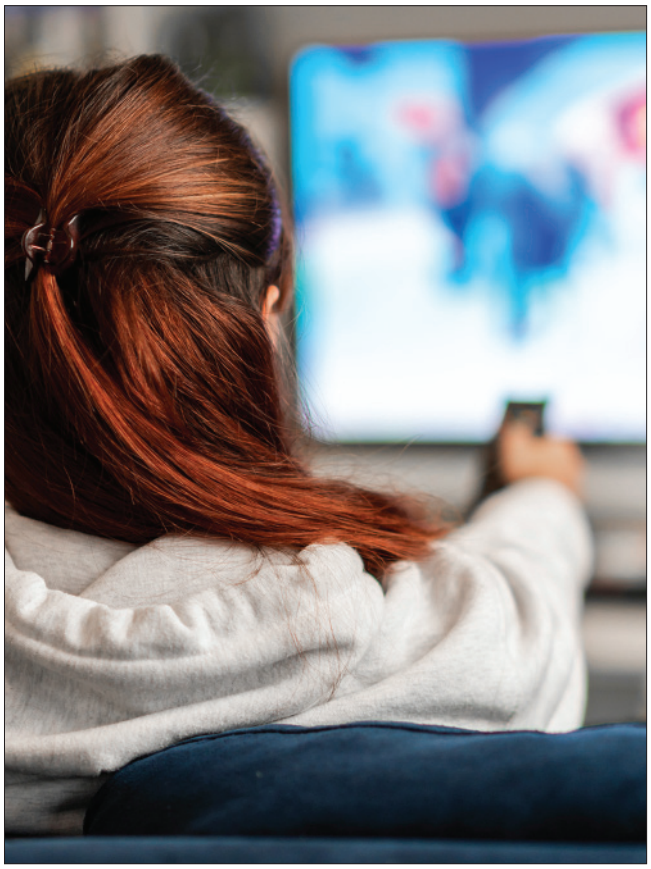

*Photo courtesy Adobe Stock*

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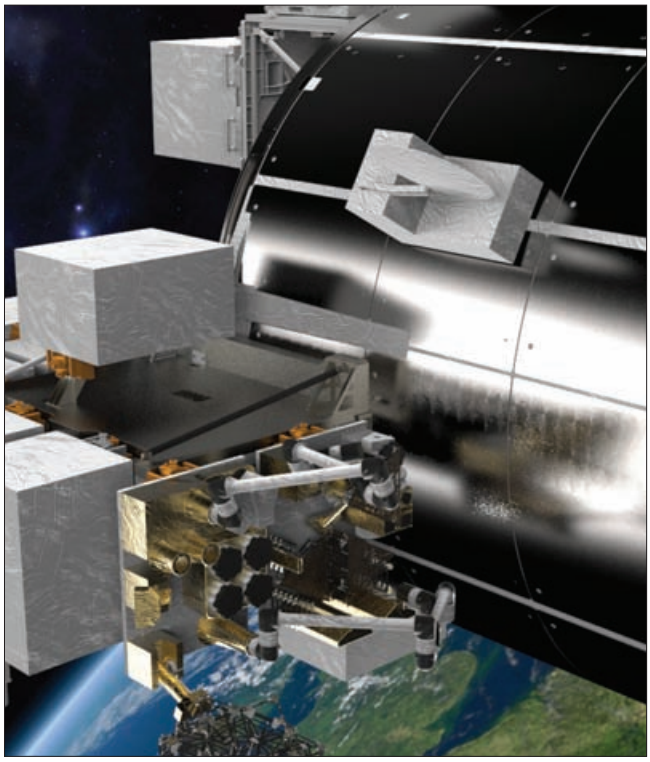

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# NPC SYSTEM introduces NEW digital tracking receiver: NEYRPIC DTR-500

With more than 50 years of experience in satellite tracking and more than 900 systems installed in over 70 countries, NPC SYSTEM proudly continues to develop and supply NEYRPIC® satellite tracking systems for the civilian and military markets.

Though a series of mergers and acquisitions from NEYRPIC® to Alstom to General Electric and finally to NPC SYSTEM in 2018, NEYRPIC® satellite tracking systems have provided a reliable tracking solution to customers. NPC SYSTEM carries on NEYRPIC's know-how in designing tracking systems for all types and sizes of fixed and mobile antennas.

NPC SYSTEM is proud to introduce its latest digital tracking receiver: **NEYRPIC DTR-500**

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# Speedcast signs partnership with Lars Thrane

**GLOBAL:** Speedcast has announced a partnership with Lars Thrane, offering a suite of terminals and the ability to deliver Iridium® Global Maritime Distress and Safety System (GMDSS) services. Following Iridium's launch of the GMDSS service in 2020, this contract formalizes the addition of the service to Speedcast's Managed Services portfolio.

As part of the agreement, Speedcast will offer the full range of Lars Thrane terminals – models LT-3100, LT-3100S and LT-4100, with the LT-3100S as the only Iridium GMDSS certified terminal available today. Connectivity service for the terminals will be delivered through Iridium's low-latency global network, providing reliable coverage even in adverse weather around the entire globe, including over the Arctic and Antarctic waters.

As the most advanced mariner safety service in the market, Iridium GMDSS encompasses a set of protocols, equipment, and communications systems designed to ensure that if a ship is in distress, aid can be dispatched from anywhere in the world. The contract scope also provisions Speedcast as a strategic partner for Iridium GMDSS, with trained engineers ready for deployment worldwide.

"Speedcast strives to continuously provide the latest advancements in technology to best equip our customers for operational success," said Jeffrey Irwin, Vice President, Product Management at Speedcast. "We're pleased to offer certified safety solutions via our partnership with Lars Thrane. By combining the delivery of Iridium GMDSS services via Lars Thrane's best-in-class terminals, with corporate and crew connectivity provided by Speedcast's global mobility network, customers can realize ubiquitous communications to meet all their fleet needs. This is a game changer for maritime industry safety."

"The decision to partner with Speedcast was straightforward, given its global footprint, maritime expertise, professional field engineers and status as a long-term partner with Iridium," said Thomas Flinth, Sales Manager at Lars Thrane. "We look forward to revolutionizing maritime safety by joining forces to deliver the communications tools necessary to keep mariners safe."

*Photo courtesy ABIR ROY BARMAN/Shutterstock*

# Intelsat establishes satellite video neighbourhood for Brazil cable distribution

**LATIN AMERICA:** Intelsat has announced the commencement of "seeding" of antennas at more than 200 cable headends in Brazil in cooperation with local vendor, Z2Gtech.

Antenna seeding is an installation program providing widespread access to cable headends across Brazil, creating a new video neighbourhood on Intelsat 14 (IS-14) at 45°WL. IS-14 will reach more than 98% of cable TV subscribers bringing value and monetization opportunities for programmers seeking to reach the Brazilian market.

"This antenna seeding creates a unique and highly targeted Brazil-focused neighbourhood offering value for our Latin America programmers. This neighbourhood serves the largest television audience in the region with specialized content and further enhances the customer profile on IS-14," says Bill O'Hara, vice president and general manager of Media at Intelsat.

IS-14 is focused on regional video distribution and has high penetration into regional systems across all Latin American countries. The antenna program is a pioneering way to enhance cable penetration to all key MSOs in Brazil.

TV Cultura, a Brazilian television network that serves over-the-air, cable, and satellite TV systems, will be an initial customer on the IS-14 video neighbourhood.

"TV Cultura viewers across Brazil will have access to high quality, cultural, informative and entertaining television content," said Nelson Faria, TV Cultura's technical director. "With Intelsat, we can broaden our reach and provide more affordable and differentiated programming to our viewers. The quality, reliability, and reach of Intelsat's video neighbourhoods enable us to achieve significant operational savings while at the same time increasing our viewership and enhancing the service offerings that we deliver to households across Brazil."

Intelsat selected Z2Gtech, a company specialized in the integration of satellite transmission systems, to manage the project. Following a comprehensive site survey, technical installations of new antennas are being performed throughout Brazil. Z2Gtech has deployed multiple teams to manage the installations and ensure full

technical excellence in the reception of IS-14 signals.

"The IS-14 antenna seeding program is an innovative approach by Intelsat to better serve the Brazilian telecommunications market, enabling programmers to efficiently grow their businesses," said Herbe Zambrone Junior, Z2Gtech's CEO.

IS-14 complements Intelsat's other video neighbourhoods in the region including, Intelsat 21 and Intelsat 34. Together, these neighbourhoods serve nearly all video subscribers throughout the region with full cable penetration.

## QVC UK signs multi-year HD contract renewal with SES at 28.2 / 28.5 degrees East video neighbourhood

**EUROPE:** Viewers across the United Kingdom and the Republic of Ireland will continue to enjoy premium televised shopping as QVC UK and SES, the leading global content connectivity solutions provider, announced a five-year contract renewal to broadcast the company's QVC, QVC Beauty, QVC Extra and QVC Style channels over SES's 28.2 / 28.5 degrees East satellites.

As part of the agreement, both the QVC and QVC Style channels will be upgraded to high definition (HD). Moreover, SES will continue to provide ground services to QVC UK, including managed encoding and uplinking services.

QVC is a world leader in video commerce, which includes video-driven shopping across linear TV, vCommerce sites, digital streaming, and social platforms. Worldwide, QVC reaches more than 200 million homes via its 12 broadcast networks. Since the 1990s, QVC has been leveraging SES's satellites to broadcast their retail channels to audiences across the UK and Ireland, as well as to multiple markets across the globe.

"Our broadcast channels are central to our business, so we are happy to continue and expand our longstanding partnership with SES to provide reliable, high-quality broadcast to our customers across the UK and Ireland," said Simone Borkar, QVC Director of Broadcast Engineering Europe. "Ensuring our customers have an immersive and engaging vCommerce shopping experience is of paramount importance and why we continue working with SES."

"QVC UK has been an important customer for our video business in Europe for the last 30 years, so we are delighted to extend our partnership for another five years," said Deepak Mathur, Executive Vice President of Global Video Sales at SES. "This renewal underscores the value satellite brings when striving to reach millions of households and the importance of delivering continuously improved viewing experiences by leveraging HD quality."

For further information on how to place your news in Satellite Evolution Global - please contact the Global Contributing Editor - crispin@dsairpublications.com


*Photo courtesy sutadimages/Shutterstock*

## Omnispace collaborates with Microsoft to enable 5G connectivity direct to devices everywhere

**GLOBAL:** Omnispace is collaborating with Microsoft to deliver its global, hybrid 5G non-terrestrial network (5G NTN) to under-served regions. The two companies will work together to architect a Microsoft Azure-centric 5G hybrid network to empower consumer, enterprise, government and IoT users with ubiquitous mobile connectivity.

Omnispace will collaborate with Microsoft to architect, develop and demonstrate an Azure-enabled 5G NTN network to enhance the performance and reach of mobile wireless networks. The global hybrid network will integrate terrestrial and satellite networks into one seamless communications experience. It will leverage Azure Orbital, Microsoft's Ground-Station-as-a-Service offering with Microsoft's Azure Operator 5G Core to route voice and data traffic direct from mobile devices via an Omnispace proliferated low-earth orbit (LEO) constellation.

The Omnispace global non-geostationary satellite orbit (NGSO) space network will utilize the company's 2 GHz mobile satellite spectrum allocation and operate in the 3GPP band n256. As the world's first 3GPP-compliant 5G NTN network, it will deliver the power of 5G directly to billions of devices everywhere, enabling people and assets to communicate in real-time through a single, seamless global service. Through integration with Omnispace network, mobile network operators will be able to cost effectively enhance and expand their service area(s), while improving resiliency, enabled by Azure services.

"Omnispace is committed to redefining the way the world thinks about mobile communications, and we believe it should be as seamless no matter where you are," said Ram Viswanathan, President and CEO, Omnispace. "That's why we are thrilled to collaborate with Microsoft on a solution that will make it possible for anyone requiring global real-time communications to connect to their devices directly from our 5G satellites."

"Through our partnership, users of Omnispace's 5G NTN will be able to access the power of the Microsoft Cloud anytime and anywhere even in remote environments enabling ubiquitous real-time communications," said Steve Kitay, Director, Azure Space.

## Another four spacecraft take Bright Ascension's flight software to space

**GLOBAL:** Bright Ascension's latest GenerationOne flight software deployments, another cluster of four spacecraft for Kleos Space's Polar Patrol Mission (KSF2), were successfully launched onboard a SpaceX Falcon 9 rocket on 1st April 2022. KSF2 was originally expected to take off in January 2022, but the launch was rescheduled after the vehicle had to disembark from the SpaceX Transporter 3 mission. Polar Patrol Mission takes Bright Ascension's current total to 33 satellites in space.

Kleos Space's satellites are designed to detect and geolocate radio frequency transmissions to deliver a global picture of hidden maritime activity for enhanced intelligence capability. The Polar Patrol Mission becomes the third mission launched by the company, following the Kleos Scouting Mission (KSM) in November 2020 and the Polar Vigilance Mission (KSF1) in June 2021.

KSF2 is designed to enhance the company's RF geolocation with a total of twelve satellites patrolling against illegal activity such as piracy, drug smuggling and border security challenges. Building on the success of the KSM and KSF1 missions, the Polar Patrol Mission spacecraft were designed and developed by Innovative Solutions In Space B.V. (ISISPACE), with the software system provided by Bright Ascension, using its innovative products to help keep development time short within the tight project timelines.

"We are thrilled to see the KSF2 mission take off after the January delay," said Peter Mendham, CEO at Bright Ascension. "With only a few months between the KSF1 and KSF2 launches, it was critical to ensure that the mission flight software was developed quickly and efficiently. Both missions use our innovative modular GenerationOne technology, which allows us to simply swap the existing and new software components in and out, without having to redesign the entire package from scratch. This makes it an ideal solution for dynamic projects like Kleos Space's missions."

As they progress through their lives in orbit, KSF2 satellites will make full use of Bright Ascension's Mission Control Software and its effortless integration with the flight software. This will help to significantly simplify, improve, and automate their mission operations.

*Photo courtesy sdecoret/Shutterstock*

## Thaicom signs global cloud infrastructure deal with AWS

**THAILAND:** Thaicom Public Company Limited has signed an agreement with Amazon Web Services, Inc. (AWS), an Amazon.com company, to quickly and easily create, transform, and deliver Thaicom digital content. By leveraging AWS's global cloud infrastructure, advanced video technologies, and pay-as-you-go-model, Thaicom can produce high-quality video streams for distribution to its national and worldwide customers.Under the agreement, Thaicom and AWS will collaborate on building and deploying Thaicom's first cloud-based satellite TV broadcast distribution platform for Asia Pacific. The broadcast platform will consist of cloud services providing software-defined encoding, transcoding, and statistical multiplexing capabilities leveraging AWS Elemental media services. Thaicom is using AWS Elemental media services to help scale its business, enhance customer experiences, and support development of Thailand's broadcast industry landscape.

Thaicom is also using AWS to help establish its earth observation data analytics platform and to support Thaicom's new space economy initiative. Using AWS to help power the Thaicom data analytics platform will also help diversify Thaicom's reach across new verticals including government and private sectors in agriculture, maritime, energy, healthcare, and education. By working together, Thaicom and AWS can help Thaicom's customers easily ingest data from space and provide analytics from satellite imagery for business owners to leverage and make fast business decisions.

Patompob (Nile) Suwansiri, Thaicom's Chief Executive Officer, commented, "This agreement marks the beginning of a successful, long-term collaboration between Thaicom and AWS. I am confident that advancing our satellite TV broadcast platform using the world's leading cloud will deliver innovative broadcast solutions and provide our customers with end-to-end solutions built on AWS. Beyond the satellite business, Thaicom sees opportunities in driving the emerging space sector with cloud. AWS helps us develop an earth observation data analytics platform and bring innovations to strengthen our position as a leader in satellite and space technology in the digital era."

Clint Crosier, Director of Aerospace and Satellite Solutions, AWS commented, "Leading satellite communications providers like Thaicom are digitally transforming their operations by using AWS to deliver better customer experiences and simplify service deployments. The collaboration between Thaicom and AWS will help accelerate private and public sector innovation using AWS's advanced cloud capabilities like data analytics and help Thaicom grow into new markets to further support their space and satellite customers.

Andrew Bond, Sales and Marketing Director, ETL Systems

Satellite Evolution Global

Q&A

# The future of military and commercial connectivity

ETL Systems are a market leader in RF design and manufacturing with a 35-year prestige. They have played a role in determining how military satcoms perform and continue to define innovation in the industry. Andrew Bond, Sales and Marketing Director told us about how the company views current connectivity challenges, and what needs to be done to overcome them.

*Laurence Russell, Assistant Editor, Satellite Evolution Group*

**Question: In the past, ETL has prided itself on its "solutioneering" approach, and capacity to satisfy "strict technical compliances". Could you break down that strategy for us?**

**Andrew Bond:** ETL is an engineering-led company. Our 40-strong engineering team has always been close to the customer and offers bespoke RF product design to the satcom world.

It's all about understanding changes and being able to tune our RF distribution equipment, as different satellites and networks require Earth stations to perform in different ways. There's certainly no one-size-fits-all in the satellite industry.

For example, a satellite in the polar region is going to have a very different type of signal to one that's on the equator. In addition, a satellite dish on a ship is going to require very different signal switching and signal performance to a static ground station.

Whether the application is defence, oil and gas, telecoms, or teleports anywhere in the world, using LEO, GEO or MEO constellations, handling multiple frequencies, ETL's engineers aim to provide a dependable solution.

*ETL's purpose-built manufacturing headquarters in Herefordshire, England*

*Havoc, the world's first single-chassis 256 x 256 RF Switch Matrix* ●●●

**Question: The gradual virtualization of our world has become a landmark of our time. Could you recap how RF has been digitizing in recent years and summarize that movement's current progress?**

**Andrew Bond:** There is a major convergence of technologies across terrestrial and satellite networks, including fibre, Very High Throughput Satellites (V/HTS), multi-orbit satellites, Wi-Fi, and 4G/5G which are all contributing to a new comms ecosystem that will contribute to the Internet of Everything Everywhere (IoEE).

There are many advances in NewSpace technology including smart, software-defined satellites; HTS platforms; higher frequencies; mesh network operations; and beam shaping. On the ground, we have historically seen slower progress in comparison to the current innovations in the space, but certainly, major advances in RF over IP will help deliver a new, digital ground system architecture.

By digitizing the signal, users will be able to physically decouple antennas from modems. For example, a control centre in London would be able to easily select between antennas located on different continents.

Through a major partnership with the European Space Agency, ETL Systems is creating a solution that will digitize analogue bandwidths into IP. This will be launched as an ETL product in 2022 and we're also collaborating with others in the industry as part of the Digital Intermediate Frequency Interoperability (DIFI) Consortium.

**Question: The ground segment of satellite networks has sometimes been accused of being slower than the technology in space, which has led to the 'NewGround' movement, as part of NewSpace. Do you agree the ground segment has lagged? If so, why?**

**Andrew Bond:** It certainly has lagged, but this is to be expected as the ground infrastructure often responds to developments in satellite technology.

Just as you cannot develop a new electric engine in the automobile industry until battery technology has moved forward, the ground infrastructure in the space sector needs to be engineered in conjunction with NewSpace technology in the sky. So, it's a chicken and egg situation, where the ground segment from antennas to amplifiers ideally need to be designed in conjunction with new satellite technology.

For example, ETL has already developed new matrices specifically for LEO networks. We are working with some of the major LEO operators to deliver the ground infrastructure for these new and developing networks. The reality is the evolution on the ground often follows that which has taken place above it.

**Question: What will it take to bring the ground segment up to speed with the orbital infrastructure being built out above?**

**Andrew Bond:** The likes of SpaceX launch about 30 or 40 satellites at a time and there are already hundreds flying around. Part of the thinking of these big constellations is that it's cost-effective, even if some of these pico or nanosatellites break or never go into service.

The trouble here is the mindset that the ground segment will be as cheap as the satellites. For some of the constellations, this is certainly not the case due to the complexity of the satellite networks.

We are still waiting to see a fully operational constellation with antennas that track the satellites as they move across the sky and provide a good signal all of the way across, in various geolocations. This is a challenge engineers are working tirelessly on through a combination of software and very fast-moving and good quality tracking antennas.

The good news is that these can be small antennas because the satellites are so much closer to Earth. This means the signal strength is often much better than MEO and GEO, however, there are still inevitably problems as the satellites are always on the move.

The development of these parabolic and flat panel antennas, capable of gathering an effective signal, will be critical in moving the ground segment further. Various industry players are working to move that technology forward and we're monitoring developments so that we can adapt and design ground equipment that will be able to handle these signals effectively.

**Question: With more ubiquitous and higher-throughput connections requiring better networks for troop welfare, besides conversations of defence entities considering 'plain-sight' data via commercial networks, how much space does ETL see for commercial developers serving defence interests?**

**Andrew Bond:** It's challenging to answer this question because every government often has different guidelines

as to how and what is allowed on commercial and defence satellites.

Let's take the example of a country that might have a foreign contingent abroad but might not have its own satellite constellation. It's either going to rent satellite bandwidth from another country and – therefore it will put all its signals through an existing government network – or it could rent from a commercial operator.

We are aware of a number of companies who sell bandwidth on commercial networks for government applications, simply encrypting and decrypting the signal at each end. If you are a UN peacekeeper on the ground and you want to call home, it doesn't make a lot of sense to use a military network, but rather a cheaper commercial option.

Of course, all providers are striving to deliver great satellite signals for as low cost as possible which, depending on the context, is likely to drive some usage by defence entities. This is especially the case for smaller countries, but is less likely for bigger nations, as they will have existing networks and bandwidth in place, waiting to be used.

**Question: Both in defence, but increasingly elsewhere, customers have put more urgent priority into cybersecurity when considering their technologies, given its sharp growth besides various major hacking incidents. How does ETL approach that rising demand?**

**Andrew Bond:** In a world where we continue to be more connected, satellites certainly continue to play a vital role in supporting defence. As remote operations become the norm, the RF ecosystem needs to grow both in size and in complexity, therefore the security of these communications is paramount.

While RF distribution devices in themselves probably would not be the first-choice target for hacking versus modems, for example, in the current climate, anything that touches the network still must be doubly secure.

So, at ETL, we've enhanced our products with up-to-date security features, such as HTTPS (Hypertext Transfer Protocol Secure) and SNMPv3 (Simple Network Management Protocol Version 3) protocols for this reason, which will benefit both commercial and government applications.

In the simplest terms, HTTPS is used for secure online communication and works by encrypting data in transit, safeguarding against eavesdropping and tampering. SNMPv3 is an interoperable, standards-based protocol used for authorization and access control.

Recently released ETL products also carry additional features such as the option to disable unused protocols, password complexity enforcement, and a restriction on the number of login attempts.

Of course, as RF signals are digitized and move into the cloud, as discussed earlier in this interview, security becomes a broader topic.

**Question: What can we expect from ETL in the next five years?**

**Andrew Bond:** We're going to see much bigger bandwidths as the world becomes even more data-hungry than it is now. As a result, all of us at ETL are aware of the move into new higher frequencies, such as Q and V bands, that will allow this growth.

These high frequencies offer the bandwidth required to meet and even exceed the next decade's demands. With the industry left with little choice, now is the time to invest in the development of these new bands. However, the technical challenges are not at all trivial and should not be underestimated.

Meanwhile, we'll continue our mission to help digitize the RF space, which will, over time, see a step-change in how satellite networks are designed on the ground.

Finally, rest assured that the ETL Systems team is full of experienced hardware and software engineers who will respond to whatever the future throws at us.

*Moog's ESPA class bus product called METEORITE. Photo courtesy of Moog*

# Revolutionizing the way to space

Moog Inc. is a worldwide designer, manufacturer, and integrator of precision control components and systems. The company's high-performance systems control military and commercial aircraft, spacecraft, launch vehicles, missiles, automated industrial machinery, and marine and medical equipment. Moog has designed and manufactured components and systems for satellites and launch vehicles for more than 60 years and is dedicated to revolutionizing a way to space by continuing to make significant investments in its propulsion facilities as well as to conduct research and development on less toxic propellants.

*Katie Gibas, Space Sector Marketing Communications Manager and Shae Williams, Ph.D., Moog Senior Project Engineer*

For decades, governments and industry leaders around the world have been looking for propellants that are safer and more environmentally friendly. Europe has been at the forefront of green propulsion primarily due to REACH legislation that may eventually ban hydrazine, and as the numbers of launches and space activity hit record levels, there is a renewed focus and attention on green propulsion and less toxic propellants.

These efforts have attracted a variety of agencies, with NASA, ESA, and the Air Force Research Laboratory all launching missions using this technology; commercial satellites have also begun using such propellants.

Since there is no strict definition for "green" propulsion, it is worth defining what we mean by the term. The challenge is that "green," in relation to the spacecraft propulsion industry, could be considered a misnomer based on the way every other industry uses the term to focus mostly on the natural ecosystem. We consider propellant "green" if it delivers comparable performance to the state-of-the-art storable monopropellants and bipropellants while being significantly less toxic. Thus, a more accurate moniker is "less toxic propellants," so we will use the two terms interchangeably.

Less toxic propellants can present several advantages on-orbit, including potentially higher performance, longer missions, and increased maneuverability of spacecraft. It is on the ground, however, where a strong driving force behind the technology becomes important. The highly toxic nature of conventional propellants like hydrazine requires specialized facilities and a highly trained workforce operating hazmat suits with self-contained breathing apparatus (often called SCAPE suits) to load the propellant into the spacecraft.

The direct hazards to the personnel and spacecraft typically mean all other operations are fully stopped while the fueling activity is performed, which can take upwards of a week at a launch site. Fueling logistics can be very time-consuming and expensive.

*Katie Gibas, Space Sector Marketing Communications Manager* ●●●

Green fuels are much safer and easier to work with and do not have the same safety and environmental concerns. That means a simplified fueling process, and operations can be performed in a matter of hours, often in parallel with other activities.

Adoption has been relatively slow, as green propulsion has only begun flying in the past decade. Moog has been a leader in space propulsion since the Apollo era and continues to make investments at their in-house engine hot-fire test facility, which allows rapid evaluation of new thruster designs.

Our engineering team has supported green propulsion since the beginning with an active research program maturing green thruster technology. We have conducted this R&D both on our own and in cooperation with government partners like NASA and the Air Force Research Laboratory (AFRL).

Our propulsion team worked with AFRL in the early development of the green monopropellant AF-M315E, and in 2009 received the first Advanced Monopropellant Risk Reduction (AMRR) contract to assist the Air Force in developing a catalyst for AF-M315E.

More recently, AF-M315E has been rebranded as Advanced Spacecraft Energetic Non-Toxic (ASCENT) propellant. These programs are important because green propellants have technical challenges relating to higher combustion temperatures and more restrictive material compatibility. Often, that means more expensive hardware.

Moog is leveraging its expertise in thermal management and high-performance thrusters to develop and supply components such as valves and tanks for use with green propellant, both conventionally and additively manufactured. Our teams are building thrusters in multiple thrust classes and even full propulsion systems for customers using green thrusters from manufacturers in the US and Europe.

## WHO WILL GO GREEN?

The space sector is seeing similar trends to most industries: emphasis on lower cost, faster design and production, and higher performance. As green technology is better able to meet those needs at scale, we will likely see it take a portion of the satellite propulsion market but not all of it. It is likely several other bespoke propellants/propulsion technologies will be used at a smaller scale.

There will always be customers who will need hydrazine or its derivatives and nitrogen tetroxide. For example, flight heritage and use launch sites such as Kennedy Space Center or Vandenberg Space Force Base which already have the special facilities and personnel needed to fuel spacecraft with traditional propellants will remain with those traditional propellants.

More agile companies, ones willing to take more risks for higher performance, and those who want to use newer spaceports, can take the best advantage of green propulsion right now. Avoiding all the legacy facility and personnel requirements and being able to more cost-effectively and rapidly fuel satellites is very attractive to some NewSpace satellite manufacturers who want the mission advantages of propulsion without the traditional trade-offs.

Moog is using green propulsion for its space vehicle family to meet the needs of the growing class of small and medium launch vehicles. This is a key design feature as many of these vehicles do not allow or have the infrastructure to support hazardous propellant options.

Moog is leveraging the LMP-103S green monopropellant that has been used on dozens of spacecraft on-orbit, most already having Moog propulsion components on them. Moog's Small Launch Orbital Maneuvering Vehicle (SL-OMV) is designed to launch on the new class of small launch vehicles.

The spaceport constraints were identified early and necessitated a green propulsion system configuration. This same propulsion system was used for Moog's ESPA class bus product called METEORITE to simplify launch

*Shae Williams, Ph.D., Moog Senior Project Engineer* ●●●

operations. The combination of our in-house materials science laboratory, state-of-the-art manufacturing, and test facilities, and the technical strength and experience of our personnel have been instrumental in allowing us to utilize these non-toxic technologies in our space vehicles family and pave the way to a greener future in space.

## THE ROLE OF ADDITIVE MANUFACTURING IN GREEN PROPULSION

The focus in the spacecraft industry is on coming up with more cost-effective ways to do the same missions. Replacing hydrazine and other conventional propellants is only the first step; green propellants offer good synergy with another important emerging technology: additive manufacturing.

Additive manufacturing (AM) has given us the ability to design and manufacture extremely complex spacecraft propulsion solutions in a more cost-effective and time-sensitive manner. AM offers unique geometries that increase propellant flow efficiencies and provide unparalleled thermal management.

Within one inch, a thruster could have a chamber that could reach temperatures greater than 2,500°F and a valve that needs to be maintained around 100°F at most. Furthermore, green propellants tend to have a higher combustion temperature than hydrazine and require heating before they will react with the catalyst. Additive manufacturing allows for these temperatures to be accommodated where traditional manufacturing methods would not meet the requirements.

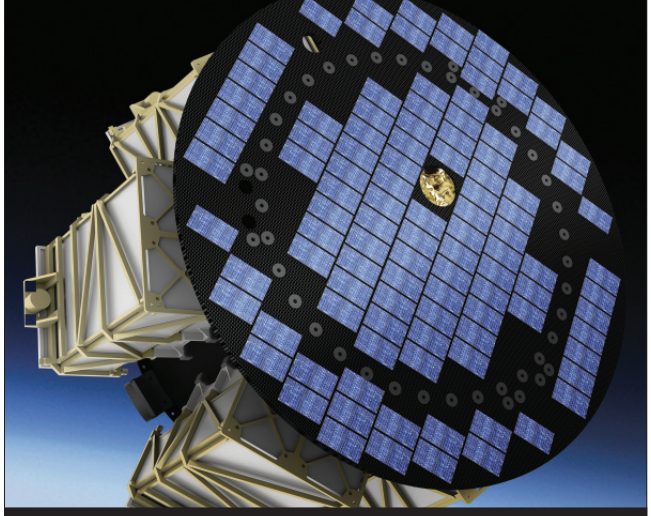
Moog's thermal management expertise, combined with our state-of-the-art Additive Manufacturing Center (AMC) has enabled us to optimize our green propulsion thruster designs and gain unique experience printing high-temperature exotic materials, including ceramics and various refractory metal alloys that stand up to the heat of combustion and the oxidizing environment these propellants create. We have demonstrated success with these challenging applications under industry-leading cleanliness and quality controls around our additive efforts.

One critical advantage of additive manufacturing is being able to print complex hardware and have it in hand faster than ever before, which is critical in development programs. For example, ordering a new rocket nozzle from a traditional supplier could take 12 months to get something brand new, making rapid development cycles impossible. Using additive manufacturing, we can go to Moog's AMC at our headquarters in East Aurora, New York with a drawing or CAD file, and they can often print parts of comparable quality in a matter of weeks or even days.

Being able to develop a new type of thruster or use a new type of propellant is far easier when enablement technologies like this reduce the iteration cycle by an order of magnitude. At the same time, Moog's demonstrated ability to meet rigorous consistency and quality standards has allowed our customers to accept additive parts in even high-temperature, fracture-critical areas such as thruster injectors and thermal standoffs, giving us a unique advantage.

## SMALL SATELLITES AND EXTENDING THE MISSION

Satellites are getting smaller, and mission operators are looking for more rideshare opportunities, which is ideal for the green propulsion market. New technologies like this tend to start small. We are working on thrusters between 22N and 1N of thrust or less, the smaller end of which have a natural home in microsatellites and nanosatellites.



*The Moog Small Launch Orbital Maneuvering Vehicle (SL-OMV) is a propulsive tug. Photo courtesy Moog*

A new market area is highly agile small satellites, including Rendezvous and Proximity Operations (RPO), such as on-orbit satellite maintenance, repair, and refueling or active space debris removal. These missions require complicated maneuvers that require precise control.

That might call for multiple thrusters of varying thrust classes. For example, in addition to a larger thruster, like a 22N, that would do the big maneuvers like changing orbits, it would also want a set of 1N thrusters for fine adjustments to stay close to another satellite or dock with it. Monopropellants are ideal for these types of operations. Green monopropellants can provide potentially higher performance for the small vehicle size and mitigate risks both on the ground and on-orbit compared to hydrazine.

As the ability to refuel spacecraft garners more interest, propellant selection will become critical. Current refueling missions leverage hydrazine because that is the propellant on-orbit today, but as more platforms leverage green propellants, compatibility with refueling systems will become a design consideration. This is likely to limit the number of different green propellants in common use akin to gasoline and diesel fuels at a terrestrial gas station.

The industry wants a one-for-one drop-in replacement that is cheaper and less toxic. While the industry is not quite there yet, green propellants have the potential to revolutionize the way to space and how spacecraft perform in LEO to deep space missions, particularly when it comes to extending a satellite's mission life and refueling on orbit. All the benefits of using green propulsion on the ground also apply in orbit. The safer and easier those propellants are to work with, the easier refueling gets. That is one of the reasons the Air Force Research Laboratory is investing heavily in green propellants and has done so for many years.

Right now, despite the slow adoption of green propellants, demand is still outpacing the technology and supply. We are steadily getting more and more requests for this hardware. That is why Moog is continuing a strategy of strong investment in green propulsion research and development, led by our materials expertise, our history of being on the cutting edge of in-space propulsion, and our ongoing investment in state-of-the-art assembly and test facilities.

*Dr Stéphane Estable, PERIOD project Coordinator and System Architect, Airbus Defence & Space*

Satellite Evolution Global

Q&A

# Testing live prototype technologies in space

The PERASPERA In-Orbit Demonstration (PERIOD) project is a combined effort coordinated by the Horizon2020 Project and funded by the European Commission which tests live prototype technologies in space to illustrate the potential for in-orbit applications. We spoke to Dr Stéphane Estable, PERIOD project Coordinator and System Architect for Airbus Defence & Space, about the project's aims, action plan, and how its success could change the industry.

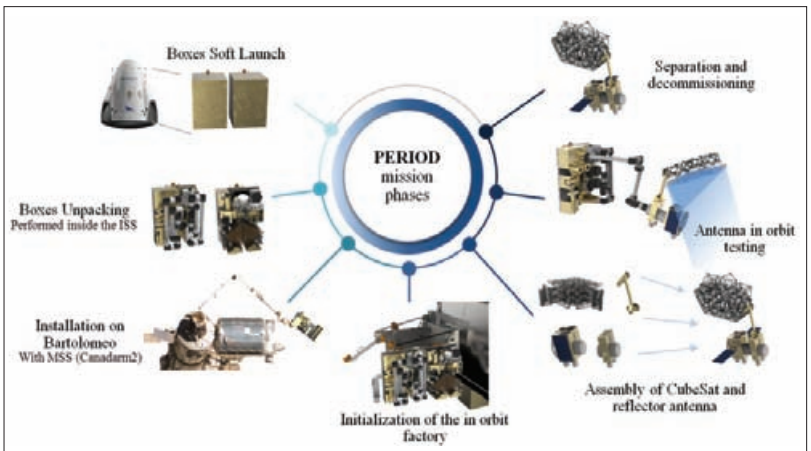
*Laurence Russell, Assistant Editor, Satellite Evolution Group*

**Question: Which emergent technologies do you predict will lead to the biggest space industries and markets in the near future?**

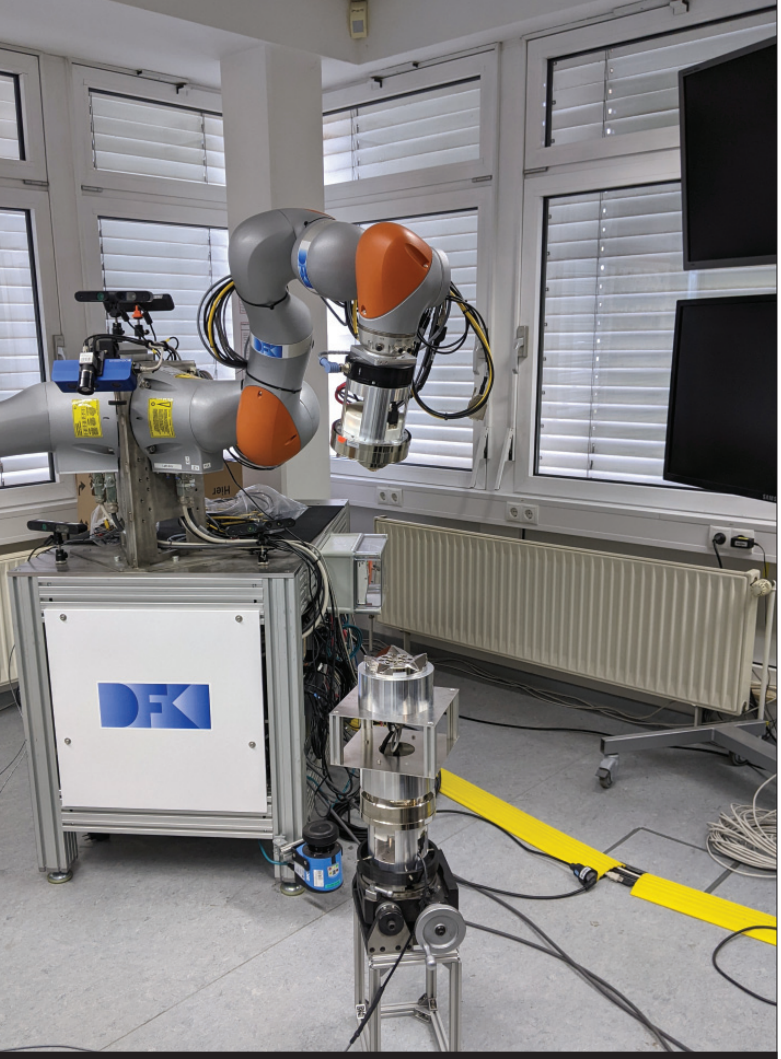
**Stéphane Estable:** Robotics and autonomy represent the active part in an infrastructure, servicing, and maintenance scenario, and deliver the enabling technologies necessary for object handling, manipulation, assembly, etc. In this context, the technologies related to "Orbital Infrastructure" and "Orbital Factory" services are predicted to occupy a significant share of the space market since the goal is to ensure sustainable on-orbit applications and also the proper operation of tens of thousands of satellites and hundreds of lunar missions in the next decade.

On-orbit sustainability aims at the introduction of economical space structures and applications comparable to terrestrial solutions. Use assets as long as possible, modify and upgrade them according to changing needs and requirements, avoid wasting resources, etc. Specific technology building blocks that are currently under development and maturation include (but are not limited to):

- Robotic arms, tools, and workbenches;
- Robotic Control Units & Operating Systems;
- Precision manipulators;




*PERIOD mission phases. Image courtesy AIRBUS*



*Mechanical & functional setup of HOTDOCK Standard Interface. Photo courtesy AIRBUS* ●●●

- Standard Interfaces (mechanical, electrical, and thermal);
- Docking devices;
- Autonomy and Data Fusion frameworks for space robotics;
- Robot vision;
- Industrial processes; and
- Robotic simulation.

**Question: What are the standout applications of ISMA (In-Space Manufacturing & Assembly) technologies?**

**Stéphane Estable:** With ISMA, larger antennas could be built with better performance and at lower costs. Larger antennas are needed for both Earth Observation and telecommunications missions. For example, the radar sensitivity is directly linked to the size of the antenna, or the missions using radar benefit from larger diameter reflectors to avoid the need for larger power distribution.

Large aperture array-fed reflector-based systems need to cope with high throughput, and the targets are increasing to hundreds of Gb/s or Tb/s requiring reflector dimensions in the order of 12m, 30m, and above 50m. The concept of LDRs (Large Deployable Reflectors) is one technology being developed to support those needs which are also in the EU technology development portfolio.

However, there will still be limitations on the maximum size of deployable reflectors that can be launched. LDRs larger than 50m, for example, are prohibitively expensive.

Also, as of today, satellites are not designed for servicing, and the industry has yet to align on standards for attachment points, refuelling ports, and other servicing-oriented features which are needed to advance the market.

Serviceable satellites will be supported by the development of the Standard Interconnects within PERIOD and a long-term servicing market could develop from 2030 onwards. More immediate mid-term applications of ISMA will be in the assembly of structures in orbit. The future space ecosystem can then capitalise on these applications which will enable the construction and maintenance of the future space infrastructure.

With the new validated ISMA capabilities, the industry can take over with the proposition of new commercial services and applications in the domains of:

1. Manufacturing, servicing, and assembly of hardware in orbit;
2. Building products in space for the return to Earth; and
3. ISRU (In-Situ Resource Utilization).

A clear focus on the technologies necessary for this will significantly increase the potential growth of the future space economy.

**Question: What will it take to establish a competitive edge in this kind of market?**

**Stéphane Estable:** The generation of independent European capacities for building the future orbital infrastructure and being competitive in the ISMA market is the ultimate target. To accomplish this, high investments would be necessary to further develop and mature the related key ISMA technologies and perform IODs (In-Orbit Demonstrations).

But this is not the only aspect for establishing a competitive edge in this market. We also need a sustainable, goal-oriented, operational, and regulative framework that gives enough flexibility to let business arise and grow in this field. Beyond that, we need to work on improving the potential customer's awareness of ISMA capabilities and the associated benefits, as well as informing them transparently about the potential risks and mitigations.

**Question: Could you introduce us to the PERASPERA In-Orbit Demonstration (PERIOD) project?**

**Stéphane Estable:** PERIOD is a Horizon2020 project, part of the 3rd call of the SRC (Strategic Research Cluster) on Space Robotics Technologies. PERIOD aims to prepare the paradigm shift for changing the way space systems are designed, built, and operated, moving from mission-specific solutions to modular spacecraft optimized for the space environment.

The envisioned ambitious demonstrator will include the manufacturing of a functioning satellite in an 'Orbital Factory'. The demonstration concept is consisted of:

1. The manufacturing of an antenna reflector;
2. The assembly of a complete satellite from building blocks equipped with SI including verification;
3. The reconfiguration of the satellite payload for system upgrade;

4. The inspection of the assembled satellite; and
5. A refuelling test with attachment.

In this first project phase (A/B1, up to December 2022) the preliminary design of the demonstration and the orbital Factory is being generated, with the objective to continue with a demonstrator in orbit.

**Question: The project partners with "all suitable European key players" including Airbus and SENER. How will the demonstration benefit them and others in the industry?**

**Stéphane Estable:** As already mentioned, the project brings together the competencies of all European key players suited to the implementation of an In-Orbit Demonstration (IOD) mission. The team is coordinated by Airbus Defence and Space GmbH and involves nine partners with different areas of expertise (Airbus Defence and Space SAS, Airbus Defence and Space Ltd, DFKI, EASN-TIS, GMV, GMV-SKY, ISISPACE, SENER Aeroespacial, and Space Applications Services).

The team has defined an ambitious demonstration that has never been realized so far. With this demonstration, we aim to convince the potential stakeholders that the European industry is ready to undertake more complex missions to meet their demands. And that these missions are feasible with lower capital expense, higher value, higher system capacity, and higher resilience.

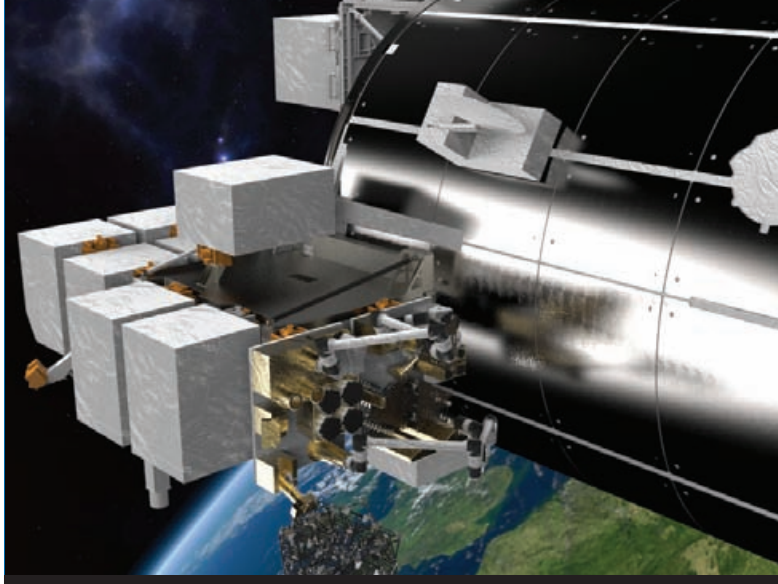
It is expected that the new market opportunities generated will strengthen the competitiveness and growth of European companies. In the medium and long term, this will be translated to an economic return for the involved industrial partners.

**Question: For the benefit of potential stakeholders, what's the bottom line about these technologies?**

**Stéphane Estable:** There is no doubt that all different actors of the space sector can benefit from ISMA in several ways. If the EU were to start ISMA developments now, Europe will avoid becoming reliant on the US and China for future space infrastructure and ensure that European industry is globally competitive as an ISMA-service provider, ensuring both economic advantage and sovereignty.

For space agencies, ISMA technologies and applications can allow scientific missions to be more ambitious and reach performances that would not be otherwise possible via traditional on-ground manufacturing, at an affordable price. Additionally, they can be key elements towards space sustainability and reducing the congestion in orbits with space traffic and debris issues.

Commercial satellite operators always seek opportunities to decrease the CAPEX (Capital Expenditures) and OPEX (Operating Expenses) of their business. This could be partly achieved via OOS (On Orbit Servicing) such as life extension, refuel, rescue, relocation, and decommissioning. Additionally, Telecom payloads can benefit from shorter life cycles than the traditional 15 years of operation of a GEO Telecom satellite. Besides servicing, new mission architectures based on very large antenna reflectors assembled or manufactured in-orbit, as well as large persistent platforms in GEO accommodating several payloads, could enable new business models.



*Accommodation of the orbital factory on Bartolomeo. Photo courtesy AIRBUS ●●●*

For satellite integrators and manufacturers, the application of ISMA at the different steps of the satellite lifecycle would allow the transition from Earth-based manufacturing to space-based manufacturing, thus producing spacecraft which are optimized for the space environment, making the best use of manufacturing and launch resources. At the same time, reliability and redundancy requirements would be relaxed via the possibility of direct in-orbit verification and validation of hardware produced in orbit.

For space insurance companies, ISMA applications would allow for both a better understanding of the events in orbit, thanks to space-based inspection/monitoring missions, and would also reduce unexpected loss of missions, via rescue or repair services, so they could save claim costs and be able to more accurately calculate insurance premiums.

**Question: With time and appropriate investment, what do you anticipate the ISMA industry will be capable of delivering a decade from now?**

**Stéphane Estable:** As already mentioned, the ISMA industry can bring revolution to the space market achieving a sustainable space ecosystem and bringing new services.

We are confident that a decade from now, considering a stepwise evolution, many different capabilities will be introduced. Large-antenna commercial satellites autonomously assembled in space will provide citizens with a wide range of services, and scientific satellites will allow us to see further into deep space than ever before. Payloads will be autonomously exchanged on standard reconfigurable satellites.

Most satellites will be repaired, serviced, or de-orbited in space, meaning that we will be able to better face the space debris issue. Advanced space robotics will be used for local and autonomously manufacturing and assembly on the space stations in LEO, lunar orbit, and Mars orbit and indeed on the lunar and mars surfaces.

Even more remarkably, the same robotic technologies and autonomous industrial processes will be used for producing resources in space and even producing human organs for the people back on Earth.

# Comtech appoints Maria Hedden to Chief Operating Officer

*Maria Hedden, Chief Operating Officer*

Comtech Telecommunications Corp., a leading global provider of next-generation 911 emergency systems and secure wireless communications technologies, has hired defense and communications industry veteran Maria Hedden as its new Chief Operating Officer (COO).

Hedden's expertise is built on a storied career that includes over 20 years of executive P&L management experience focusing on improving business performance, and she has worked with some of the largest names in defense and mission-critical communications, including BAE Systems and L3Harris. In her most recent position, she served as Senior Vice President of Operational Transformation for Leidos, where she was responsible for establishing manufacturing excellence for a multi-billion product portfolio.

"At Comtech, we are focused on becoming the most trusted provider of Failsafe Communications, so that communication and data transmission is possible anytime, anywhere - and critical to achieving that goal is having someone at the top of our organization driving operational excellence, customer satisfaction, and structuring our business to scale successfully," said Michael Porcelain, President and CEO of Comtech. "Maria's track record speaks for itself, and she has the skillset needed to take Comtech into the future as Failsafe Communications become even more ingrained into our daily lives, no matter what the application."

In her new role, Hedden will be responsible for leading and implementing operational excellence across Comtech, such as improving production capabilities and on-time delivery schedules, through retaining and scaling engineering and operations teams to improve margins and to keep pace with expected business growth. As COO, Hedden will ultimately drive continued customer satisfaction with her proven ability to efficiently deliver the solutions all of Comtech's customers have come to rely on.

"My career has largely been in pursuit of making great companies better, and putting them on the path to meet their potential. Particularly for organizations in the most crucial of disciplines – such as providing critical satellite, space and public safety communication solutions – improved operations can have a significant trickle-down effect on their customers," said Maria Hedden. "Comtech provides an invaluable service to its clients, and in becoming the most streamlined, strongest version of itself, will become a leading, end-to-end provider of Failsafe Communications."

Hedden began her career in manufacturing with FMC, narrowing her focus on defense when FMC sold that division of their business to BAE Systems. It was there that she introduced Lean Manufacturing to BAE's European business unit and rationalized the Land and Armament business. It was a following move to L3Harris that inspired her interest in general management, where she led an operational turnaround that culminated in her appointment to President in 2015, and ultimately operated as the head of L3Harris' Security and Detection division when the company was sold, before joining Leidos.

## Mynaric CCO Tina Ghataore named Via Satellite's 2021 Satellite Executive of the Year

Mynaric's Chief Commercial Officer Tina Ghataore was named the 2021 Satellite Executive of the Year at Satellite 2022. Annually awarded since 1988 from Via Satellite Magazine, Satellite Executive of the Year is the most prestigious award in the industry, selecting winners who have made significant contributions to the global satellite markets, technologies, business practices, services and innovations. The winner is decided through a combination of votes from the public and Via Satellite's editorial board. Upon accepting the award, Ghataore thanked her team for surrounding her with support.

"The industry has confirmed what we already believe, Tina is a true asset to our executive team," said Mynaric CEO Bulent Altan. "Under her leadership, I know that Mynaric will continue to lead the industrial age of laser communication. We will continue the momentum of developing products and innovation in response to the needs of our customers."

Ghataore brings more than 20 years of experience in the industry and currently leads the commercialization of Mynaric's technology, including strategy, business development and product management. She played an integral role in Mynaric's listing on Nasdaq and rolled out Mynaric's newest product advancement, the CONDOR Mk3, in 2021. Over the past two years, Ghataore signed new customers including SpaceLink, Cloud Constellation, Capella Space and Northrop Grumman.

# Seraphim Space announces Bob Wigley, Chairman of UK Finance, as Senior Advisor

Seraphim Space has appointed Bob Wigley as a Senior Advisor. The appointment further deepens Seraphim's existing financial services expertise, following the launch of Seraphim Space Investment Trust Plc on the London Stock Exchange in 2021. Globally respected as a British finance expert, Bob brings exceptional experience and networks to the Seraphim team. Bob is currently Chairman of UK Finance which represents the UK Banking and Finance sector with HM Government and regulators. Previously he was the Chairman of Merrill Lynch for EMEA (now Bank of America) and a Court Member of the Bank of England. Bob also chaired the Green Investment Bank Commission. Since leaving banking Bob has chaired and invested in several Fintech companies. With Space set to play a powerful and unique role as we look to address climate change his unique blend of experience and expertise further strengthens Seraphim's commitment to Environmental, Social and Governance (ESG) goals.

Rob Desborough Managing Partner commented: "Seraphim supports pioneering entrepreneurs building the infrastructure in space to address some of the world's most pressing challenges. With $12.9bn private investment globally into the domain during 2021 Space is now at a critical inflection point and poised for significant growth. The appointment of Bob as a Senior Advisor brings a new level of City expertise, investment banking, government policy insight, entrepreneurialism and climate understanding to our team. We are over the moon to have him join us in our mission."

*Bob Wigley, Chairman of UK Finance, as Senior Advisor, Seraphim Space*

Bob Wigley commented: "The UK has world leading spacetech expertise and I am looking forward to working with Seraphim, the world's leading specialist investor in Spacetech to seek to take advantage of the extraordinary technological opportunities space presents both for Seraphim and the UK more widely."

## Boeing announces Senior Leadership updates

Boeing has announced Ted Colbert as President and Chief Executive Officer of its Defense, Space and Security business. Colbert succeeds Leanne Caret who is retiring following nearly 35 years of exceptional service with The Boeing Company. Stephanie Pope has been appointed as President and CEO of Boeing Global Services (BGS), succeeding Colbert.

"We are grateful for Leanne's dedicated service and I'd like to thank her for her outstanding contributions to our industry, our customers, our company and our employees over her extraordinary career at Boeing," said Dave Calhoun, Boeing President and CEO.

As President and CEO of Boeing Defense, Space and Security (BDS), Colbert will oversee all aspects of the company's business unit that provides technology, products and solutions for defense, government, space, intelligence, and security customers worldwide. BDS had 2021 revenue of $26 billion.

"Throughout his career, Ted Colbert has consistently brought technical excellence and strong and innovative leadership to every position he has held," said Calhoun. "Under his leadership, BGS has assembled an excellent leadership team focused on delivering safe and high-quality services for our defense and commercial customers. His leadership track record and current experience supporting the defense services portfolio ideally position Ted to lead BDS."

As President and CEO of Boeing Global Services, Pope, who is currently Boeing Commercial Airplanes chief financial officer, will lead the company's business unit that provides aerospace services for commercial, government and aviation industry customers worldwide, focused on global supply chain and parts distribution, aircraft modifications and maintenance, digital solutions, aftermarket engineering, analytics and training. BGS had 2021 revenue of $16 billion. Prior to her assignment as BCA CFO, Pope was chief financial officer of BGS and was part of the business when it was established in 2017."

Stephanie brings decades of wide-ranging business and financial leadership to her new role," said Calhoun. "Given her significant experience in all aspects of BGS, Stephanie's deep understanding of the global services portfolio since its inception and the needs of BGS customers will help accelerate this meaningful business."

Colbert and Pope's new assignments will be effective April 1. Until her retirement later this year, Caret will serve as executive vice president and senior advisor to the CEO, reporting to Calhoun, to support the leadership transition, business continuity and critical talent acquisition efforts.

# Digitizing gateways for NewSpace: The ticket to play in the virtual satellite world

When Gottfried Wilhelm Leibniz developed the modern binary system 350 years ago, the digitization of the modern world was set into motion. Most enterprises on Earth have long embraced "digital transformation" to advance their business operations and benefit from the replacement or augmentation of physical devices with virtual functions. However, due to the nature of working in space, the satellite industry has been one of the last to fully adopt today's most widely spoken language: zeros and ones.

*Jonathan Baker, Chief Technology Officer, Kratos Antenna Solutions*

Market demand for more bandwidth and faster services has driven a space revolution of high-speed LEO constellations as well as increases in operating frequencies like Q/V-band, W-band, and laser—all of which must be addressed on the ground. The continued growth of terrestrial services has also pressured the satellite industry to keep pace with technology to stay relevant. Now, with new virtual ground systems, satellite operators can realize numerous advantages, from better performance, signal quality, and signal management flexibility to lower costs and increased revenue opportunities. However, transitioning to these new digital architectures and orchestrated ground operations requires a 'digital on-ramp' and this digital transformation begins at the antenna.

## THE ADVANTAGES OF DIGITIZING

A digitized antenna gateway system improves quality and provides operators with the tools and flexibility they need to meet today's challenges and ultimately keep satellite at the forefront of continuing communications advances.

The first, and most basic advantage of digitization, is eliminating the range limitations between baseband and earth station locations inherent with traditional RF over fiber. In contrast, digitized RF, running over IP networks, overcomes these boundary constraints to gives operators greater reach and flexibility, providing new options for signal routing and site diversity. Digital frequency tuning allows for dynamic alignment with new flexible payloads and transponder frequency plans. Also, when traditional L-band and IF signals are digitized, signal processing will facilitate group delay, slope, level, pre-equalization, and other common signal distribution issues to be managed in new ways that improve overall link performance. Another significant benefit is that a standardized digital interface and gateway design can be used, thus minimizing system roll out and site integration time by simplifying the earth station architecture.

*Digitizing parabolic antenna systems is the first step towards successfully leveraging IP networking and cloud adoption for digital architectures. Photo courtesy Kratos*

Coupling these advances in signal processing with cloud technologies, and baseband signals can be kept in the Cloud and then converted to analog RF in the antenna hub. Just a few clicks on a cloud-based application and an antenna and RF system can be re-configured for a different carrier type or even a different use case. This enables the operator to maximize the capabilities of their asset and investment.

The advent of Q/V-band satellites is pushing the need for smart gateway diversity with M:N (a many-to-many relationship in the database) gateways being used dynamically. Combining the power of the cloud and digitized RF over IP means that M:N site diversity and redundancy can be realized in ways that were not previously possible. Moreover, the use of the cloud and digitized RF allows the antenna and RF gateways to be more closely aligned with operator OSS/BSS systems, providing more end-to-end signal and service management.

A digitized gateway system opens the door not only to a better understanding of data traffic flow but also to the

*Jonathan Baker, Chief Technology Officer, Kratos Antenna Solutions* ●●●

capability of machine learning for higher degrees of automation. Big data analytics deliver the possibility of greater digital signal storage and analysis, which benefits both operators and regulators while improving service quality.

## THE CHALLENGES OF DIGITIZING

There is a constant tension between digital and analog signals and their relative trade-offs. On the one hand, digitization can provide much desired flexibility and control for signal processing, on the other, signal fidelity is most ideal when produced in the analog realm (albeit being susceptible to noise). Therefore, processing power and the sample bit depth will always be factors against digitization. Despite this, processing power will always improve, and bit sampling depths will also continue to improve thereby minimizing the effects of rounding and truncation.

In addition to signal fidelity, digitized RF also produces far larger amounts of equivalent data, requiring more bandwidth for it to be moved around the network, contributing to the argument against digitization. While compression techniques for this type of data have marginal benefit, cloud networks and high-speed data connections continually advance, and digitized data can take advantage of these standard high-speed data connections, rather than simply relying on dark fiber connections as is the case for RF-over-fiber solutions.


*Digitizers: OpenSpace SpectraNet digitized analog RF into IP packets for transport and signal processing in public cloud, private data center, or hybrid cloud environments.* ●●●

Despite these challenges, the pathway for the satellite industry's future growth and evolution depends on digitization. It is not a matter of 'if' but rather 'when' this changeover will happen.

## WHAT ARE TODAY'S OPTIONS?

There are, of course, inherently digital antennas such as the FPA (Flat Panel Antenna) and ESA (Electronically Steerable Antenna) currently being manufactured. One example is the impressive user terminal that SpaceX has achieved at Ku-band. But these are small terminals, not gateways. While these solutions are ideal for LEO satellites and user terminals there will continue to be a need for fixed gateway antennas for GSO (geosynchronous orbit satellites).

FPAs are a long way from being able to offer the power, RF performance, instantaneous bandwidth, and competitive pricing for GSO satellite gateway high throughput satellite (HTS) applications. So, traditional large aperture parabolic dishes will likely be around for some time to come. But how can we modernize them and keep them at the forefront of technology? How can we use the power of the cloud, digitization, and wide acceptance of IP traffic to keep parabolic antennas and associated RF equipment up to date and at the cutting edge?

Digitization will not remove the need for high power amplifiers and LNAs (Low Noise Amplifiers) or LNBs (Low Noise Block Downconverters) in such gateway systems. We can consider how far up the RF chain it is possible to digitize in order to provide signal management flexibility and signal quality control, as well as to give operators the tools and capabilities necessary to maximize revenue from their assets.

The time has come to digitize the traditional gateway antenna by creating an antenna solution where the interfaces between the antenna and indoor equipment are carrying digitized, IP traffic-based signals. This can be achieved by integrating a digitizer, such as SpectralNet (an OpenSpace family product), at the antenna and other locations throughout the ground system.

## STANDARDS FACILITATE DIGITAL TRANSFORMATION

Standards, whether it comes to data, computers, phones and nearly any other current technology, are a key facilitator to growth and advancement as well as global digital transformation. Operational and developmental standards at the appropriate interface points allow for interoperability that is beneficial to the industry and yet doesn't hinder innovation and competition. The market drives the will, the industry derives the way.

A recently formed group called the Digital Intermediate Frequency Interoperability Consortium (DIFI) has created a standard for building interfaces so that digital satellite data can be sent and received interoperably based on VITA 49. VITA 49 on its own is not an interoperable interface, it is a framework, and so it can be implemented in many ways.

DIFI has published a specific schema for VITA 49 to unite the industry on its specific implementation for interoperability. This implementation is designed to enable interoperability at the IF level to prevent vendor lock-in and ensure a robust, innovative, and competitive supply chain that will support the ground segment and help usher the industry forward to reap the value of digital transformation.

## THE ROAD TO DIGITAL TRANSFORMATION BEGINS WITH DIGITIZING THE ANTENNA

According to Melvin Vopson, Senior Lecturer of Physics at the University of Portsmouth, "In 2018, the total amount of data created, captured, copied, and consumed in the world was 33 zettabytes (ZB) – the equivalent of 33 trillion gigabytes. This grew to 59ZBs in 2020 and is predicted to reach a mind-boggling 175ZBs by 2025."[1] The satellite industry is set to be a massive contributor as one of the last remaining tech industries that is not completely digitized.

Digital transformation, backed by standards, is expected to have impacts across the entire spectrum of the industry, from space to the ground. From digitizing antennas to virtual signal processing, to fully orchestrated ground systems, it will truly transform the industry and deliver new applications and opportunities that we've not even begun to consider.

The path to a flexible, efficient, and cost-effective software-defined ground system begins with digitization. Digitization provides fast, assured data transport without distance limitations. Once antennas are equipped with digitizers, IP networking can be leveraged. From there, depending on an organization's business model and goals, hardware modems, FEPs (Front End Processors), and more can be migrated into software with virtual products like OpenSpace quantum. Lastly, digitization opens the door to the adoption of fully orchestrated ground system operations with fully virtualized and software-defined ground systems like the OpenSpace Platform, by Kratos. Business activity and projected growth will determine what's next beyond digitization. Are you ready?

*Photo courtesy Shutterstock*

*The consumer doesn't care how content gets to their personal devices – it just needs to be cost effective, highly available, at good quality, and ubiquitously usable. Photo courtesy Adobe Stock*

# Full speed ahead: How satellite operators manage to be both – an ISP and a TV broadcaster

Over the past few years, stagnating revenues in the TV and radio broadcast market have led GEO satellite operators to consider a change in their market approach. Most of them have identified internet for maritime and aeronautical customers requiring governmental and civil services as key market drivers. With the arrival of services exploited by NewSpace ventures in the same market space, traditional operators must quickly adjust their commercial and technical orientation to compete. Hence, the only way forward is "full speed ahead."

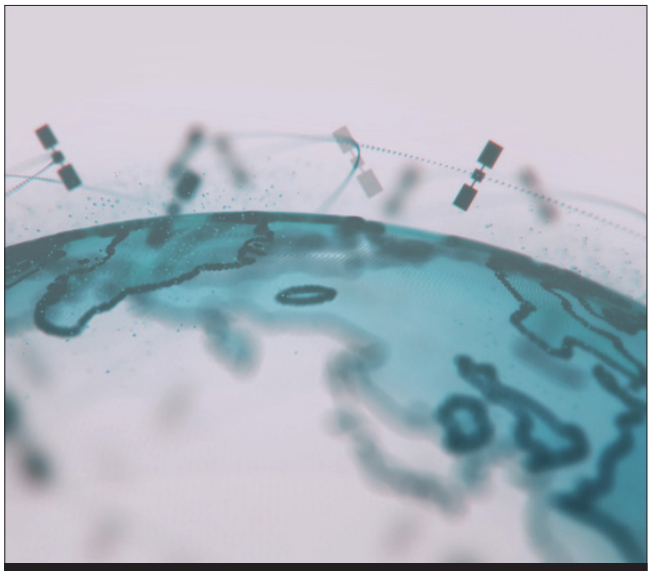
*Andreas Voigt, Director, the Satcoms Innovation Group*

Broadcasting has been the cash cow for GEO operators for years and consequently a massive area of focus for the entire business. With the transition to being predominantly a B2B and B2C internet service provider, internal service structures needed to be adjusted to accommodate all the new requirements. Although satellite operators always had the idea to provide internet access as a business line in their portfolio, the game changer has been the move to mass market and the shift in the competitive landscape. Satellite has left its niche market position and is now required to compete against other service providers, not just other traditional satellite operators.

That said, the broadcast market is still substantially big and continues to represent a customer base. Moreover, the broadcast market will remain a key component as operators look to move towards IP service delivery. While some operators and market analysts might have seen broadcast vanish completely, additionally accelerated by the COVID-19 pandemic considerably affecting free-to-air (FTA) programs, it needs to be recognized that GEO satellites have the exact infrastructure to deliver additional value in this arena. Reaching hundreds of millions of spectators with one transmitter is and will be the only truly cost-effective technical solution. As long as linear television sets exist, so too will geostationary satellite broadcast – delivering content to CATV providers, cruise ships, airplanes, and as a DTH (Direct to Home) service.

## ADAPTING VIEWING HABITS

The way in which TV and radio is consumed has changed drastically. When you consider that the average household



*Satellite operators always had the idea to provide internet access as a business line in their portfolio, but the game changer has been the move to mass market and the shift in the competitive landscape. Photo courtesy Adobe Stock*

has more mobile phones than television sets and consumers expect all content to be available across any device, the ability to enable viewing on mobile devices is important to stay relevant. The consumer doesn't care how content gets to their personal devices, just that it is cost effective, highly available, at good quality, and ubiquitously usable.

It is important to understand that satellites in GEO are the technological solution for broadcast – not the format or modulation that is used to transmit the channels. Linear TV and radio programs are watched by many hundreds of millions of users worldwide via installed DVB infrastructure on their TV sets. Currently, almost none of those programs being distributed using satellite technology are viewed on mobile phones or tablets. This is mainly because of satellite's incompatibility with the signal structures of the mobile communication industry.

An intermediate transmission format change is needed to translate DVB broadcast content into IP delivery content. Broadcast channels are no longer demodulated at home, but at a DSL/CATV/RAN headend and delivered for an extra fee via the end customer's specific internet access, reaching their phone, tablet, or TV set all at the same time. It is a question of economics of scale to implement the service as such. Revamping DVB receivers to forward content into an existing home IP network will always have limiting factors.

Giving up on broadcast completely or staying in the status quo of today's broadcast technology development is not an option for a successful future of combined services. There are a lot of countries in the world whose political leaders or spiritual groups want to ensure proper unidirectional distribution of information in and around their country, including regional coverage as well as worldwide perspective. GEO satellite operators can provide this service via their proven broadcast technology platforms for an attractive price at high availability using proven technology.

By applying clever market innovation and selected company cooperation, this content will then be able to be consumed on those traditional TV sets as well as on mobile phones and tablets—all at the same time and within the global service delivery portfolio of satellite communications. To make that step possible, the satcom and mobile communication industries need closer cooperation. They also need to clarify their roles to find synergies in worldwide recognized broadcast norms.

## HOW OPERATORS ADOPT CHANGES

Driven by the needs of its users, the broadcast industry is embracing various technology changes that will start to bear fruit. To reduce RTT (round trip time) for Internet access, most of the traditional geosynchronous satellite operators have decided upon using satellite constellations in lower orbits using a mix of satellite fleets that provide truly flexible and fully global communications.

For internet access, those additional LEO or MEO fleets are already in service or close to being officially operational. In addition, the traditional GEO operators have opened new markets with the latest new flexible and customer definable satellites on the fly, very high throughput (VHTS) systems with Ka, Q and V-band, and powerful satellites in Ku-Band with ultrawide footprints for broadcasting.

An interesting dilemma that is unfolding with regards to providers of NewSpace satellite fleets is the lack of understanding that the frequency licensing rights need to be fully coordinated on a worldwide perspective. This is becoming of critical importance as LEO/MEO fleets are using the same frequencies in uplink and downlink both in Ku- and Ka-Band as the GEO operators do to close their communication links.

Up until now, we do not have any filing of interference for any GEO/LEO combination with regards to gateway or user links on either system. Developments in flat panel antenna (FPA) multiple beam pointing on board these LEO satellites – using, in combination, live onboard GPS data correlation – has made that possible. As such, these low-orbiting satellites know exactly, 100 percent of the time with minimum error, where they are in latitude, longitude, and altitude. This allows for accurate onboard beam pointing to their gateways and user terminals, while avoiding disruption of existing GEO satellite links.

These technology developments will eventually be a game changer with the help of innovative FPA ground segment antennas, no matter if installed for mobile or fixed services. Only a FPA assembly will allow a bidirectional IP connection through the LEO/MEO fleet or VHTS satellites while receiving GEO broadcast content in parallel with multibeam technology in transmission and reception.

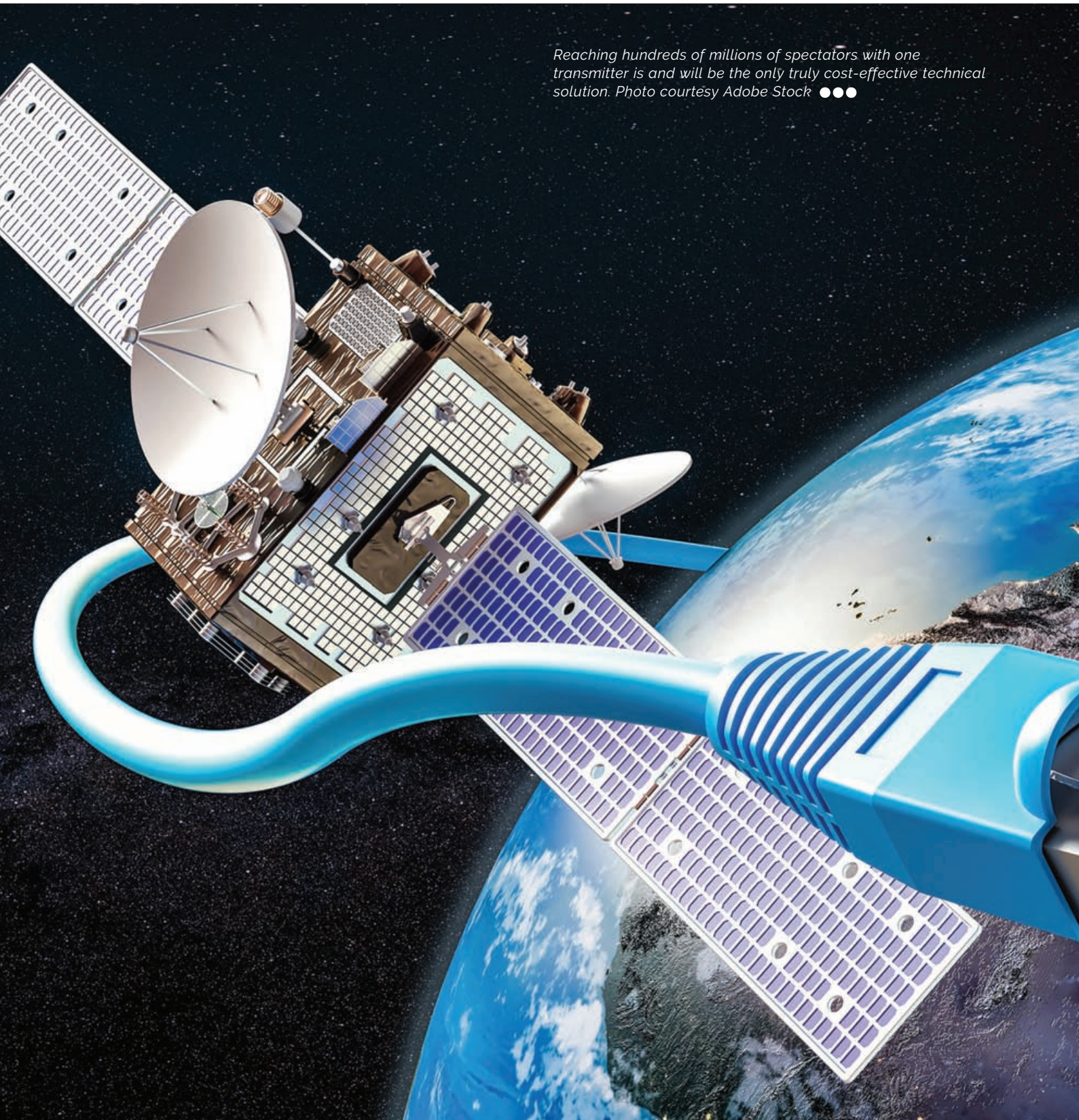
Any FPA system that can receive from and transmit to GEO satellites today, will eventually be able to do the pointing on LEO satellites in the same frequency range without a problem. Flexible beam pointing and adjustments grant it. It does not matter if the vehicle or the satellite moves – or both. In addition, with such a GEO capable FPA system, link margins for LEO will be excellent.

## THE FUTURE OF SATELLITE IP CONNECTIONS AND BROADCAST

Because of NewSpace activities, traditional GEO satellite operators have understood the changing climate and are evolving by rewriting the rules of the game. Worldwide low-level RTT Internet access delivery can now be

guaranteed and delivered where needed, even in polar regions that GEO satellites can't reach. In parallel, existing and relatively low-cost user terminals for VHTS connectivity, flexible satellite infrastructure with customer definable space capacity for secure communications, and high power DTH broadcast capabilities are all available at the same time—adjustable and tailorable for customer needs.

They are installable at home, in a car, on a boat or on a plane. The satellite solution of the future will be a combination built from several services, potentially combined in one FPA installation, having several links to multiple satellites at a time. As such, the customers can go "full speed ahead" with their individual communication requirements, no matter if it is in IP, DTH or a combination of both.



*Reaching hundreds of millions of spectators with one transmitter is and will be the only truly cost-effective technical solution. Photo courtesy Adobe Stock*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*Brooke Frischemeier, Senior Director of Product Management, Robin.io*

# Shaping a cloud-native future for 5G, with the use of Kubernetes

According to UK-based market research firm, Precision Report, the global Container and Kubernetes market is expected to reach a value of US$2,178 million by 2024 as operators and providers worldwide continue to move from legacy equipment to modernized, streamlined, and automated solutions. Where mass 5G rollout is concerned, operators are leveraging cloud-native solutions to drive the massive scaling of services and applications.

*Brooke Frischemeier, Senior Director of Product Management, Robin.io*

As networks become increasingly adaptable, operators adopting fully orchestrated cloud-native platforms can expect deeper market penetration and faster innovation for their operations, whilst achieving significant growth and return on investments. Kubernetes platforms, with their unified operations models and shared resource pools, are helping to realize the potential of 5G services, providing users with a more vibrant supplier ecosystem while saving costs through advanced metal to service automation.

## ENABLING 5G SERVICES WITH EDGE COMPUTING

Real-time functionality and low latency communications are now an essential requirement for many modern devices and applications. Internet of Things (IoT) devices are everywhere, and businesses involved in all kinds of industries including energy, agriculture, smart cities, and logistics have all turned to these to revolutionize their existing operations. With 5G connectivity comes insurmountable expectations, requiring high bandwidth connectivity and low latency. Edge services have become vital to enable this, while enhancing the QoE (Quality of Experience) for users.

MEC (Multi-access Edge Computing) enables cloud-computing capabilities at the edge of the network, amplifying the opportunities made possible through efficient service delivery. Virtual environments are hosted close to the devices that require connectivity. Instead of backhauling all data to a central site for processing, operators can now access a service that can run locally, whilst offering increased throughput alongside minimum latency. This is empowering applications such as VR/AR (Virtual and Augmented Reality), Autonomous X, Industry 4.0, and UHD (Ultra-High-Definition) videos that require a real-time connection.

## CONNECTING LIFECYCLE TASKS WITH KUBERNETES

Most operators are now migrating from VMs (Virtual Machines) to containers, with 30 percent of IT leaders expecting to significantly increase container usage in 2022. For an operator to scale just one part of an application with VMs would traditionally necessitate an entire additional VM to be instantiated, requiring the compute, network resources, store and guest operating system associated with it too.

Kubernetes allows this process to be reduced from minutes to seconds, with isolated systems able to run on a singular OS (Operating System). Applications are broken down into constituent parts and functions called micro-services. Doing this allows operators to scale out the micro-serviced container responsible for a specific function or task, greatly improving efficiency.

Kubernetes can also be set to auto-scale the microservices that can be based on several KPIs, further reducing network reaction times to content delivery requests. Similarly, Kubernetes can heal itself when there is a discrepancy between the declared optimal state and any suboptimal state. For example, malfunctioning resources or fault stages can trigger an automated response.

## SELECTING A CLOUD-NATIVE PLATFORM FOR ADVANCED CONTENT DELIVERY

When it comes to the deployment and massive scale-out of 5G services, how you automate is as important as what you automate. As more professionals move their big data applications to containers empowered by Kubernetes, demand for ML (Machine Learning) applications and IoT technologies continues to grow. Variation between different platforms and orchestration solutions means there can be large disparities in time to outcome, resource utilization, solution costs, and opportunities. There is no simple cure-all for scale-out or repetitive tasks, and operators need to be aware more is required for 5G services to be a success at a scale, especially when choosing between the comparative benefits of automated

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*Kubernetes platforms are helping to realize the potential of 5G services. Photo courtesy Shutterstock*

cloud platforms and orchestration solutions.

The ease of use of a system is key to an operator's success throughout the lifecycle of its service. Unification of lifecycle automation, workflows and overall operations is essential, even when deployed across a wide variety of locations, including VM and container environments.

## HANDLING STATEFUL WORKLOADS FOR OPTIMAL PLATFORM EFFICIENCY

One factor becoming more prevalent in Kubernetes is the ability to handle stateful workloads such as subscriber information. If handled well, the efficiency and agility of an operation can be significantly improved. However, as Kubernetes microservices can add further complexity, snapshotting and cloning storage volumes can no longer be considered enough. For zero-touch-automation, an operator would also need to snapshot the other constructs, such as application metadata, configuration, and SLA (Service Level Agreement) policies. By doing so, applications can be rollbacked to a previous state or cloned to enable a fully functioning running database from a previous snapshot, with no hunting, hardcoding, or restarting from scratch required. The storage only way of doing things goes against the agility and efficiency expected of a platform like Kubernetes and will only serve to restrict the capabilities of the overall solution.

## DATA-DRIVEN SOLUTIONS FOR AN INTEROPERABLE ECOSYSTEM

Concerns over interoperability are inevitable due to the open, multi-vendor nature of Edge and MEC solutions. Operators will no doubt wish to manage potential challenges like overall service orchestration to achieve an end ecosystem that harmonizes VMs and containers, as well as unifying lifecycle automation workflows across a variety of domains up and down the hardware, software and operations stack. The result of this is the elimination of both resource and operations silos, making operations more efficient and lucrative.

Using IoT and Cloud Agnostic analytics platforms, physical information can be taken and converted into digitally processable data. Whether demographics, footfall, path movement, weather, temperature or shopping activity, any measurable data can now be collected and processed. Such information can even be used to provide insight and reports that can be harnessed to enable data driven solutions for any industry using AI (Artificial Intelligence) and ML tools.

To this end, the components must be able to support the entire service edge ecosystem by leveraging multiple services across cloud computing and contributing towards an end-to-end 5G solution. Services such as data analytics, network functions and lifecycle automation, all the way down to the infrastructure and hardware layers must be in harmony to work together.

## MEETING 5G EXPECTATIONS WITH ENHANCED OPERATIONS

In 2021, 68 percent of IT professionals increased their use of Kubernetes due to the pandemic, and this trend is expected to increase over the coming years. Seeking a competitive edge Rakuten became the industry's first telecom operator to provide a 100 percent cloud-native architecture, which is being leveraged in a multi-vendor, end-to-end 5G rollout.

With now considered to be the secret weapon for unlocking cloud-native potential, these platforms will undoubtedly continue to automate development with increased flexibility and adaptability. Operators who leverage the benefits of a cloud 5G can expect to achieve a more competitive service offering, with faster innovation towards delivering high-quality connectivity in the face of immense demand.

Enabling metal to service orchestration for deployment and life cycle management of the network services at 5G scale will be a key enabler of delivery of services at the edge. Robin Telco grade Robin Cloud Native Platform (CNP), coupled with the multi-cluster orchestration capabilities of Robin Multi Data Center Automation Platform (MDCAP) can reduce time to service delivery by 80 percent, CapEx savings by 50 percent, and OpEx costs by 40 percent.

*When it comes to the deployment and scale-out of 5G services, how you automate is equally important as what you automate. Photo courtesy Shutterstock*

Photo courtesy Shutterstock

# Reducing interference issues between 5G and C-band satellite communications

The re-allocation of C-band for mid-band wide area coverage of 5G presents increased interference issues between new networks and existing RF systems. UK-based Filtronic, which last year received the Queen's Award for Enterprise for International Trade 2021, is helping its customers resolve the situation.

*Ben Snow, Field Sales Engineer, Filtronic*

Interference is a problem that is as old as telecommunications technology itself. However, new frequencies where issues can occur are constantly emerging as demand for spectrum and bandwidth becomes more intense. In recent years, new spectrum has been carved out by the re-farming of existing frequency bands from technologies that are being phased out, and also from the release of spectrum such as that resulting from the switch-over from analogue to digital television – known as the 'Digital Dividend'. The latest problem is the proximity of the mid-band 5G spectrum (in the range 3.4 – 3.8GHz) to established satellite communications channels in C-band [1].

These recent changes in spectrum allocations have inevitably led to the occurrence of interference problems between new networks and existing RF systems. Minimizing spectral emissions and attenuating interference is an issue that is therefore constantly evolving, although the basic mitigation techniques are well-established and just require some adaptation to meet the latest specifications. Many of the new channels are small and close to others, which means that interference mitigation filters need to provide a level of rejection that causes the smallest possible loss of usable spectrum, and with minimal impact on the characteristics of the wanted signal. Depending on the application, interference and blocking protection can be designed either as a standalone unit or be integrated with other filtering or combining functions.

## INTERFERENCE AT SATELLITE GROUND TERMINALS

Satellite communication terminals operating in C-band have a receive band in the range 3.4 – 4.2GHz and a transmit band of 5.85 – 6.425GHz. Although the 3.5GHz band was previously allocated for WiMax it did not achieve widespread use in that application, and the band has now been re-allocated for mid-band wide area coverage 5G. Spectrum auctions have been organised by local regulators in various regions of the world, including in the UK where the winning bids for 3.6 – 3.8GHz allocations were announced in April 2021.[2]

Because the satellite signals received at a ground terminal are orders of magnitude weaker than the 5G signal, it is these signals that need to be protected from interference. Even if the 5G signal meets all the relevant regulatory specifications, interference could still occur if the base station is near the ground terminal. If other electromagnetic radiation is also occurring locally – for example from aviation, AM and FM radio and TV transmitters – then it can be exceedingly difficult to predict what problems might occur. Even when the interference is out of band, intermodulation products between the interfering signal and either the satellite receive signal itself or the local oscillator can appear within the band.

For effective mitigation it is therefore necessary to survey the whole RF environment surrounding the ground

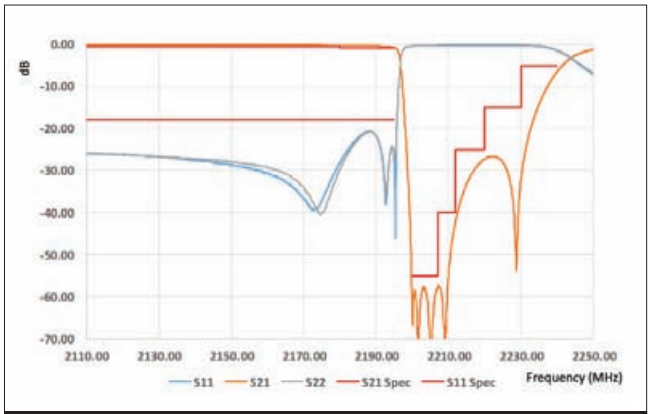


*Figure 1: Typical response of quad bandstop filter giving 55dB minimum attenuation in the 2200 – 2207MHz band*

*Ben Snow, Field Sales Engineer, Filtronic*

terminal, as even third order and fifth order intermodulation can interfere with the received satellite signal in an unpredictable or unexpected way. It has been determined by Norsat[1] that the interference sensitivity of a C-band satellite low noise block (LNB) is typically -55dBm, which represents the threshold below which any interfering signals must be reduced. This unpredictability means that for satellite ground stations, interference mitigation is unlikely to be solved by an off-the shelf filter but would need customization for each location and its surroundings.

Other problems that can be caused by interference include receiver saturation, which can occur when the interfering signal is greater than about -45dBm, blocking reception of the wanted signal. Gain compression can also take place if the total power at the input exceeds the input P1dB figure, which can cause distortion, and in extreme cases can cause the modem to lose its lock on the received signal. Noise floor degradation has also been identified as a potential problem.

## FILTER PERFORMANCE

A range of filter technologies are available, dependent upon the specific filter requirements such as size, response, power handling, insertion loss and rejection. The standard technologies include metal cavity filters, ceramic, combline, interdigital, lumped element, suspended substrate, waveguide and thin-film. Enhanced functionality including field reconfigurable filters and switchable filters, or DC feedthrough, can also be provided. Previously successful designs have been produced to solve interference mitigation problems including:

- LTE 800 interference with air-to-ground (ATG) cellular and specialised mobile radio (SMR), and with digital TV during the transition from analogue to digital.
- LTE 2600 interference between FDD and TDD, and with radar systems.
- Interference between GSM-R and 3G or EGSM.

An example of the performance available from these filters can be seen in Figure 1, which shows the typical response of an AWS quad bandstop filter giving 55dB minimum attenuation in the 2200 – 2207MHz band. The receiver passband is 1710 – 1780MHz, with a maximum insertion loss of 0.3dB and minimum return loss of 18dB.

> "Because the satellite signals received at a ground terminal are orders of magnitude weaker than the 5G signal, it is these signals that need to be protected from interference. Even if the 5G signal meets all the relevant regulatory specifications, interference could still occur if the base station is near the ground terminal"

The transmitter passband is 2110 – 2195MHz, and the AISG passband is 2.176MHz ±100ppm with a maximum insertion loss of 0.2 dB and 18dB minimum return loss. The isolation between the Rx and Tx passbands is rated at 60dB, and passband average power handling capability is 75W (500W peak). Intermodulation products in the receiver band are below -118dBm. Figure 2 shows a block diagram of the filter.

## CONCLUSION

Filtronic has a long track record in technology for mitigating interference, and its range of filters provide a simple, cost effective and low loss solution for minimising unwanted spectral emissions and attenuating interference signals. Interference mitigation filters can be designed for easy integration into the system, with minimum size and weight, and with flexible mounting options to suit the application. Custom or reconfigurable designs can be created to suit the filtering requirements of a particular cellular base station or satellite ground station scenario.

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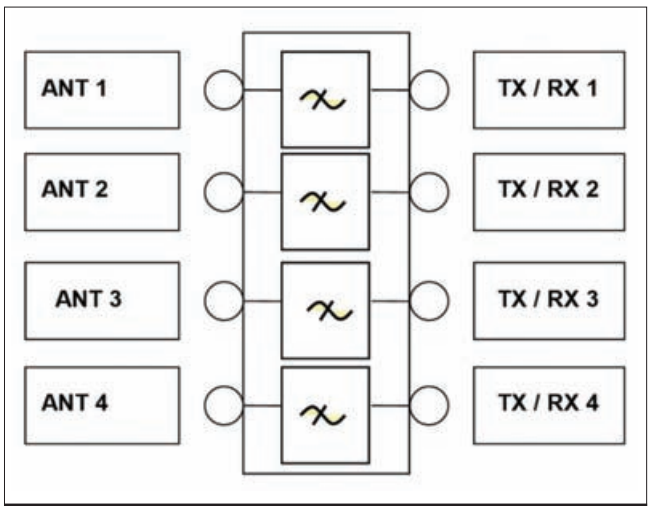


*Figure 2: Block diagram of quad bandstop filter*

# Space Foundation releases The Space Report 2022

Space Foundation, a nonprofit advocate organization founded in 1983 for the global space ecosystem, has released *The Space Report 2022 Q1*, which examines key US space employment data and workforce issues, the field of new launch vehicles expected to debut this year, and other industry economic indicators such as insurance premiums and US spaceport capacity.

In a three-part analysis, the Q1 edition focuses on US workforce data, the concern among space industry leaders and educators about the supply of skilled workers, and a Space Foundation program that exemplifies efforts to spur students' interest in science, technology, engineering and mathematics (STEM).

"One thing business leaders and educators readily agree on is that if we are to have sustained growth in the space industry, we must have an uninterrupted pipeline of talent," said Space Foundation CEO Tom Zelibor. "The jobs available in the global space ecosystem are becoming more varied and increasingly technical in nature and are destined to help create new products and services both in space and on Earth. If we are to realize that growing potential, we must have the talent pool to get us there."

The Q1 edition continues more than a decade of reporting by The Space Report on the space workforce, focusing in this edition on 2021 data from the US Bureau of Labor Statistics and core space employment numbers. According to preliminary 2021 data, employment in the core US space industry employment is at a 10-year high, climbing past 2011's core employment of 149,818 to reach 151,797. In the last five years, US employment in the core sectors has grown 18.4 percent, driven largely by employment in the launch vehicle job sector. These numbers do not track space employment as a whole because of the lack of comprehensive annual data. Instead, annual employment data on key job sectors most closely associated with the space industry is tracked to provide the most consistent growth analysis over time.

- Since 2016, core US space employment has grown by 18.4 percent.
- Private-sector space pay grew 29.4 percent in 2020, more than double average US private-sector pay.
- 2-year US college programs are seeing a 4-year enrollment decline for engineering technicians, precision production and other skilled trades.
- 15 new launch vehicles are scheduled to debut in 2022.

The workforce section also updates information on pay in the space sector. In 2020, the latest available year for annual data, the average US private-sector space salary was $125,214, according to BLS data, which was more than double the average annual salary of $62,247 for all US private-sector jobs and 27.3 percent more than the average

*Photo courtesy Shutterstock*

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salary of $98,340 for STEM occupations. Job growth and higher-paying salaries, however, aren't doing enough to attract workers into the skilled labor jobs that support some crucial jobs in the space industry. Enrollment at two-year US institutions has declined steadily since 2018 in fields such as engineering and science technicians, engineering, and precision production.

The Q1 edition also offers an overview of the 15 launch vehicles expected to debut this year, making it the busiest debut year in space history. The United States leads the class of 2022 with five new launch vehicles, and four of them provide the highest payload capabilities, ranging from 30 to 110 tons. A sixth US company, Blue Origin, announced in late March that it was pushing the launch of its New Glenn to 2023. China is next with three new launch vehicles, followed by the United Kingdom with two new vehicles.

The Q1 edition also examines the climbing rate of launches at US spaceports. Last year, they experienced the busiest year since 1967, helping set a 2021 record of 145 global launch attempts by contributing 45 launches. That increasing rate comes with usage limitations. Of the 13 Federal Aviation Administration (FAA)-licensed launch sites in the US, only four are operational and licensed for vertical, orbital launches. Two of these launch sites — Cape Canaveral and Vandenberg — account for 97 percent of all domestic orbital launches since 1957. In this article, Quilty Analytics examines how some spaceport development faces congressional spending limits and update some of the new development in progress.

An often-overlooked aspect of the space economy and infrastructure gets a look in the Q1 edition, too. Coming off the best year for the space insurance industry since 2016, insurers are bullish on the future with an anticipated boom in satellite and launch policies ahead. Increasing congestion and debris in low Earth orbit could add risk, driving some concerns.

However, insurers are beginning to navigate what policies and premiums could be as more tourists head into orbit and firms begin construction on the first commercial space stations.