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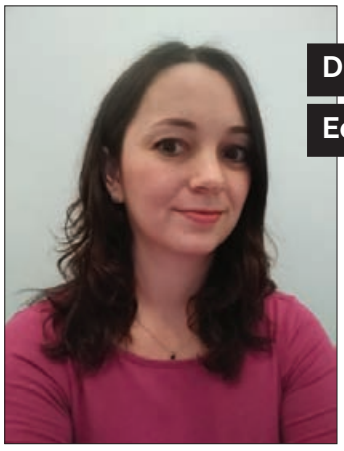
Issue 4 / Volume 1

# NewSpace INTERNATIONAL

In this issue: #MOON #SPACE #4G #LEO #ESA #GROUNDSEGMENT #OMNISPACE #RBCSIGNALS #AI



**Dr Amy Saunders**

**Editor**

Welcome to the inaugural 2021 issue of NewSpace International! You might be thinking that it's been ages since you've read an issue – we juggled our publication issues this year to align with NewSpace-relevant events more closely (should any event ever take place in real life again), but we'll still be bringing you three jam-packed issues this year!

It's been an interesting couple of months for the NewSpace arena. In April, SpaceX's Falcon 9 launched the Dragon crew capsule, safely transporting astronauts from NASA, JAXA and ESA from the Kennedy Space Center to the ISS. This marks the first human spaceflight mission to fly astronauts on a flight-proven Falcon 9 and Dragon.

NASA has awarded a firm-fixed price milestone-based contract to SpaceX totalling US$2.89 billion for the continued development of the first commercial human lander that will safely carry the next two American astronauts – including one woman - to the Moon. This news has been met with dismay by rival company Blue Origin, which has filed a 175-page protest with the Government Accountability Office less than two weeks after the contract was announced. NASA had funded the development of three prototype landers including Blue Origin's and was expected to select two – due to short funding from Congress, only one was selected. The general gist of the complaint is that NASA misjudged several parts of Blue Origin's proposed Blue Moon lander and had taken a 'high risk' decision in which the goalposts were moved 'at the last minute.' SpaceX's Elon Musk has been quick to respond (naturally) via Twitter: "Can't get it up (to orbit) lol." Moving on…

In this first NewSpace International issue of the year, we've interviewed OmniSpace to learn more about their hybrid 5G network, set to offer ubiquitous, low latency, two-way communications for a wide range of users and applications, worldwide. We've also spoken with RBC Signals about their latest project with Aurora Propulsion Technologies, in which their global ground station network works in support of the AuroraSat-1 mission. SIG's Helen Weedon shares her thoughts on the future of artificial intelligence within the satellite sector. Meanwhile, we've reviewed the latest developments in low Earth orbit satellite constellations, looking at the movers and shakers set to bring low-cost connectivity into reality. We have also explored the rollout of 4G connectivity on the Moon; several entities are gearing up for demonstrations in the near future.

*A render of the Artemis Base Camp. Photo courtesy of NASA*

Long-time no see


Front cover: Photo courtesy of Shutterstock

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# SpaceLink and Mynaric join forces

Mynaric and SpaceLink have agreed on the framework of a partnership to expand Mynaric's laser communication product portfolio for use in SpaceLink's data relay network. The strategic relationship will help drive forward the SpaceLink satellite relay service, which provides secure, continuous, high-capacity communications between LEO spacecraft and the ground.

The companies will work together to expand Mynaric's product portfolio with an optical inter-satellite link (OISL) terminal for satellites in Medium Earth Orbit (MEO), where the SpaceLink constellation will operate. The new terminal will also be compatible with the Space Development Agency (SDA) Transport Layer.

Mynaric will supply more than 40 OISL terminals as part of the plan outlined in a term sheet, which includes units of the new, advanced product for satellites in MEO as well as units of Mynaric's CONDOR terminals for SpaceLink LEO customers. SpaceLink and Mynaric have also agreed to an option that would increase the number of terminals delivered upon SpaceLink's expansion of its MEO constellation.

Laser communication technology is critical for SpaceLink to build the communications superhighway for the new space economy. Mynaric's product portfolio is a natural choice as it meets SpaceLink's programmatic requirements, provides high performance, and is fully compliant with the OISL Standard driven by the SDA. This is a major benefit that allows SpaceLink to serve the largest possible range of commercial and government customers.

SpaceLink is building its high-capacity data relay network to meet pent-up demand for continuous, fast, and secure access to the growing amount of data available from space. The Always in Sight™ constellation helps satellite operators maximize the value of on-orbit assets with near real time transmission of user data to the ground for immediate access via the Internet, private cloud, or other secure delivery. Mynaric was selected as a supplier to support SpaceLink's mission given its industrialized approach towards the production of advanced laser communication products.

"Our work with Mynaric to implement advanced OISL capability into the SpaceLink constellation will ensure performance and interoperability. Mynaric has exceptional expertise to advance a new generation of OISLs that address our requirements and our mission to speed massive amounts of data to users no matter where they are located on Earth. Together with Mynaric, SpaceLink will enable our customers to take a quantum leap in delivering data that saves lives and advances humanity to a new age of space commerce, exploration, environmental awareness, and security." -David Bettinger, CEO SpaceLink.


"This partnership closes on the largest direct acquisition of laser communication products by a commercial entity to date to our knowledge and touches multiple aspects that are at the core of our strategy of industrializing laser communications: Signing a lead customer to expand our product portfolio with a product suitable for MEO satellites while gaining a channel partner for our LEO terminals compliant with the SDA Standard. We are excited to partner with SpaceLink to supply products to and support their mission to enable secure, high-capacity data access in space." -Bulent Altan, CEO Mynaric. ■

**To include your news in NewSpace International magazine please contact**
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**amy.saunders@dsairpublications.com**

**SSTL signs up LatConnect 60 for high resolution earth observation data**

Surrey Satellite Technology Ltd (SSTL) has signed a contract with LatConnect 60, based in Australia, to provide high resolution optical data from the SSTL S1-4, an Earth observation satellite which was launched in September 2018.

SSTL will retain ownership and overall in-orbit satellite operation, and will lease imaging payload capacity as well as enable operational access to LatConnect 60 to submit tasking requests for its capacity share from Australia for the satellite's lifetime, designed to be in excess of 7 years. The new contract will contribute high resolution panchromatic and multispectral optical data to LatConnect 60 in support of their activities in Australia and beyond.

LatConnect 60's team in Western Australia will process the data further to provide analytics-ready data products and insights.

Phil Brownnett, Managing Director of SSTL said "We are very pleased to announce this new contract for SSTL S1-4 data with LatConnect 60 which furthers the UK's ties with the Australian space industry and brings SSTL's sub metric earth observation data to new markets."

Venkat Pillay, CEO of LatConnect 60 said: "We are very excited to have signed this agreement with SSTL and to be working together at the forefront of space innovation. Utilizing this satellite capacity exclusively in Australia, LatConnect 60 will be able to fill key data gaps for customers, while developing local capability which will create jobs and help grow the rapidly emerging Australian space sector."

# Conformal Antennas

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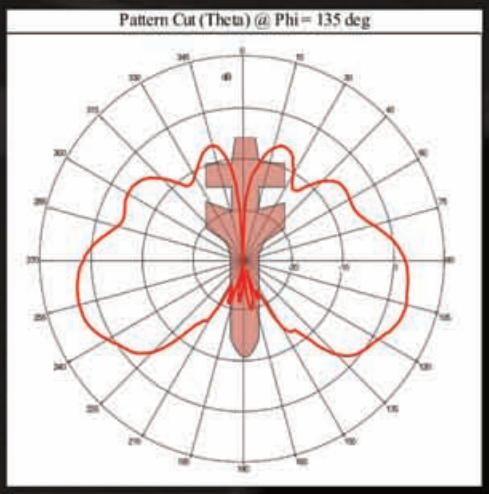
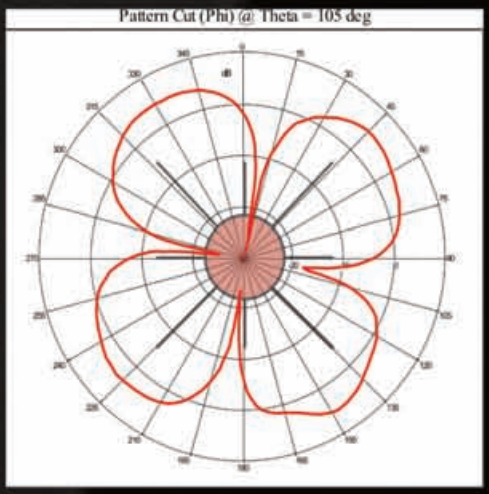
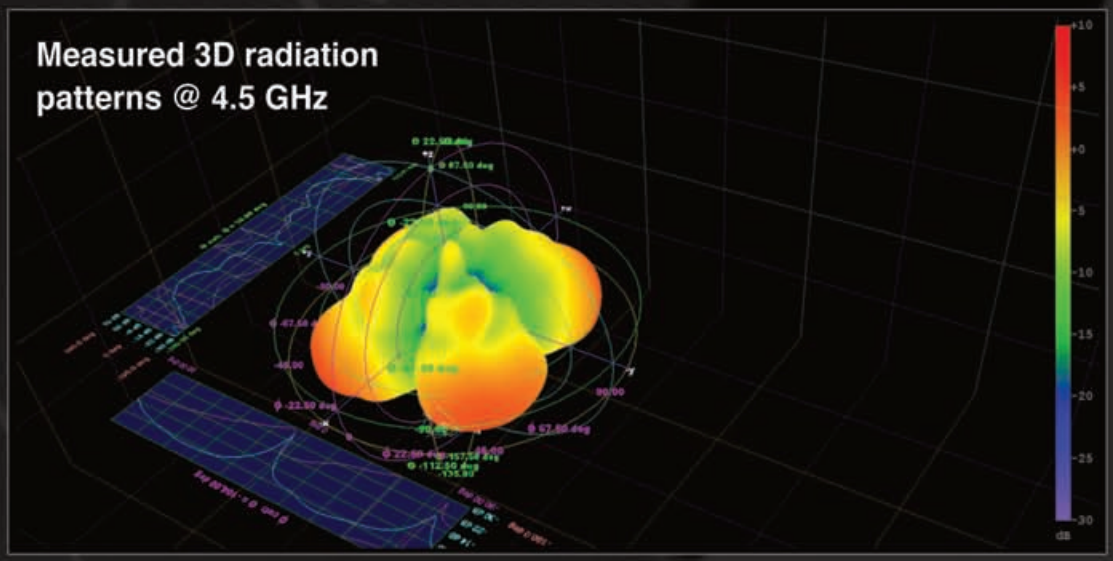
| Parameters | Description |
|---|---|
| Frequency Band | 4.5GHz |
| VSWR | < 1.5:1 |
| Peak Gain | 4.9dBi |
| Half-Power Beamwidth (HPBW) | Referring to results for detail |
| Polarisation | Linear Vertical |
| XPD | >30dB |
| Configuration | Conformal Flight-Qualified PCB |
| Connectorisation | RG188 Coaxial |
| Footprint | Diameter = 76.2mm, Length = 75mm |
| Mass | TBC |




Right: 2D radiation patterns

Below: Curved Antenna showing radiation patches.

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# Revolutionizing global connectivity

5G technologies and satellite architecture stand to revolutionize global connectivity, forging new ground for emergent technologies and business cases. With enhanced sophistication, new affordability and standards will be possible for all connective architecture, steadily bridging the digital divide. Ram Viswanathan, Omnispace CEO, outlines how their hybrid network coming in 2022 can change the world.

*Ram Viswanathan, CEO, Omnispace*

*Laurence Russell, Assistant Editor, Satellite Evolution Group*

**Question: What are the opportunities and risks of 5G in a nutshell?**

**Ram Viswanathan:** For Omnispace, we see very little technical risk and tremendous opportunity. We are among more than 100 telecom industry participants collaborating in the development of a 3GPP standard for 5G communications utilizing satellite platforms, which will ensure our solutions contribute to and are interoperable with 5G platforms from a commercial perspective around the globe. The broad support from across the wireless telecom industry is indicative of the magnitude of the opportunity to further grow what is already a trillion dollar plus industry.

**Question: You've recently announced a new round of successful funding for your hybrid 5G network. What will that investment help you achieve?**

**Ram Viswanathan:** This additional funding allows Omnispace to build upon the investments and progress we have already made to advance our 'one global network' vision. At this stage we are working to demonstrate 5G connectivity, directly to commercial products, from space, employing the work currently underway at 3GPP. It also paves the way for us to accelerate market access initiatives to secure the requisite authorizations to sell services globally.

Together these efforts provide the foundation for partnerships with technology and distribution partners,


*Omnispace is creating a new global communications platform that powers 5G connectivity directly to mobile devices from space. Photo courtesy Omnispace*

toward the realization of our global hybrid network vision.

**Question: You'd like to see more ubiquitous access to 2GHz mobile satellite services. What are the applications of that kind of speed?**

**Ram Viswanathan:** The 2GHz band is ideal for a satellite-terrestrial hybrid network implementation. While authorized spectrum is a critical ingredient of any wireless network, network performance is dictated more by the system architecture and implementation than just the frequency band(s). The system we are working on will have the performance and capacity to support a wide range of commercial, enterprise and government applications.

Our network will leverage our priority 2GHz MSS spectrum rights and employ 3GPP standards to enable direct-to-device connectivity and interoperability. By employing these 3GPP standards, we are enabling the capability to connect directly from our network to devices seamlessly around the world. This is a key differentiator of the Omnispace network and is a prerequisite to truly implementing a hybrid network. It will deliver a service capability, quality, and coverage area unmatched by industry incumbents.

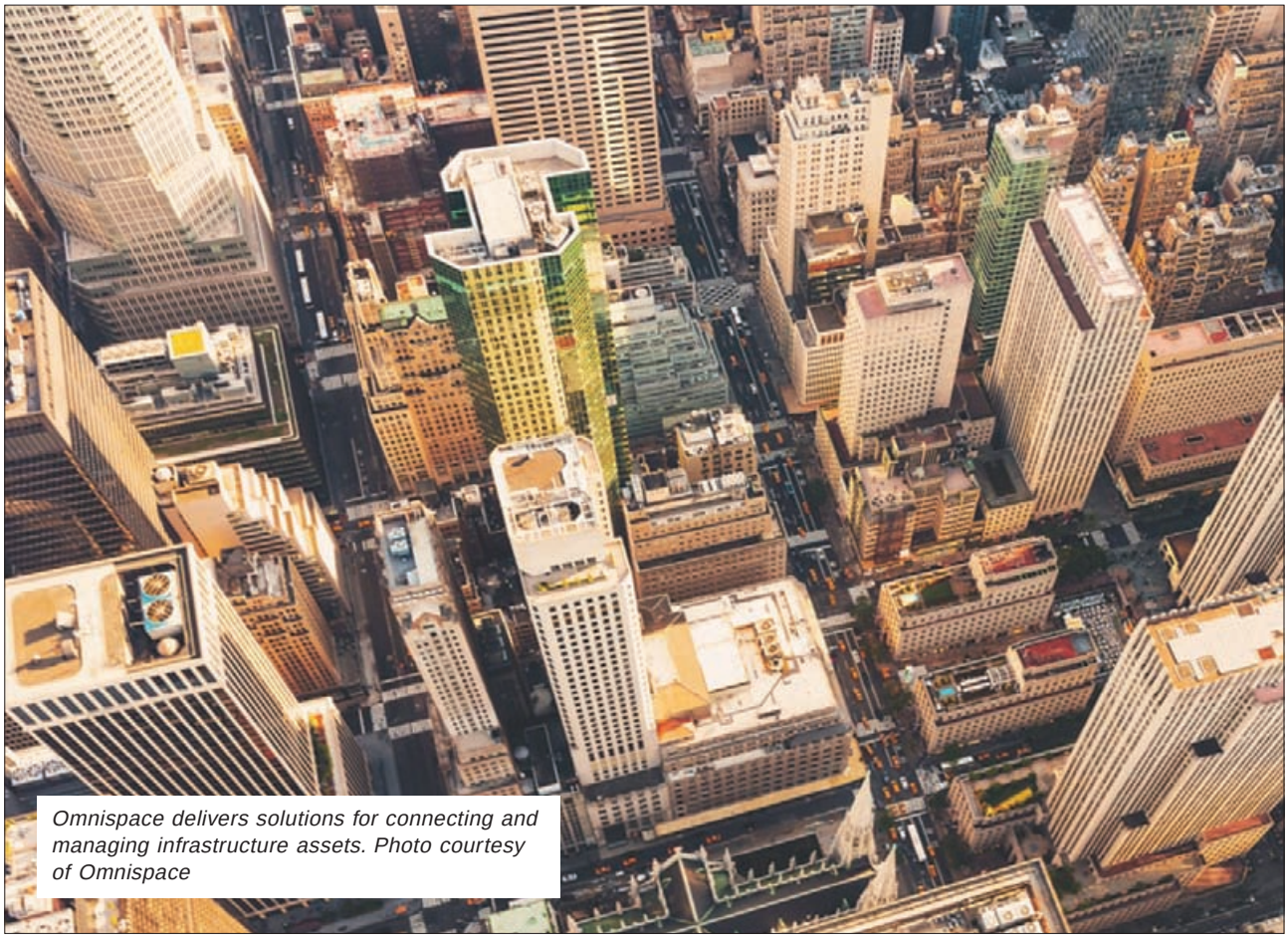
**Question: After speeds like this become the norm, do you think we will see more emergent consumer technologies like smart city IoT, active AR, or mobile cloud gaming realized?**

**Ram Viswanathan:** There is a lot of talk about consumer use of 5G such as AR and video. Our view is that 5G will be far more transformative to enterprise users that will use the wireless technology to redefine their operations. We also see this as an opportunity to close the digital divide, effectively levelling the playing field for economies around the world. Imagine digitizing, analyzing and then automating supply chains, production, operations, and sales from source to shelf, enabling smart infrastructure nationwide or real-time tracking of assets and vehicles. Our 5G hybrid network will offer ubiquitous, low latency, two-way communications for a wide range of users and applications, worldwide.

**Question: It may not be obvious to stakeholders and consumers how much more valuable a global satellite service such as this is when compared to the terrestrial competition. This widens the span of business cases quite a bit, doesn't it?**

**Ram Viswanathan:** The value that a global satellite overlay can add to existing mobile networks is underestimated by many. However, mobile networks operators well understand the enhanced customer experience that can be achieved with increased reach and enhanced resiliency. It is important to note that we do not see our satellite network as competitive to terrestrial networks, rather we're planning to partner with mobile telecom providers to extend their network reach and augment the services they are already providing.

Mobile connectivity is a critical component for socio-economic development and growth in the 21st century. We see our global 5G service as contributing to enablement of this growth, especially in underserved and undeveloped parts of the world. Imagine providing mobile internet access to unconnected regions of Latin America, Africa, or Asia. These groups have little to no



*Omnispace delivers solutions for connecting and managing infrastructure assets. Photo courtesy of Omnispace*

reliable connectivity presently. Even basic internet access would be a game-changer for many in these regions.

The Omnispace network is an unparalleled combination of communications technologies, functionality, reliability, and global reach. Our team is confident that we can build a network that has the power to help transform entire industries around the world.

**Question: Your hybrid network will begin entering service in 2022. What are your priorities this year to best support that?**

**Ram Viswanathan:** We will continue to execute our program on multiple fronts. Advancing our work to demonstrate 5G technology operating from satellite focusing on both the satellite platform and the user devices will be a top priority. We will also progress our efforts to implement a virtualized 5G core network and open up additional markets for the delivery of our services.

Omnispace also announced a shared vision to redefine mobile communications for the 21st century, by collaborating with Lockheed Martin to deliver a potential global 5G from space solution. You can expect more announcements from Omnispace with regards to how we will deliver this dual use 5G platform in the months ahead.

**Question: How do you think 5G will change the world by the time it is in full swing?**

**Ram Viswanathan:** In addition to transforming the enterprise as mentioned earlier, 5G also provides an opportunity to, for the first time, harmonize satellite and terrestrial communications around a common standard. This common standard will enable networks the ability to seamlessly integrate to deliver communications through one global network.

We believe that ubiquitous global connectivity will transform how people, businesses and governments think of the role connectivity plays in everyday lives. Because of the scale that hybrid 5G services will be able to achieve, we foresee a consolidation of sorts in the wireless connectivity industry where users will transition from alternative and proprietary technologies to 5G providing even greater scale and efficiencies to end users. When we all look back a decade from now, we expect that many will ask why satellite and terrestrial were not fused into a single network well before now. ■

*Global reach supports tracking in remote areas and of critical commodity assets. Photo courtesy of Omnispace*

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# 4G on the Moon

Since man first ventured to the Moon, communications technology has been brought with us and either returned home or abandoned, built bespoke for purpose, and rendered obsolete after use. As our ambitions for space have become more realised, the development of permanent lunar infrastructure has materialised.

*Laurence Russell, Assistant Editor, Satellite Evolution Group*

**In 2018, Nokia Bell Labs, alongside Vodafone Germany** and Audi, expressed intention to bring long-term evolution (LTE) services to space by installing a 4G network on the moon, enabling advanced communications, faster connections, and high-definition video streaming of the lunar landscape to aid lunar missions, and pave the way for future lunar commercialisation.

Innovative micronized technologies were theorised to make the dream a reality, resulting in space-grade hardware which weighs less than 1kg, optimized for the lunar surface, capable of withstanding extreme temperature, solar radiation, vacuum conditions, and the shock impact of launch and landing. "This project involves a radically innovative approach to the development of mobile network infrastructure," said Hannes Ametsreiter, CEO of Vodafone Germany.

The network was planned to be put to the test by a pair of Audi lunar Quattro exploration vehicles set to communicate with each other and a base station located in what was then referred to as the Autonomous Landing and Navigation Module (ALINA) which would transport them to the Moon. "Whether it is meteor mining or lunar landing or Mars, we have to learn how to communicate in space," Marcus Weldon, Chief Technology Officer of Nokia and Head of Bell Labs said at the time.

In the years since Vodafone has stepped away from the project, and Audi's rover has been replaced by that of Intuitive Machines, who are also involved in the lunar ice drill project as part of the Polar Resources Ice Mining Experiment (PRIME-1) planned for execution in December 2022. While the collaboration lasted, many tests were conducted in vacuum chambers and a slew of demonstration equipment was delivered, forging the foundation for a more sustainable project to come.

## The tipping point

In late 2020, the project was included in NASA's Tipping Points funding program besides a dozen other companies, which led to US$14.1 million in federal investment. The scheme awarded over US$370 million to various market leaders in space technology across three topic areas: Cryogenic fluid management, lunar surface infrastructure, and closed-loop descent and landing capability demonstrations.

"NASA's significant investment in innovative technology demonstrations, led by small and large US businesses across nine states, will expand what is possible in space and on the lunar surface," said NASA Administrator Jim Bridenstine. "Together, NASA and industry are building up an array of mission-ready capabilities to support a sustainable presence on the Moon and future human missions to Mars."

*A render of the Artemis Base Camp. Photo courtesy NASA*

*An artist's rendition of an Artemis astronaut wearing the xEMU spacesuit and xPLS life support backpack. Photo courtesy NASA*

4G networking will support exploration and science missions, but alongside the other Tipping Point projects, is considered a stepping stone in the process of realising human lunar habitation, which NASA hopes to establish by 2028, beginning with the first woman on the moon in 2024 as part of Project Artemis. Those achievements will cement a foothold further fuelling efforts to reach Mars.

While original plans couldn't factor in 5G considerations, 2020 offers a fresh perspective, allowing developers to work in the interest of comfortably upscaling to 5G when the technology becomes available for space-grade applications.

## Lunar demonstrations

In late 2019, Nokia Bell Labs successfully tested their advanced prototype LTE BTS as part of an internally funded effort. With the help of the High Power Radio Frequency Laboratory, run by both ESA and the Valencia Space Consortium, Nokia simulated the 'multipactor' effect, a phenomenon in which strong radiofrequency energy generates a spike of secondary electron emissions in a vacuum, causing damage or even total loss of hardware.

Using radioactive Strontium-90 sources and ultraviolet lamps to seed low-energy electrons across three lunar temperature ranges, the experiment confirmed that Nokia's LTE Base Station architecture does not induce the multipactor effect, making it suitable for space deployment.

Interestingly, the environment of space isn't all adversity. Many aspects of 4G technology can be expected to operate better in an extra-terrestrial environment.

The absence of atmosphere, ground interference, elevated terrain and ground-level obstructions means that the same technology will go further on the Moon, providing an assurance of connection reliability one couldn't expect on Earth.

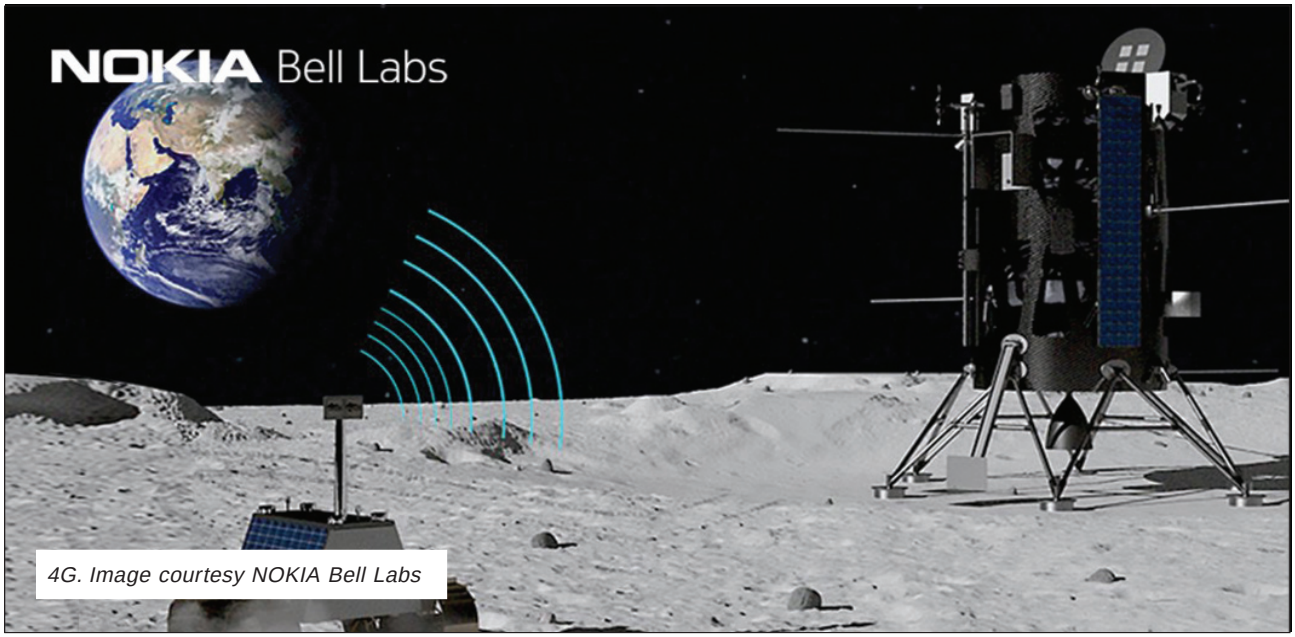
In 2022, after a successful Moon landing, Nokia's technology will connect to Intuitive Machines' rover, establishing a cellular link, just as a phone tower would to a smartphone user, and test surface communications across short ranges up to 300m, and long ranges up to 3km.

## The LunaNet

Currently, China leads the field of lunar communications, being the only country to have sent a signal from the Moon to somewhere other than Earth; their Moon/Earth halo orbit Queqiao Relay Satellite, which was able to operate as a go-between for their ground station and Chang'e 4 on the dark side of the Moon, after it completed humanity's first lunar soft landing, which touched down in 2019.

Perhaps slighted, NASA expressed hopes to answer China's lunar connection fidelity in a big way. Nokia's efforts with 4G are the first steps towards NASA's ongoing effort in establishing the LunaNet, which hopes to gradually define protocols and standards for off-world connectivity while supporting occurring exploration missions, eventually blossoming into a Solar System Internet. An Astranet if you will.

In the next decade, cutting-edge lunar connectivity could lead to the kind of edge computing and IoT that opens doors to space virtualization, wherein space exploration vehicles can make better use of remote hardware to do their computational heavy lifting, leaving room onboard for other critical onboard processes. Realistically, this virtualization would be best delivered by hubs in a hypothetical moon base, the like of which



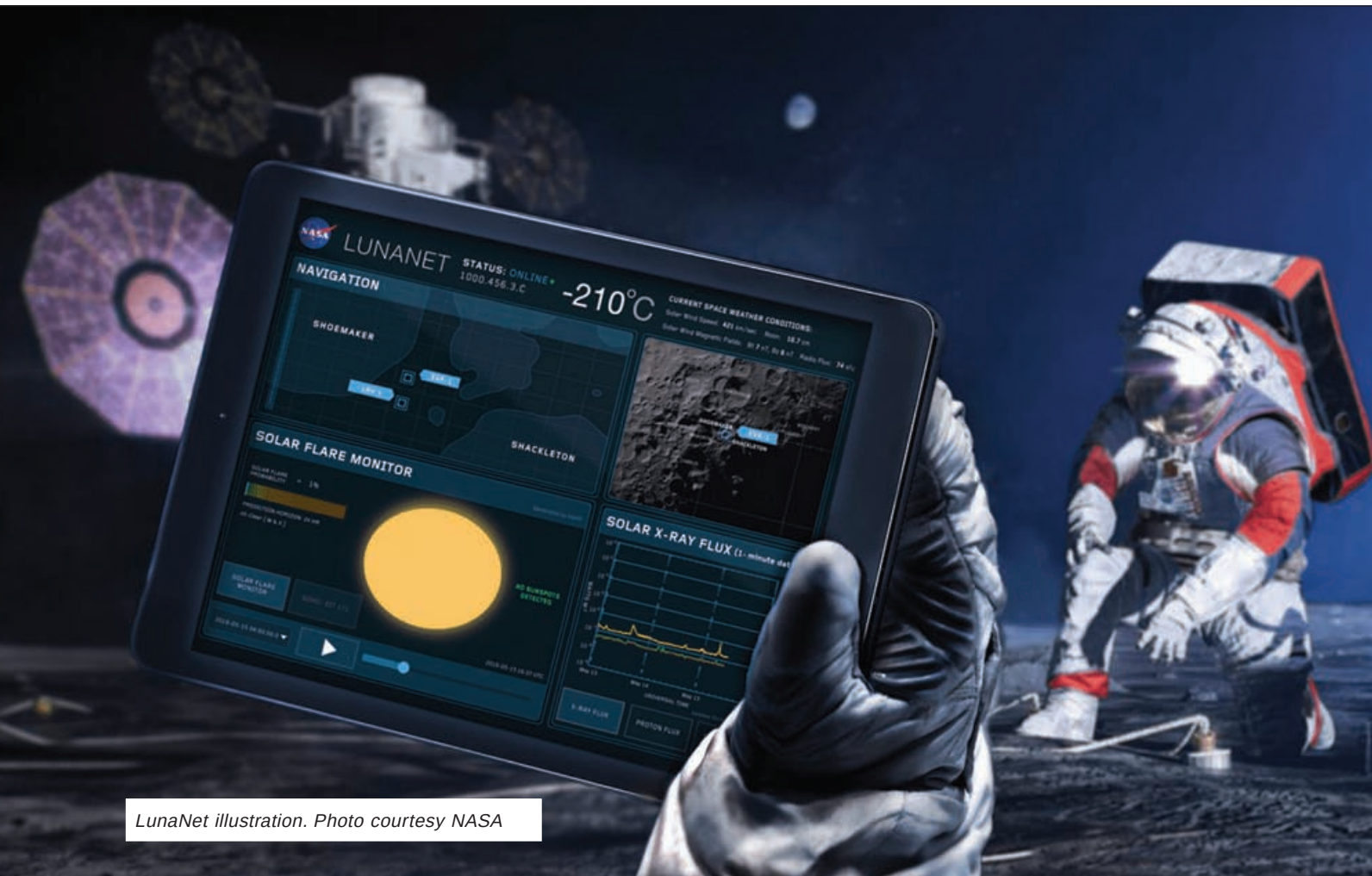

4G. Image courtesy NOKIA Bell Labs

lunar 4G paves the way for, as well as an interconnected network of lunar orbiters to provide relay services and a lunar positioning system to coordinate autonomous pathing.

"The analogy that I use," explains NASA Exploration and Space Communications Projects Division Architect David Israel, "is that when the mobile networks started you could only get phone coverage in the city. But when you went out to the country you didn't have coverage anymore. You didn't need a new phone, they just needed to put base stations out there. So, the build-up of the LunaNet is very analogous to the build-up of mobile networks and the Internet."

Because the LunaNet revolves so heavily upon interoperability standards between providers and users, it will never be owned, just like the Internet. It's built from the ground up to serve governments, commercial and academic bodies, and eventually space tourists indiscriminately. With space companies properly connected, many applications could rapidly open up.

Unlocking the Moon as a staging area for exploration would be a game-changer. Radio astronomers have long coveted the notion of running complex observations from its surface, particularly from the dead quiet dark side, which would garner the clearest space signals ever received by human technology.




LunaNet illustration. Photo courtesy NASA

# Supporting the ground sphere

RBC Signals recently announced a partnership with Aurora Propulsion Technologies on the exciting AuroraSat-1 mission launching in 2021, supplying ground station connections as a service. CEO Christopher Richins shares his thoughts on the upcoming demonstration, as well as the clear concern around reprioritizing the NewSpace sector to better support the ground sphere in order to meet the demand of emerging orbital technologies.

*Laurence Russell, Assistant Editor, NewSpace International*

*Christopher Richins, CEO, RBC Signals*

**Question: Reliable ground segment technologies are essential in supporting space applications of all kinds. What are the foremost priorities in that industry?**
**Christopher Richins:** The highest priorities that we are seeing in ground segment technologies are in the areas of flexibility. Flexibility in the frequency bands that can be supported from UHF/VHF to S-band and X-band to increasingly Ka-band and Ku-band. Another area of flexibility is the ability to ground systems to be truly multi-mission/multi-tenant.

This requires software-defined ground stations. We are seeing more satellites going into many different orbits, so have location flexibility with a global ground station network is more and more important. Finally, another area of flexibility is being data-centric in your network architectures. This means being more cloud-connected for data-intensive applications where compute, storage, and bandwidth are critical.

*Photo courtesy RBC Signals*

**Question: RBC Signals is working with Aurora Propulsion Technologies, sharing their global ground station network in support of the AuroraSat-1 mission. Could you tell us a bit more about that partnership?**
**Christopher Richins:** RBC Signals is providing ground station as a service (GSaaS) to Aurora Propulsion Technologies. Rather than Aurora Propulsion Technologies having to make large capital investments in custom-built new ground stations, they are able to access RBC Signals' global antenna network to communicate with their satellite. This ends up being more capital efficient and allows Aurora Propulsion Technologies to focus on their differentiated capabilities.

**Question: There have been overarching conversations in the past around the NewSpace sector concerning the trend of orbital applications in the space economy seeing more investment than those on the ground, which had led to a certain technological gap between the two. Do you agree such a disparity exists, and how should it be addressed?**
**Christopher Richins:** We do believe that in the NewSpace sector, more attention has been paid to the

sexier parts of the sector such as launch and satellite/sensor manufacturing. This means that ground systems sometimes get thought about later in the process. The reality is that most of the NewSpace businesses are data businesses and getting their data from the satellites to users on the ground is critical.

We are confident that as NewSpace companies prove their new data businesses and technical feasibility, the need to scale significantly in ground infrastructure will follow. RBC Signals is excited to be part of the solution as more data needs to make its way to customers. We are looking to bring our customers innovations in inter-satellite networking, optical communication systems, and phased array technologies to increase data communications.

**Question: Much has been made of the evolving danger of space debris in our time. How important are debris mitigation technologies, and how viable do you see their business cases becoming?**

**Christopher Richins:** As more satellites are launched into low Earth orbit (LEO), space debris mitigation technologies are becoming increasingly important. The first area of investment needs to be in the area of space domain awareness. Ground systems that are helping to provide intelligence about what is in orbit and whether collisions are likely to happen and be mitigated play a critical role. De-orbiting technologies are also critical to keep space a safe operational environment for all. Innovations such as those being developed by Aurora Propulsion Technologies could play a key role in keeping space safe.

**Question: The AuroraSat-1 mission launching in 2021 will involve a demonstration of Aurora Propulsion Technologies' Plasma Brake solution for de-orbiting. Could you explain that to us?**

**Christopher Richins:** Plasma Brake is a module produced by Aurora Propulsion Technologies that slows down the satellite and eventually brings it back to the atmosphere where it burns away without leaving any harmful debris in space around the Earth. Plasma Brake consists of a microtether made of extremely thin metal wire that is deployed. The microtether interacts electrically with the surrounding plasma, causing drag that de-orbits the satellite by slowing it down.

**Question: When can we expect the AuroraSat-1 mission to take place, and how do you foresee your partnerships with Aurora Propulsion Technologies progressing?**

**Christopher Richins:** The current launch is scheduled for June of this year. RBC Signals and Aurora Propulsion Technologies have been working very well together. Aurora Propulsion Technologies has more planned missions in the near future and they will continue to take advantage of RBC Signals global ground station network as it meets their mission requirements.

**Question: As the space economy becomes more crowded and advanced, how can space communications providers in the ground segment ensure they keep up with the pace?**

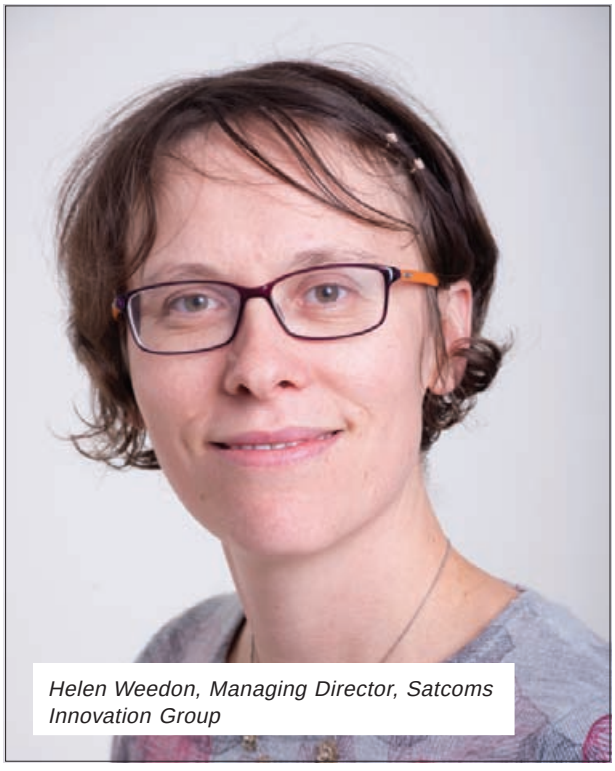
**Christopher Richins:** Space communications providers need to listen to their customers and respond to their needs. Space communication providers also need to be prepared for significant growth in the sector and thus put systems and processes in place that enable them to scale to meet the growing demand in the sector. This will require innovation in making systems more cost-effective, flexible, quickly deployable, secure, and resilient. ■

*RBC Signals install team. Photo courtesy RBC Signals*

# How can AI improve satcoms?

Artificial intelligence has caught the interest of businesses, government, defence, and the general public alike, each group imagining the possible benefits to everyday life and the potential for the future. Satcoms is no exception, with entities throughout the value chain watching closely.

*Helen Weedon, Managing Director, Satcoms Innovation Group*



*Helen Weedon, Managing Director, Satcoms Innovation Group*

**For some time, we have been discussing the** potential of Artificial Intelligence (AI) to revolutionise the satcoms industry, from detecting problems to maximising efficiencies. While it has not yet reached anywhere near its full potential, it does seem as if some progress is being made, both in terms of the technology itself and how that is applied to satcoms. What is the full potential of AI for satcoms and how do we make sure we harness it effectively?

## AI and machine learning

When we talk about AI, we are more often referring to machine learning, essentially teaching a machine to do something by example. Every time your Internet browser asks you to identify which squares have a certain image in them, you are adding to the machine's knowledge. AI can actually apply to a whole range of different techniques. One such example is knowledge engineering. This is about extracting the knowledge of those experts in the field into a set of generic rules and algorithms that can be applied for problem solving, something that is challenging but could be very interesting in the satcoms industry.

The use of AI across a multitude of different sectors has been steadily increasing. It is already being used for a range of applications, from serving customers with personalised ads and content recommendations, to analysing chronic conditions with other medical data for early diagnosis. With each new application, the underlying technology is getting better and better. And all the reports seem to indicate that it is set to rise further over the coming years. According to Statista, the global AI software market will reach US$22.6 billion by 2025, with approximately 54 percent growth year-on-year. Gartner forecasts that 50 percent of enterprises will have devised AI orchestration platforms to operationalize AI by 2025. This is up from fewer than 10 percent in 2025. The same report also states that AI will be the top category driving infrastructure decisions. Gartner also believes that by 2024 the degree of manual effort required for the contract review process will be halved for those companies using advanced contract analytics solutions.

## Why AI makes sense for satcoms

At the same time, the satcoms industry has been growing rapidly over recent years. We have never had more satellite launches than we have had in the last two years with all the LEO launches. New launches and increased ground equipment are all adding complexity to an already challenging environment. As the skies become more crowded, there is an ever-increasing risk of things going wrong. Whether that is satellite interference or large-scale collisions, the consequences will be dire.

Anything we as an industry can do to reduce those risks has got to be worthwhile and AI has the potential to do just that. At the same time, one thing we are not short of in this industry is data, the cornerstone of any AI solution. Coupled with the presence of lots of manual, repeatable processes, it is the perfect recipe for AI to have maximum impact.

However, understanding present risks and even more judging upon and using AI in the right way to apply effective countermeasures is a demanding task. It is not something that can simply be applied quickly and forgotten about. We need to think about probabilities of events which might happen, are detected and might be eventually mitigated. AI cannot take out all remaining risk percentages and will never be able to do so, but it can help the industry to understand that challenge a lot better. The key to have these values calculated well enough to use them lies in the definition of questions, answers, and recurrent acting advice by senior expert engineers, as well as the acceptance of any commercial and environmental risk by the company decision makers. Implementing AI is not a task that engineering or management can decide upon alone. Both groups need to be in full understanding if we are to have AI implemented successfully in our industry.

Erwin Greilinger, Product Line and Sales Manager for Satellite Monitoring Solutions, at Atos, commented: "AI has the potential to be a game changer in the satellite industry, where it could be used to improve processes and increase efficiency. AI could establish a digital assistant, capable of processing information about everyday satellite procedures, resolving and predicting issues before they become errors. On top of this, it could be taught a whole spectrum of things relating to the day-to-day tasks of satellite operations engineers."

### AI development so far

As mentioned above, we are beginning to see innovation for AI applications within the satcoms industry. One area in particular where there has been lots of innovation is that of onboard observation and data processing. This includes from companies such as LatConnect 60, Raytheon Intelligence & Space, CS3, and Northrop Grumman. Building AI tools into the satellites themselves so that they can process data collected in space and alert operators to problems early seems like a leap in the right direction. In LEO, AI and ML are much more prevalent, being used already for orbit prediction by current operators, for example.

There have been several other innovations, from using AI in manufacturing, to predicting the location of satellites and debris and monitoring the health of satellites in orbit. There have also been a number of AI-specific research projects undertaken, such as from the Centre Tecnològic de Telecomunicacions de Catalunya, which has been comparing RF signals for interference detection using Signal Correlation, ML and AI. Having demonstrated automated GSM interference retransmission detection based on I/Q samples, work has been done in projects to identify also other types of interference correlation such as ASI and XPOL, making it possible to have interference detection and analysis done in the background without first human intervention.

SIG member, Integrasys, sees itself as pioneers in AI within the satcoms industry. Its product portfolio drives end-to-end automation, taking previously manual tasks and making them automated. Alvaro Sanchez, CEO, Integrasys, commented: "We have an extended experience in network automation solutions. Our product portfolio covers design and deployment to monitor and maintenance, with no human touch, intuitive interfaces, and high-quality outputs that help to transform space data into tangible operations in ground by an intelligent system." He added that its latest patents focus on AI advanced methodologies for end-to-end automation in the new LEO and MEO world.

Atos is another member that has been extremely active in the development of AI tools and technology. Throughout 2020, Atos carried out extensive research and development looking at how AI could be applied to carrier monitoring and geolocation systems to address a number of issues and improve the efficiency of these systems. Greilinger said: "To combat the rising interference challenge before it becomes completely out of control, new solutions are being developed. While working groups and associations like the Satcoms Innovation Group (SIG) and the Global VSAT Forum (GVF) educate a growing number of members on both proactive and reactive responses, the best cure for satellite interference has been and will continue to be vigilant monitoring by advanced sophisticated interference detection systems, with algorithms that determine the identity of interfering carriers."

The research carried out by Atos has proven that AI can help to address interference. It was able to enable automatic identification of interference situations via spectrum analysis, predict satellite link quality degradation caused by bad weather scenarios, and enable interference detection in complex satellite environments.

### The future AI use cases

As technology continues to improve, the potential use cases in the satellite industry are extensive and far-reaching. I can see a future where AI will feature right through the satellite chain in all orbital regimes, from autonomous operations for satellites, to automated deployment of ground infrastructure, to interference detection, classification, and prevention. It could also have a huge role to play in space situational awareness and collision avoidance.

It is certain that getting there requires a new technology to be taken up by satellite operators – mathematics. After RF as a baseline and IT on top, this will be the third main domain and a revolution in technology for conservative GSO satellite operators. This will be much quicker for new space operators coming to the industry with a fresh perspective.

Satellite engineers will also be critical to the success of AI. Partly that is about tapping into the extensive knowledge of today's engineers. Perhaps more importantly, it is the engineers who will steer the right questions to ask the machine as well as assisting computers stuck in a "can't decide" situation. Ultimately AI will make processes more efficient and error-free, but it needs to be complemented by experts with years of experience. ■

*Photo courtesy Satcoms Innovation Group*

# Gearing up for LEO

With more people than ever working from home in a drastic life-changing year, demand for high-speed, low-latency Internet connectivity has never been higher. LEO satellite constellations promise to provide this connectivity, affordably, across the globe.

*Amy Saunders, Editor, NewSpace International*

**Satellite constellations have been big news for** decades now, providing essential services from GEO, MEO and LEO. The Global Positioning System (GPS) constellation, established in 1993, is one of the oldest and most successful to date; 24 satellites orbiting in six planes 20,180km above the Earth deliver essential geolocation services to this day.

Constellation operator stalwarts such as Iridium and Globalstar have made great successes of their constellations over the years. Both provide essential voice and data communications services globally, with Globalstar making later forays into IoT applications. The two companies have both moved beyond their initial constellations onto newer, refreshed generations as needed, proving to doubters that there is a strong business case for targeted satellite constellations for specific applications.

In recent years, as satellite technology has become increasingly advanced and miniaturised, we've seen a whole host of innovative new constellation proposals, the first of which are being built out as we speak. However, all is not going smoothly for these new enterprises, with financial hurdles appearing more often than we would like.

## OneWeb emerges from Chapter 11 with a bang

One of the better-known planned LEO constellation operators, OneWeb, has released several big news items this year. OneWeb Satellites, a joint venture with Airbus, is shooting for a 648-strong satellite constellation intended to deliver high-speed, low-latency connectivity.

In a unique roller-coaster adventure, OneWeb went from the rising star of the LEO world to near end-of-game in 2020, before finally emerging from US Chapter 11 bankruptcy protection and achievement of all regulatory approvals with new investments of US$1 billion from a consortium of UK Government and Bharti Global. With this news, OneWeb announced 17 December 2020 as its 'Return to Flight,' with launches commencing and production lines brought back into service.

Despite its initial grand plans, January saw OneWeb announced the streamlining of its planned constellation from 47,884 to just 6,372 satellites, meaning that, after accounting for the satellites for which it is already licenced, the complete constellation will be around 7,000 - not the 48,000 we first heard about. Interesting news indeed, coming in the wake of the company's commitment to its new owners; the UK Government and Bharti Global. According to a release, the 'streamlining activities highlight OneWeb's plan for global connectivity services and for future generations and possibilities for the network.' Just a couple of days after, OneWeb announced that it had secured additional funding from Softbank and Hughes, bringing its total funding to US$1.4 billion.

In March, OneWeb confirmed the successful launch of all 36 satellites by Arianespace, bringing its total on-orbit constellation to 146 satellites. This second – of a total of five – launch will enable OneWeb's connectivity solution to reach all regions north of 50 degrees latitude by the middle of the year, with services expected to start by year-end. Said services will include coverage for the UK, Alaska, Northern Europe, Greenland, Iceland, the Arctic Seas and Canada. OneWeb then intends to make global services available in 2022.

"This is the second of our 'Five to 50' launch series and represents a key moment in OneWeb's return," commented Neil Masterson, OneWeb CEO. "The next launch in the series is scheduled for the end of April, as we continue our drive towards commercial service this year. OneWeb is rising to the challenge of our mission to provide connectivity to everyone, everywhere, all the time. Backed by exemplary shareholders, we are connecting the world."

Further cementing its real-world applications, OneWeb recently demonstrated its turnkey satellite-based communications system to the US Department of Defense (DoD) at a live event conducted in front of service representatives from the US Space Command at OneWeb's demonstration facility in Melbourne, Florida. During the event, OneWeb demonstrated, under test conditions, how an initial constellation of 110 LEO satellites and two ground user terminals provided data rates up to 500Mbps at latency levels as low as 32ms. The demonstration also illustrated the seamless

*Photo courtesy of Shutterstock*

handover of connectivity between multiple LEO satellites as they passed overhead. Additional demonstrations were planned for April to illustrate OneWeb's capability to the US Special Operation Command (SOCOM) and US Central Command (CENTCOM).

"This hugely successful demo shows how Government customers including the US DoD can benefit from our innovative solution to support their rapidly evolving needs for low latency, high bandwidth, affordable and reliable global communications, enabled through innovative Internet Broadband coverage," outlined Head of Government Sales at OneWeb, Dylan Browne. "We are going to be a core component in the global communications architecture of Governments, providing defense customers with secure, resilient and resilient voice and data communications anywhere in the World," he added.

From a more holistic perspective, OneWeb continues to rapidly hire new bodies, with more than 200 new employees joining since Autumn 2020 despite the pandemic and near closure. The company is continuing to build its global ground station network and is pushing forward on user terminal development including a US$73 million contract with Intellian to provide compact, affordable user terminals for enterprise and government applications as well as a contract with Satixfy for an inflight terminal to deliver Wi-Fi on aircraft.

### Telesat edges closer to finish line

One of the less well-publicised constellations comes from Canada's Telesat, which announced its intention to launch a LEO constellation back in 2016. The Telesat Lightspeed constellation will consist of 120 Ka-band satellites in polar and inclines orbits of around 1,000km above the Earth, operating in six orbital planes. The planes comply with the Canadian Government's Enhanced Satellite Constellation project, but also provide global coverage.

The plans have evolved in the years since, expanding to 298, 700kg satellites and 50 ground stations across the world in 2017. The constellation is expected to deliver 16-24Tbps of capacity, with 8Tbps dedicated to customers, and with latencies of 30-50ms. Phased array antennas on each satellite are combined with beam hopping technology to activate around 135,000 beams that can dynamically focus multiple Gbps of capacity into demand hot spots like large airports or major seaports. Almost 1,200 high-capacity optical links interconnect the satellites with multiple, highly resilient transport paths, creating a super-fast data superhighway in space. Last year the plan was again expanded to include more than 1,600 satellites. Lightspeed will support data processing in space, including full digital modulation and demodulation on the satellite, which when coupled with an end-to-end network operating system will eliminate gateway hops to enable to enable

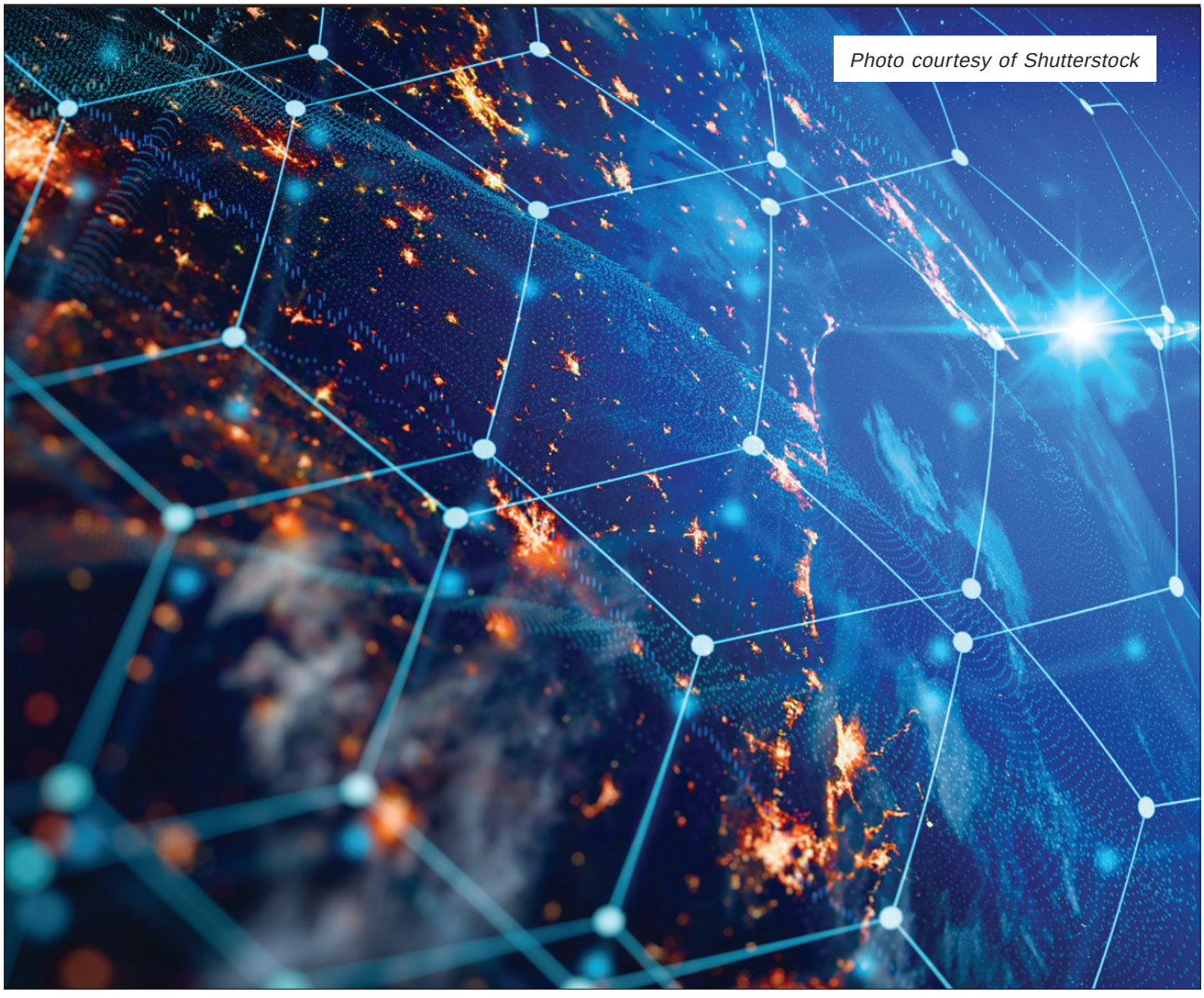


Photo courtesy of Shutterstock

fast, secure, end-to-end data delivery.

Telesat launched its Phase 1 pathfinder test satellite in 2018, allowing customers and manufacturers to test transceiver equipment. Meanwhile, in 2019 Telesat contracted Blue Origin and Relativity Space for future constellation launches. The first Lightspeed satellites are expected to be launched in 2023 according to the latest reports, with commercial services commencing in the second half of 2023.

"The name Lightspeed underscores the essential speed advantages inherent to Telesat's LEO design," said Dan Goldberg, President and CEO of Telesat. "Lightspeed is the most technologically capable satellite communications network in history and exploits the latest advances in space-based data processing, laser communications, digital antenna technology and machine learning."

Recent months have seen Telesat win new funding from the Government of Quebec, which will invest US$400 million into Lightspeed/ In return, Telesat will reportedly invest US$1.6 billion into Quebec both directly and through its supply chain, which will include a significant proportion of Lightspeed's manufacturing and operations and 600 STEM jobs. Telesat has also been gearing up on the ground segment for its new constellation, working with SatixFy for landing stations and user terminals, and CloudOps for the development of Telesat Lightspeed Cloud, which will allow Telesat to deliver flexible services with cloud infrastructure, cloud-native data platforms and systems operations.

### SpaceX connects rural homes in the US

SpaceX has been making headlines for years in the run up to its Starlink constellation, and not just amongst the aerospace community. The general public has become fascinated with all things SpaceX thanks to the showmanship of owner Elon Musk and his other fantastical projects.

SpaceX's Starlink constellation is intended to provide a whole host of services, including high-speed low latency Internet connectivity to help bridge the digital divide. Some of the mass produced 260kg satellites will be sold for military, scientific or exploratory purposes. In 2019, SpaceX submitted filings to the ITU via the FCC in order to arrange spectrum for 30,000 additional Starlink satellites on top of the 12,000 already approved. It has been a busy few years for the company, launching 60 satellites at a time as of 2019, with a goal of reaching 1,584 in orbit by the end of this year.

Interestingly, the Starlink constellation is already coming into use. In December, the Wise County Public School District in rural Virginia announced that it would provide some families in the area – where 40 percent of teachers and pupils do not have Internet access at home - with Starlink connectivity to support remote learning. The Starlink units were deployed in January and more than 40 homes are now connected with high-speed Internet connectivity.

Addressing concerns from the space community around the sudden addition of thousands of new satellites in LEO, March saw NASA and SpaceX sign a special information-sharing agreement to ensure that Starlink satellites do not collide with other objects. The agreement takes the standard Conjunction Assessment (CA) process and allows deeper cooperation between the two entities. It is structured around NASA maintaining its planned trajectory with Starlink satellites set to automatically manoeuvre around NASA objects. In rare instances in which Starlink cannot manoeuvre, then NASA will do what it can to avoid collision. NASA will also provide technical support to Starlink, notably with regards to limiting photometric brightness, which is the reflectivity of a flat or uniform surface.

### The Kuiper Project

Amazon established Kuiper Systems LLC in 2019 to deploy a constellation of 3,236 LEO satellites to deliver broadband satellite Internet connectivity to unserved and underserved communities around the world at an estimated cost of US$10 billion. The satellites will operate in 98 orbital planes in three orbital shells, one each at 590km, 610km and 630km above the Earth.

The Kuiper project has come on in leaps and bounds ever since, although is expected to take up to a decade to fully deploy all of its satellites. In December 2019, it emerged that Amazon had asked the FCC to waive the requirement to have applied by 2016 in order to achieve licensing, which was met with calls of rejection from SpaceX, among others. Kuiper Systems did eventually receive its license, which included a non-interference clause not previously applied to other constellation applicants.

In December, Project Kuiper hit another key milestone when it unveiled a high-level overview of its low-cost flat panel antenna with Ka-band phased array technology. The 30cm antenna operates at 17-30GHz and is expected to support 400Mbps of throughput with a fivefold cost reduction compared with other flat panel antennas.

"If you want to make a difference for unserved and underserved communities, you need to deliver service at a price that makes sense for customers," said Rajeev Badyal, VP of Technology for Project Kuiper at Amazon. "This simple fact inspired one of our key tenets for Kuiper: To invent a light, compact phased array antenna that would allow us to produce an affordable customer terminal. It's incredible to see such a small form factor delivering this type of speed and performance."

The Kuiper Project antennas use tiny antenna element structures overlayed one another – in contrast with being placed adjacent to each other as in other phased array antenna designs – which has never before been accomplished in Ka-band. The result is a smaller, lighter terminal offering higher bandwidth and better performance. The design uses a combination of digital and analogue components to electronically steer Ka-band beams toward satellites passing overhead.

It also emerged that Kuiper Systems will be launch-agnostic, not sticking solely with Amazon's Blue Origin launch capabilities. A smart move considering the sheer magnitude of launches required to orbit such a constellation.

### Facebook – In or out?

There's been a lot of jumbled mis information doing the rounds on Facebook's plans for space in recent years, thanks in part to the company's cloak and dagger style of approaching satellite technologies.

The experimental Athena satellite was filed with the Federal Communications Commission (FCC) in 2018 under a company called PointView Tech LLC, formed in 2017 and which does not seem to have any notable

online presence. It was eventually traced back to Facebook, however.

At 150kg, Athena weighs in at approximately the same as other constellation satellites but uses high-frequency millimetre-wave radio signals that promise faster data rates. PointView Tech estimates that its E-band system will deliver up to 10Gbps down and 30Gbps up, providing fixed and mobile broadband access in unserved and underserved areas, according to the FCC application. Part of Athena's two-year mission is to test the technical barriers of using E-band in orbit – these high frequency millimetre waves are prone to absorption from air or water particles. Three ground stations – a teleport near Venture, California, the Mount Wilson Observatory near Los Angeles, and a business park in Northridge, California – were specified in the application.

In September 2020, Facebook confirmed that it now operates an experimental satellite, which rode to orbit in a rideshare mission courtesy of Arianespace. The entity has stressed that it is not planning to become a provider of satellite connectivity or to launch constellation but has not provided any more information. Facebook has previously stated its belief in satellite technology to enable the next generation of broadband infrastructure to help bridge the digital divide.

For now, it looks like Facebook or PointView Tech will remain out of the constellation business, but as we all know, all things change with time.

## A done deal?

The way many of these would-be constellation operators have been talking, you would assume that the upcoming influx of small satellites delivering high-speed connectivity across the globe was a done deal. But that's not strictly speaking true. Significant concerns have been raised about this new wave of satellite mega-constellations, most of which are caused by the sheer volume of new satellites in the works:

- Astronomy: With tens of thousands new manmade objects in the night sky, terrestrial astronomers, including ground-based detection of atmospheric chemistry, would be hindered.
- Orbital debris: The addition of so many new satellites into MEO and LEO comes with increased opportunity for collision, particularly since most small satellites do not have a great deal (if any) of on-board propulsion technology. Moreover, most satellites in MEO and LEO have no or ineffective end-of-life plans, with many being left to decay into lower orbits. In contrast, the majority of GEO satellites are moved safely into an outer graveyard orbit so that they do not interfere with other satellites or contribute to problematic debris.
- Shielding effect: Satellites in lower orbits travel between geostationary orbit and Earth, creating a shielding effect whereby signals between GEO and Earth may be disrupted. This has not been a challenge with the still relatively small number of satellites in MEO and LEO, but in the years to come, this may change.
- Ethics: Is it even ethical for a very small number of companies to change the night sky's appearance so drastically?

Action groups, collaborations and general protesters are working tirelessly to gain better transparency and visibility of all the impacts of these constellations, should they come into existence.

Despite the concerns, the need for high-speed, low-latency Internet connectivity have never been clearer than it is today, and it is this demand that is being targeted by all the new and planned satellite constellations. While GEO satellites have proven their worth time and time again, the lower latency and higher user speeds being promised by LEO constellations renders them better suited for mobile connectivity. With millions of people forced into working from home with no warning at the start of 2020, broadband Internet access has gone well and truly from a 'nice-to-have' to a 'must-have' for people across the globe. For those of us with already acceptable home Internet speeds, the change was tough but manageable, but for those without accessible broadband or the means to acquire it due to location or price, life became very difficult indeed.

With the global need for broadband Internet access well-established and stronger than ever before, the price point is a tricky matter. Is it really possible for such a service to be delivered, from space, at comparable prices to fibre or other terrestrial sources, while also allowing for adequate profit for the operators? This is a sticking point for many, particularly given the recent failings of some planned constellations on financial grounds.

Naturally, the current market players need to remain wary of becoming another LeoSat; the Luxembourg-based company planned to launch 78-108 satellites into 1,400km orbit and actively worked towards that goal over 2013-2018. Despite promised investments from Hispasat and SKY Perfect JSAT, LeoSat ceased operations in November 2019 due to insufficient capital investment, and of course failed to meet its ITU January 2021 deadline for launching the first of its satellites. OneWeb, too, has survived by the skin of its teeth only thanks to a buyout, and with a much pared-down constellation plan to boot.

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# ADVERTISERS' INDEX

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