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SATELLITE EVOLUTION

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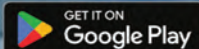
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Enabling a brighter future

Once solely the domain of educational institutions and government agencies conducting experiments or demonstrating the viability of some new technology, small spacecraft (SmallSats) are now dominating Low Earth Orbit (LEO) by the thousands, delivering all sorts of applications that are improving our lives on Earth. While in 2012, an estimated six percent of all SmallSats were operated by commercial businesses, 99 percent of SmallSats deployed a decade later were commercial missions. Of course, 80 percent of those were Starlink satellites, but you get the point.

According to data compiled by Kongsberg NanoAvionics, today the five most common primary satellite missions include: communications, Earth Observation (EO), technology development, space science, and navigation. Except for navigation, these missions are increasingly performed by SmallSats. For example, 80 percent of communications satellites and 79 percent of technology development satellites have launch masses below 300 kg. Indeed, nearly 72 percent of active satellites fall into the SmallSat category. Here is the breakdown: Super-Microsatellites (2379); Microsatellites (331); and Nanosatellites—of which CubeSats are a subset (790).

We've seen how SmallSats are changing the way wars are being fought and how those attacked are managing to survive. SmallSats are being utilized to track climate changes and help victims of weather-related disasters. They are enabling better practices for farmers and those drilling for oil and minerals. They also are helping to revolutionize global communications and bridge the digital divide.

NASA uses CubeSats to show how novel technological advancements will work in the space environment. In 2018, the space agency had its first dedicated CubeSat launch which included ten Educational Launch of Nanosatellites (ELaNa)-19 payloads. Experiments ranged from measuring high energy particles in Earth's radiation belt to the implementation of navigation plans for exo-planet exploration. A number of experimental CubeSats were deployed from Artemis 1. Not all worked as planned, but among those functioning today are the BioSentinel which carries a cargo of specially engineered yeast that will be used to measure cellular damage from radiation to help us understand how to protect astronauts in deep space. Also, operational thus far are Lunar IceCube and LunaHMap both of which will look for lunar water ice.

Whether we are trying to solve problems on Earth or support activities in space, SmallSats are key. They are far more affordable, can be created within a two-year timeframe, and can now support applications that used to require satellites that cost more than US\$100 million and took nearly a decade to design and manufacture. In one of the darkest times of US History, President Abraham Lincoln wrote, "The best way to predict the future is to create it." That, I believe, is what our industry is doing.

In this issue of Satellite Evolution Global, we interview Paul Kostek, advisory systems engineer with Air Direct Solutions LLC to get his opinion on whether the UK is still on track to become Europe's leading space nation. We also talk with Jonny Spendlove, Senior Product Manager of Connectivity at John Deere to find out how satellite communications can enable dramatic improvements in efficiency for farmers worldwide. John Yates, CEO for Atheras Analytics delves into the opportunities and challenges facing space start up companies and Oko Davaasuren, Senior Director at Techstars explains how his company is advancing Saudi Arabia's space infrastructure and economy. Finally, Joakim Espeland, CEO of QuadSAT shares his thoughts about whether the industry is ready to deal with the potential for RF interference as a result of mega constellations in LEO.



Crispin Littlehales, Executive Editor ●●●



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OneWeb Technologies demonstrates seamless multi-orbit integration of advanced technologies

NORTH AMERICA: OneWeb Technologies has announced the successful conclusion of a series of demonstrations during the US Marine Corps' 1st Air Naval Gunfire Liaison Company (ANGLICO) "Exercise Red Flag." The demonstrations showcased the seamless integration of a combined multi-orbit, low earth orbit (LEO) and geostationary (GEO) solution to deliver high-bandwidth, reliable communications in denied and degraded environments.

Exercise Red Flag showcased 1st ANGLICO's ability to support Large Force Employment training across the full spectrum of conflict, including air superiority, precision engagement, close air support, command and control, intelligence coordination, and personnel recovery.

The demonstration consisted of OneWeb Technologies' global, low-latency LEO communications network, Kymeta Corporation's LEO terminal for low-latency and high-bandwidth connectivity, along with

Viasat's high-capacity, and multi-band, multi-mission terminal (MMT) connecting to the Viasat geosynchronous (GEO) Global Network (VGNet). The solution utilized Viasat's NetAgility™ SD-WAN router to connect the LEO and GEO networks together.

A key part of this training was demonstrating the ability to interoperate with other systems, and multiple orbital planes. The combined OneWeb Technologies, Viasat and Kymeta solution showcased multi-orbit capability and connectivity is possible between solution providers, which is an important component of the 1st ANGLICO's automated primary, alternate, contingency, and emergency (PACE) plan. The PACE plan supports the maneuvering warfighting function's (WFF) mission command requirement to maintain communications, seamlessly by transitioning connectivity across multiple networks.

"Connectivity in a denied and degraded communications environment is an essential safety requirement, and I am proud of OneWeb Technologies' ability to support the 1st ANGLICO at Exercise Red Flag. We are looking forward to future opportunities to enable Marine Corps operations with advanced satellite communications (SATCOM) solutions," said Kevin Steen, CEO of OneWeb Technologies. "Our collaboration with Kymeta and Viasat highlights our commitment to leveraging cutting-edge technologies and strategic partnerships to offer our government customers the mission-critical connectivity solutions they require."

The trial followed OneWeb Technologies' participation



Photo courtesy sdecoret/Shutterstock ●●●

in a similar successful demonstration, known as "Exercise Northern Edge," held at the Joint Pacific-Alaska Range Complex (JPARC) in Alaska.

"Viasat is pleased to collaborate with partners like OneWeb Technologies and Kymeta to demonstrate multi-network mission capabilities with the optionality and increased resilience required to operate in contested environments," said Craig Miller, President of Viasat Government Systems. "Our advanced network orchestration technology is a critical component, enabling assured connectivity and a seamless user experience across a multi-orbit, multi-network SATCOM solution that offers the operational flexibility warfighters need."

"Kymeta has been steadily working on ruggedized and hardened communications on the pause and move tactical systems. The combination of our terminals and OneWeb's low latency, high data rate, and satellite communications available through OneWeb Technologies will provide warfighters with the tactical edge they need today," said Walter Berger, President and Co-CEO of Kymeta.

OneWeb Technologies continues to advance its SATCOM capabilities and is committed to supporting military and government organizations in achieving their communication objectives on the modern battlefield. ●

Blue Origin awarded NASA partnership to turn lunar regolith into solar-power systems on the Moon

NORTH AMERICA: NASA has awarded Blue Origin a US\$35 million Tipping Point partnership to continue advancing its innovative Blue Alchemist breakthrough revealed earlier this year.

Blue Alchemist is a proposed end-to-end, scalable,

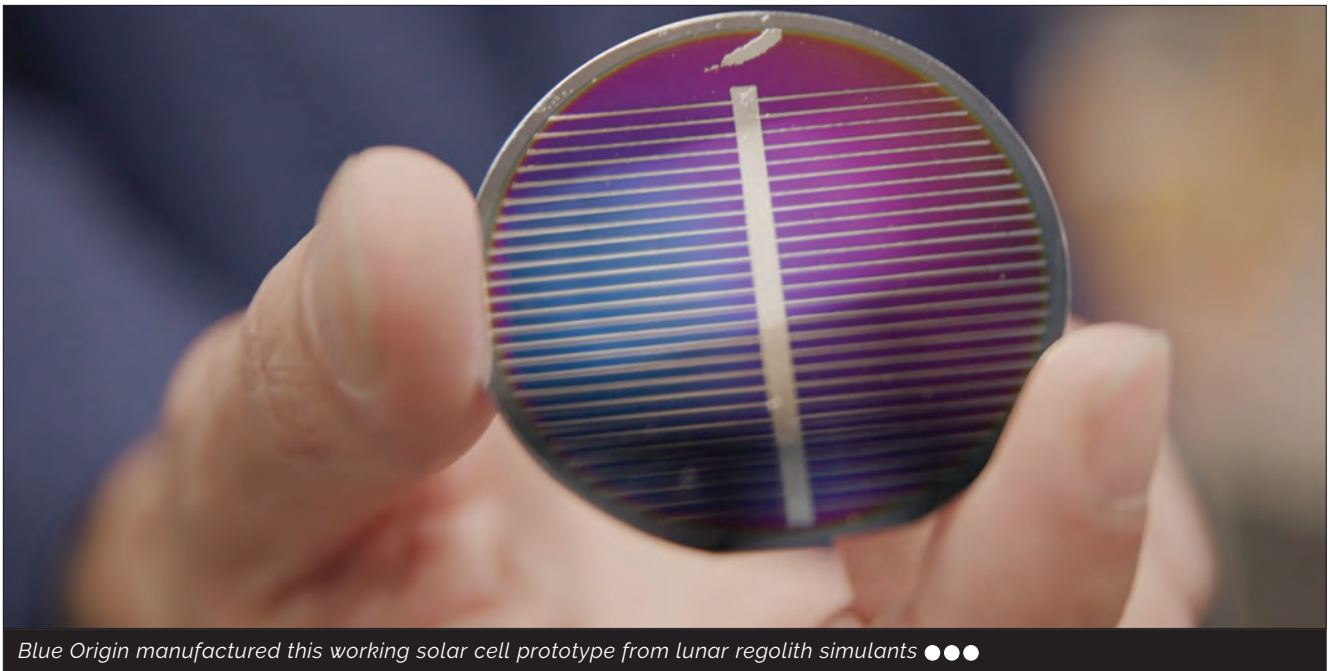
autonomous, and commercial solution that produces solar cells from lunar regolith, which is the dust and crushed rock abundant on the surface of the Moon. Based on a process called molten regolith electrolysis, the breakthrough would bootstrap unlimited electricity and power transmission cables anywhere on the surface of the Moon. This process also produces oxygen as a useful by product for propulsion and life support.

According to NASA, a technology like Blue Alchemist is considered at a Tipping Point if the agency's investment can help grow the innovation into a viable commercial solution. Today's investment will result in a demonstration of autonomous operation in a simulated lunar environment by 2026.

"Harnessing the vast resources in space to benefit Earth is part of our mission, and we're inspired and humbled to receive this investment from NASA to advance our innovation," said Pat Remias, vice president, Capabilities Directorate of Space Systems Development. "First we return humans to the Moon, then we start to 'live off the land.'" ●

BlackSky releases imagery of near-complete Chinese military naval station in Cambodia

SOUTHEAST ASIA: BlackSky Technology has released a ten-image collection captured over Ream, Cambodia, showing the rapid pace of development of a large Chinese military naval station from August 2021 until July 2023. The high-resolution, electro-optical images are part of a collection of more than 520 images captured from October 2019 until now and contains time-diverse imagery taken as early as 8 a.m., and as late as 7:58 p.m., Indochina Time.



Blue Origin manufactured this working solar cell prototype from lunar regolith simulants ●●●

"BlackSky's unique ability to capture and quickly deliver large volumes of dawn-to-dusk, time-diverse imagery increases transparency into strategic military and economic activities that otherwise would have gone unnoticed," said Brian E. O'Toole, BlackSky CEO. "Our commercial high-frequency monitoring satellite constellation and AI-driven tasking and analytics platform gives our customers the on-demand ability to observe critical change over time."

"The speed of development at the Ream base makes it difficult to deny the intentional velocity behind China's overseas basing initiatives," said Craig Singleton, China Program deputy director and senior fellow at the Foundation for Defense of Democracies. "Cambodia's receptivity to hosting China's second overseas naval port increases Beijing's strategic ability to project military power into the Indian Ocean."

"There is a near-exact similarity between an angled deep-water pier located on the western shore of the Ream base and another military pier at the People's Liberation Army Support Base in Djibouti. Both main piers are 363 meters long and large enough to support any ship in

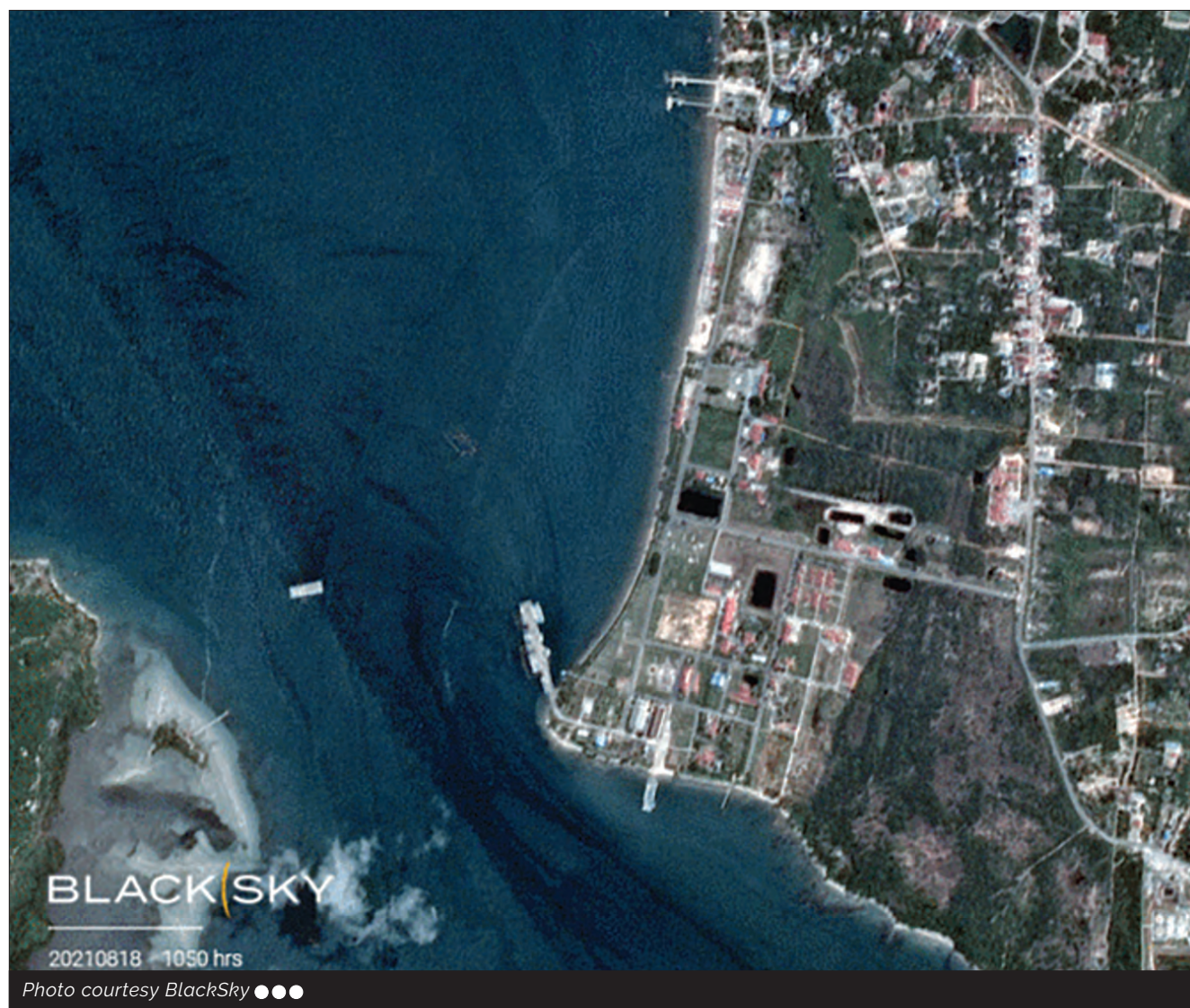
China's naval arsenal, including the new 300-meter-long Type 003 Fujian aircraft carrier," Singleton said.

Third-party analysts have also observed the development of a thirty-eight thousand square meter artificial peninsula on the southern shore of the base and many architecturally distinct Cambodian and Chinese military buildings, including an alleged headquarters facility, barracks and fuel storage areas.

BlackSky's high-resolution constellation can capture imagery on an hourly basis up to 15 times per day. This unique ability to gather images from dawn until dusk is possible because BlackSky's constellation flies predominantly in inclined orbits, horizontally oriented around the equator.

Traditional satellite imagery providers are limited to capturing images between 10 a.m. and 2 p.m. because they fly in sun synchronous polar orbits.

BlackSky delivers thousands of images and analytics every month to organizations worldwide, delivering transparency and insights into border crossings, nuclear and port facilities, and other economically critical infrastructure at scale. ●



Rivada Space Networks joins MEF industry association

NORTH AMERICA: Rivada Space Networks has joined MEF, a global telecommunications industry association of network, cloud, security and technology providers working together to accelerate enterprise digital transformation. The organization and its members drive networking standards and certifications that ensure service quality and empower enterprises to leverage digital transformation and grow their business.

The communications landscape is evolving rapidly with the increasing convergence of terrestrial and satellite networks and the expectation of interoperability, whether connecting on land, sea or air. Next-generation low earth orbit (LEO) satellite systems are critical for the future expansion of enterprise connectivity, and Rivada will enable enterprises to dynamically scale their networks and tap into the \$80 billion Carrier Ethernet market.

Rivada is launching a global low-latency point-to-point connectivity network of LEO satellites: the "OuterNET." This unique next-generation architecture combines inter-satellite laser links with advanced onboard data routers to create an optical mesh network in space. This approach to "orbital networking," where data stays in space from origin to destination, creates an ultra-secure satellite network with pole-to-pole reach, offering end-to-end latencies similar to or better than terrestrial fiber.

"Membership in MEF offers an opportunity to engage in business-driven collaboration with leading global organizations. Together, we enable dynamic, trusted, and certified services that empower enterprises to embrace



their own digital transformation and grow their business. We welcome Rivada Space Network as the newest addition to our growing, vibrant community of MEF members who are working to progress our MEF 3.0 Global Services Framework," said Nan Chen, President, MEF.

Konrad Nieradka, Rivada Space Networks VP Products & Services, said: "The MEF standards and certification process are already a well-recognized 'stamp of quality' in the telecoms industry. With the continued convergence of terrestrial and satellite networking, we are delighted to join this prestigious organization to ensure this standard is applied to our next-generation satellite architecture and seamlessly integrated into our customers networking operations."

Declan Ganley, Rivada Space Networks CEO, said: "We are moving full speed ahead to deploy the first true OuterNET, with its unique data-connectivity capabilities. By empowering our customers and partners to offer ubiquitous, ultra-secure, low latency communications that are standards-compliant with existing terrestrial infrastructure, we are accelerating enterprise connectivity on a truly global basis."

NPL and UK Science & Technology Facilities Council partner on new test facility for small satellites

UNITED KINGDOM: Scientists and engineers at the National Physical Laboratory (NPL) are working with colleagues at the Science and Technology Facilities Council's (STFC) RAL Space to deliver a small satellite calibration facility.

The new facility is being designed, manufactured and tested at NPL's Teddington site in south-west London and will be located at Harwell Campus. It will draw on expertise from NPL's STAR-cc-OGSE facility, which provides innovative solutions for calibrating scientific instruments on satellites before their launch into space.

It will provide a state-of-the-art solution to instrument calibration and characterisation, ensuring the required performance for both full satellite payloads and components is achieved.

The facility is intended for use by small satellite providers at short notice to perform essential pre-flight calibration and characterisation tasks for individual satellites.

This will ensure the end-to-end performance of a satellite instrument is understood before it is launched,

which is a critical task for any space mission. By checking that all on-board instruments are correctly calibrated before launch, the new facility ensures that the satellite will collect reliable, accurate and trusted earth observation (EO) information that can be used by governments to make informed decisions on policies relating to climate change and emission reduction.

The new facility forms part of the UK Government's Department for Science, Innovation and Technology's £200M 'Earth Observation Investment Package' that was launched last year to drive innovation in the UK EO sector. It will build on NPL's and RAL Space's existing programmes that support the UK's thriving EO sector, with a particular focus on how EO technology and data can help solve global challenges such as climate change. These programmes also aim to create attractive opportunities to encourage individuals to develop their skills and build their careers here, and explore exciting new international collaborations. The facility will support the government's aim for the UK to become the global home for trusted climate and earth information services.

Will the launch of mega constellations cause satellite interference?

Satellite interference has long been front of many operators' minds. Over the past few years, we've seen tools launching to prevent, detect, and resolve interference that have made a big impact. Operators also have developed better processes for dealing with interference including everything from improving staff training, to ensuring antenna types are approved to meet minimum performance requirements. We've also seen much closer collaboration between operators to make the process of resolving interference much quicker and smoother than it has ever been.

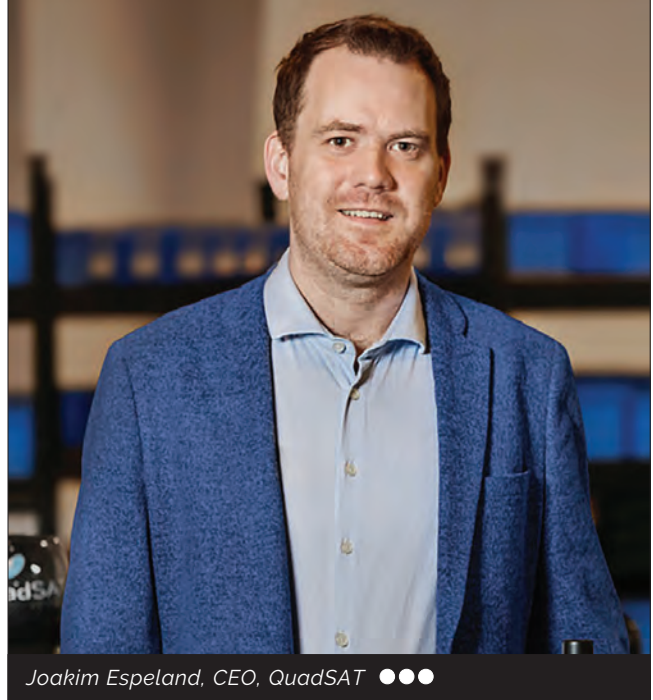
Joakim Espeland, CEO, QuadSAT

With the launch of mega constellations in LEO, RF interference (RFI) is again becoming a major technical risk. Scalable rollout of ground segments designed to accommodate this new generation of technology has yet to be seen, and this is significantly increasing the risk of RFI. Is the industry able to optimize or innovate quickly enough to accommodate the rapid deployment of satellites in order to avoid harmful interference in space?

TECHNICAL CHALLENGES OF LEO SATELLITES

RFI is indeed nothing new and all satellites are at risk from it. What is different now with the launch of mega constellations in LEO, is the non-geosynchronous nature of these satellites. To deliver a seamless service, these satellites are required to continuously switch from one teleport to the next. Ground segments need to be able to track these satellites as they transit across the field of view, as well as carrying out smooth handover processes as satellites switch teleports. All of this makes for a much greater chance of error than is seen with geostationary satellites. From experience, we know that adding dynamism to the mix increases the risk of RFI. We have seen this with Comms-On-The-Move (COTM) networks which have historically been the largest contributors to unintentional harmful interference among satellite operators, precisely because the user terminal is dynamic.

The ground segment needed to support these constellations is much more complex than has been required in the past, because of the need to track and



switch through multiple gateways. It is imperative that all parts of the network are functioning accurately. If an antenna makes even a small error as it carries out this process, it can have significant implications not just for the user, but also other users in the same environment.

As consumer demand for connectivity grows, it is becoming increasingly apparent that LEO networks, with their compact user terminals, have the potential to deliver low-latency, fast and reliable connectivity to users in static and on the move locations, often where networks cannot serve as well. So, it follows on from there that if COTM user terminals are sending and receiving signals to and from LEO satellites, the resulting system is mechanically dynamic through and through. All communications, both up and down, will be dynamic as there are both moving user terminals and satellites.

Another issue distinct to the mega constellations is density. In general, the ground segment has been developed for much smaller scale constellations than are now coming into existence. These constellations are called 'mega' for a reason. They are made of hundreds, or in the case of SpaceX, thousands of satellites and this high volume of satellites all in the same orbit only serves to magnify the risk of RFI.

Alongside dynamic networks, complex ground systems and high density of constellations, another complicating factor with LEO mega constellations is frequency. With the use of smaller dishes as are often used with these networks, Ku and Ka-bands are preferable because they offer greater throughput. However, when using these bands, along with greater throughput, greater directivity means the margin for error is smaller, which of course increases the risk of interference.

IMPORTANCE OF STANDARDIZATION

Even a seemingly small performance related issue or minor equipment error has the potential to cause interference, and that can have a big impact on service provision and continuity. Ensuring that equipment meets the operator's quality and performance requirements is critical for the efficient and effective operation of satellite networks. These requirements may well differ from one operator to the next so it can be difficult for equipment manufacturers

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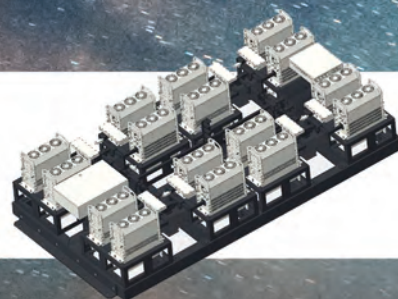
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Another issue distinct to the mega constellations is density. Photo courtesy Shutterstock ●●●

to ensure that their products meet the needs of operators. To resolve the issue, SOMAP (Satellite Operator's Minimum Antenna Performance) invested a lot of time and energy in getting multiple competing operators to all work together to agree on a set of standards that were acceptable to all. It required a lot of coordination, not to mention determination, and really was an impressive achievement.

It matters because SOMAP approved equipment gives operators peace of mind that equipment meets the minimum standards for quality and performance needed to minimise the risk of RFI and any ensuing service disruption. To test equipment against the standards, there are dedicated test facilities for user terminals as well as case by case procedures developed by satellite operators on how to test over a satellite. However, some limitations apply, such as which frequencies can be tested, and tracking performance.

While industry standards exist for parabolic antennas, that isn't the case for all antenna types. We're now seeing the same issue play out again, as new antenna equipment emerges, for which there are no agreed performance standards in place. This is certainly the case for flat panel antennas (FPAs) which, because of their technological capabilities, are fast becoming the antenna of choice for LEO constellations.

This lack of standardisation around FPA performance requirements is creating real problems for the industry. Not only do operators struggle to optimize networks, which leads to inefficiency and poor service for users, but inferior or incompatible equipment also increases the risk of interference. To address this issue, key industry stakeholders need to work together to develop a suitable set of standards that FPA manufacturers can adhere to, so that operators have that same piece of mind that they currently have when using parabolic antennas. However, achieving the required level of cooperation between operators to establish a new common set of standards is easier said than done.

ROLE OF TESTING

The testing process begins at the point when equipment is validated as operating to industry standards. The Global VSAT Forum (merged with GSOA in May) established itself as an expert in the field of testing, and operates a quality assurance scheme. Its antenna type approval program provides manufacturers and operators with reassurance that equipment conforms to performance standards.

That said, using equipment that meets the required quality standards is just the beginning of the testing process. Operators also need to carry out rigorous testing before equipment is put in to use. Additionally, there is a need to implement regular ongoing testing and calibration to ensure that equipment is consistently operating accurately.

Over recent years, testing capabilities have become ever more sophisticated, with new technologies that allow for testing to be carried out effectively in-situ. Despite this, the complexity of the ground segment needed to manage LEO constellations makes the testing and calibration of its equipment significantly more challenging than is seen with traditional ground segments used for GEO networks.

Testing methods for LEO networks require testing of the antenna's ability to accurately track the satellites and handover effectively. The sheer size of the LEO constellations only adds to the complexity of testing, because the individual components of the mega constellation must be operating effectively, and at the same time. Each part must be working in harmony with all other parts of the network.

THE BOTTOM LINE

It's clear to see why the launch of mega constellations in LEO has the potential to increase the risk of RF interference. To mitigate this risk, the satellite industry needs a multi-pronged response. It needs to work collaboratively to develop standards for all kinds of antennas so that they are manufactured to minimum performance requirements. Also needed is further innovation and development to existing ground segments to ensure that they can support mega constellations now and in the future. Underpinning all of this is ongoing effective testing and measurement of ground segments to ensure that the likelihood of complex ground segment equipment malfunctioning is reduced as far as possible. ●



Photo courtesy QuadSAT ●●●

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● ● Paul Kostek, IEEE senior member and advisory systems engineer with Air Direct Solutions LLC

Satellite Evolution Global

Q&A

Is the UK still on track to become Europe's leading space nation? ● ●

In 2021, the UK's National Space Strategy was being touted as the catalyst that would enable "Galactic Britain". Key to the plan were the country's evolving launch capabilities. Indeed, the launch of Virgin Orbit's LauncherOne was heralded by the government as a key step in growing the country's space industry. In the wake of LauncherOne's failure to reach space and the subsequent shut down of Virgin Orbit, many are wondering, "what's next"? We spoke with Paul Kostek, IEEE senior member and advisory systems engineer with Air Direct Solutions LLC to get his opinion on what the future holds.

Crispin Littlehales, Executive Editor, Satellite Evolution Group

Question: In April, after the failure of the Virgin Orbit launch, the UK Space Agency announced it would launch a £20 million fund to support NewSpace capabilities through both national investment and the strengthening of international industrial partnerships. Where will that money likely be spent?

Paul Kostek: Although £20 million might be able to sustain a spaceport, I'm not sure that amount can fuel expansion unless it is used to invest in some successful startups that will use the facilities.

A big challenge with any of the UK spaceports that are being created is to figure out how you are going to invest in the future – especially if you've only got one initial kick off customer that fails. Some of the funding



Photo courtesy Virgin Orbit ● ● ●

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will probably have to be used just to keep the infrastructure that's been put together in Cornwall in place.

A million pounds or dollars won't go very far in terms of building infrastructure. It's more a matter of how many companies are going to commit to using Space Cornwall. I know that US based space company, Sierra Nevada Corporation, recently signed a memorandum of understanding with Cornwall to explore future collaboration opportunities for landing its Dream Chaser spaceplane but I'm not sure how soon Sierra will be flying.

Another restriction that could hinder progress for the spaceport is the limited number of launches allowed each year. How can they be competitive with companies like SpaceX or Rocket Lab which are talking about launching every three days? You might attract the small companies and universities that want to send up small satellites for research but you're not going to attract a huge commercial business because they are looking for more launches. Then, too, there is the whole question of vertical launches versus just horizontal lift off. Not offering vertical capability is going to be a limitation.

Question: The UK's seven proposed spaceports have been said to all be operational by 2024. What kind of investments are needed to assure that? What does a successful spaceport need to thrive?

Paul Kostek: Building seven spaceports and having them all in place by next year might be possible if you take hangars and convert them to be used in payload assembly, and then command and control of the launch. But when you start thinking about spaceports, and what companies are doing around the world, it's all about vertical launch and not launching and landing spaceplanes.



Photo courtesy Gorodenkoff/Shutterstock ●●●

There are lots of discussions of how many spaceports and rocket capacity is needed right now since there is a lot of demand because of all the LEO constellations that are planned. But once everything is in orbit there won't be the massive launches that we are seeing right now. So, the question is, how are seven spaceports going to survive? Will there be enough ongoing activity to make that financially worthwhile?

For European companies that want to put satellites into low Earth orbit, there is an advantage to launching from the UK as opposed to French Guiana, or New Zealand, or the US. You don't have to send your rocket or your payload on an airplane or a ship to the South Atlantic to get it launched. Still, is it prudent to create seven spaceports when your kick-off spaceport doesn't have a second customer yet? If the next customer at space Cornwall is Sierra space, will they only be using the facility to land? There are still questions that need to be answered.

We are going to see mergers and acquisitions in the space industry just as we have in the aerospace industry both in the US and the UK. How many airlines have been created, flown for a while then either merged or sold off their assets? We are in the same boat and that is the danger for a government that is creating a whole group of spaceports. They may end up with some pretty buildings and signs but never get the market they expect.

Question: The Virgin Orbit launch failure at Cornwall was a setback for the nation's space strategy. How does the UK space sector make up for this?

Paul Kostek: The sudden failure of Virgin Orbit changed what people perceived was going to happen. I think that initially the government will have to determine what kind of projects are needed for these spaceports to be viable. Perhaps the government will decide to use the facilities for military and defense purposes. Whatever the case may be, finding the clients who want to use the spaceports will be essential for survival.

There will be some situations where the ESA site in French Guiana or the Esrange Space Centre in Arctic Sweden won't be ideal, and the UK needs to position itself to be the alternative. It might be more difficult for space Cornwall considering that every company that had a payload on the Virgin Orbit flight might be hesitant to do another airplane launch.

Question: A huge issue with NewSpace industry worldwide, and uniquely in the UK, is its associated skills gap. The UK doesn't have enough academics and engineers to support the growth in space technology because we abandoned our world class space program in the 80s. How do we get it back?

Paul Kostek: I recently read a book entitled *When the Heavens Went on Sale*. One of the people mentioned by the author is Peter Beck, founder of Rocket Lab. He started off as a tool-and-die-maker apprentice at Fisher & Paykel company. He's not an engineer and he didn't go to university, yet he taught himself about rockets and propellants.

Because of the nature of the way the world is going with rocketry, there is no rule that says the founder of a



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company must be an engineer. Look at Elon Musk. He has degrees in economics and physics. It's about having the ability to come up with a concept that you can sell to venture capitalists or the government or whomever might be supporting it. I think a lot of these stories need to be told so that people understand you don't have to have a PhD in aeronautical engineering to start a space company or even build a rocket.

There are also people who might have backgrounds in related areas, like automobile design, and now they want to transition to building space vehicles. It's not that different. What's more, a lot of young people are coming out of engineering schools, and they want to work in the space sector.

I don't see talent as the biggest concern because I believe that young people are excited by what's going on in space and want to work for NewSpace startups.

I think the business side of things will be challenging. There is a lot of competition. There are many nations that are developing launch capabilities and payloads with ambitions to go to the moon and to Mars. The challenge for the spaceports is understanding who their customers are and what offerings are most important to them.

Question: Reusable rocket tests are projected to begin in 2024 at Estrange, the new EU spaceport in Sweden. What can the UK's national space sector learn from Europe about supporting the space industry?

Paul Kostek: SpaceX, Rocket Lab, and Blue Origin are all demonstrating how reuse saves money and time. This interest in reusing rockets is only going to grow and perhaps it is an area that space Cornwall should consider. Even if they don't develop vertical launch capabilities, the spaceport could be a landing spot for rockets that have done a vertical lift elsewhere. That idea would work well

with the spaceport's commitment to being environmentally responsible in that they would be supporting reuse of rockets.

The UK government needs to decide how much it wants to spend on building its own rockets or helping to fund companies that are willing and interested and moving forward to compete with what's going on in Europe, the US, and other parts of the world. There are the politics of funding things and the need to justify decisions. These government projects do create jobs and opportunities. The hope is that some of those people who work on government projects will then go and create their own businesses, thereby growing the customer base for the spaceports.

Question: What are your expectations for the UK space industry by 2030?

Paul Kostek: I doubt there will be that much winged flight by 2030 – but Stratolaunch, the company that recently purchased Virgin Orbit's Cosmic Girl plans to use that spaceplane in hypersonic test missions. Additionally, at some point one of the spaceports might be dedicated to tourism. If Virgin Galactic continues to succeed, I wouldn't be surprised if Sir Richard Branson decided to bring that business to the UK. The other area that could be fruitful is on the defense side. The US Space Force, for example, has two X-37B reusable robotic spacecraft. They launch off a rocket but land like an airplane.

The UK government might also invest more heavily in a manned space program, given the country's strong aeronautical history. I expect the UK would want to have a role in future space stations and be part of developing a presence on the Moon. I can see the UK partnering with the US, Canada, and Japan on these kinds of missions. They would be a good fit. ●



Photo courtesy Andrey Suslov/Shutterstock ●●●

Navigating the satellite industry: Opportunities and challenges for startups ●●

Unlike so many other industries, the satellite industry appears to have been reasonably resilient to COVID. The sector is as commercially buoyant today as it has ever been. There's also an increased awareness of the applications of satellite technologies and this has led to the establishment of many national and international funding programs. Additionally, investors are recognizing the potential for a high return on investment. This is all good news for the industry, and for startups.

John Yates, Chief Executive Officer, Atheras Analytics

It's an exciting time to be part of the satellite industry. Increased demand for connectivity and satellite-based services is driving phenomenal growth in the market and creating opportunities across the sector. Technological advancements have lessened many of the financial and operational barriers to manufacturing, launching, and operating satellites, and this is helping to pave the way for new entrants.

There are of course many challenges inherent with starting up a business, and these exist whatever industry you're in. The long hours, the setbacks, and walking the financial tightrope are a few of the obvious ones. However, satellite and technology startups face some unique challenges that new companies in other fields may not

encounter as often. It can take ages to develop your technology and then just as long to commercialize it, so you need to keep stakeholders engaged over a long period. Research, development, prototyping, testing, and certification if required, all take a huge amount of time and capital, and obtaining funding and securing investors at this level can be challenge.

IT ALL STARTS WITH A GREAT IDEA THAT MEETS A NEED

A great idea is the foundation of a successful startup. The seed of an idea may come from your own experience and industry knowledge; or from market or other research that helps to identify niche opportunities; or, to put it another way, problems waiting for solutions.

My own journey started around nine years ago when I was the UK Delegate to the European Space Agency (ESA) with responsibility for satcoms. While in that role, I received a request for ESA ARTES funding from Dr. Spiros Ventouras, a satcom engineer with RAL Space. He anticipated the future need for predicting link outages at high frequency bands—Ka-band, and Q/V-band, which are especially sensitive to weather and rain attenuation—to support Smart Gateway Diversity techniques and to maintain high quality of service levels. I immediately recognized the commercial potential and authorized the funding request which became the successful ESA ASALASCA ARTES program.

Fast-forward to 2020 when I was asked by STFC/RAL Space to review the outcomes of the ASALASCA program and validate the commercial opportunities for the technology. By this point, with the wide-spread adoption of Ka-band and Q/V-band for high-speed data satellite communication links, in my view, the need to be able to

predict link outages had become even more pressing. My affirmative re-validation of the commercial demand for the technology led to me being asked to establish and lead the spin-out company which became Atheras Analytics Ltd.

FINDING THE RIGHT INVESTORS

Since then, securing investment has undoubtedly been challenging, and we've had to reassess the type of funders we target. It's important to get to grips with how different types of investors operate because some will be a better match for your startup than others. In our case, while we see our technology as vital, it's still niche, and we couldn't develop a business plan based purely on the space sector that would realize the levels of returns that many venture capitalists have come to expect. A high return on investment is a priority for venture capital funding, and the amounts invested are often large, over £1 million. Run by fund managers as an investment vehicle purely for financial returns, venture capital funding will not be the right fit for every startup.

Angel investors, on the other hand, are wealthy individuals who invest their own money into startups. They typically invest smaller amounts than venture capitalists, which could be as little as £10k or as much as £500k. Their motivations for investing often are diverse. Some may be driven by the potential for financial return, while others want to make a positive difference, and some may be attracted to the idea of nurturing a small company and helping it to be successful. Compared to venture capitalists, angel investors typically have low or no fees. But they can also be difficult to find.

There are angel syndicates to consider as well. These



John Yates, Chief Executive Officer, Atheras Analytics ●●●

are essentially a membership group of angel investors. Amounts invested by angel syndicates are usually higher than angel investors, ranging from £150k to £1 million, and they may also focus on a specific sector. With angel syndicates, the whole group of investors are presented with the funding opportunity. This can save a lot of time

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because you're not having to locate and approach multiple angel investors individually.

GETTING YOUR TECHNOLOGY IN FRONT OF THE RIGHT PEOPLE

Naturally, you'll want to showcase the value and capabilities of your product or service to the right audience. This generates interest, attracts early adopters, secures initial customers, and validates your market presence. Connecting with the right individuals and groups can also help you to form strategic partnerships, which will likely play a significant role as you move forward. At Atheras, we're taking every opportunity we can to present our technology at international conferences and other fora, and to explain how the use of these techniques can simultaneously reduce ground network capex and significantly improve quality of service at these high frequency bands.

From a technology and market perspective, we seem to be ahead of the game, which is both a blessing and a curse. We're finding that many satellite operators are only just beginning to recognize and face the challenges posed by the impact of weather on their Ka-band and Q/V-band satellite links.

It's all about getting in front of the right people, but even then, it doesn't happen overnight. Convincing people that there is, or will be a problem that needs solving is no mean feat when it's not something already at the forefront of their minds. It definitely takes tenacity and patience.

ADVICE FOR STARTUP BUSINESSES ON A SIMILAR PATH

If I had to home in on some key pieces of advice to give to others who are beginning their startup journey, firstly, I would recommend establishing an experienced and knowledgeable board of directors. Developing a new satellite technology requires high levels of technical expertise and industry knowledge. This is why, in my view, one of the most important things a startup needs to do early on is to establish a board of directors with substantial industry expertise. A well-appointed board provides valuable strategic guidance, diverse perspectives, technical and industry knowledge, as well as insights to help steer the company in the right direction. Having an experienced, well-respected board of directors also instills confidence in investors, which could make it easier to attract funding.

Secondly, take advantage of the many excellent government and ESA start-up funding initiatives. These kinds of funding schemes are crucial for startups in the space and satellite industry, not only because they provide much-needed financial support, but also because they help to cover the high costs of research, development, and testing. Obtaining public funding can also help to add credibility by validating the viability of your idea. This can make your technology more attractive to investors. Funding initiatives also offer startups access to valuable resources, expertise, and networking opportunities, and can be great for exposure.

Thirdly, remember to factor in commercialization time into your business model. As I touched on earlier, the commercialization of your technology can easily take just as long as the development phase. Factoring this in is

important for financial planning, resource management, and for managing investor expectations. With a sensible commercialization timeline, it's much easier to manage investor expectations and provide a realistic outlook for the time it will take to generate revenue and achieve profitability. This transparency and alignment of expectations are crucial for maintaining investor confidence and attracting additional funding if needed.

NO ONE SAID IT'S EASY

There's no doubt that starting up a company is difficult regardless of what field you're in. Being a technology startup in this industry definitely has some added challenges. Yes, it can be difficult to get the funding you need, and there are a lot of ups and downs. I would say that it does feel as though now is a good time to be a startup in this industry. As is typical of a growing industry, there's an increasing demand for products and services, and this is creating a larger customer base and potential market. A growing industry creates many opportunities and gaps that need to be filled, making it an ideal environment for a startup to carve their niche. I don't think there's a blueprint for success because every company and situation is different. One thing that will always be true is, you have to surround yourself with the right people and networks, and approach it all with dogged determination. ●



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● ● Jonny Spendlove, Senior Product Manager of Connectivity at John Deere

Satellite Evolution Global

Q&A

Satellite IoT can help farmers feed the world ● ●

The number of connected IoT devices is expected to reach more than 14 billion by the end of the year and nearly double by 2025. 4G and 5G network implementation is driving this growth, bringing the necessary latency and bandwidth to support connected technologies. But there's an important caveat to this progress: 4G and 5G implementation is only happening at scale in urban environments. We asked Jonny Spendlove, Senior Product Manager of Connectivity at John Deere, to explain how satellite communications can bridge that gap and enable dramatic improvements in efficiency for farmers worldwide.

Laurence Russell, Writer

Question: The rise of the LEO market has been a pillar of the NewSpace race story. What part does IoT play in this brave new industry?

Jonny Spendlove: For years, urban connectivity has been prioritized over rural environments due to population size and density. While urban regions may have more people, rural connectivity can have the largest global impact. Farmers are responsible for feeding the world and doing so at scale amid a growing population requires more advanced technology like machine-to-machine communications, connected sensors, and real-time data collection. Satellite communications brings the connectivity needed to power these technologies to farmers around the globe.

Question: Following food and labour insecurity in global economics with environmental concerns on the horizon for the agricultural industry, what are future-conscious farmers looking to invest in to secure their businesses? Are there technologies that the majority of them are unaware of that they should be paying attention to?



Autonomous tractor. Photo courtesy John Deere ● ● ●

Jonny Spendlove: By 2050, farmers must produce double the amount of food to meet the demands of our rapidly growing world population. At the same time, they're facing a mix of challenges, including labour shortages, unpredictable weather, extreme variability, and tight time windows to get jobs done. The combination of intuition, experience, and technology is the key to a farmer's ability to overcome these challenges.

Farmers have been using technology for decades like precise GPS to guide machines in a straight line across their fields. More recently, farmers have built upon location-guidance technology to harness tools like computer vision and machine learning. Incorporating these technologies into agricultural machines replicates how a human brain works, creating an interconnected system within the machine. Like our human brains, this technology gives the machine spatial awareness and helps it to continuously learn by constantly ingesting its surroundings. With this deep knowledge, machines can treat crops on the farm at an individual level, providing only what that plant needs in the moment. This benefits the crop itself and ensures the chemicals used to treat these crops are applied more efficiently, protecting the surrounding environment.

An example of this is Deere's See & Spray Ultimate technology. Rather than requiring farmers to spray an entire field with herbicide, this technology only sprays weeds by using machine learning and computer vision to differentiate weeds from crops. This reduces herbicide usage by 60 percent, saving money and resources for farmers, while also protecting the land.

The thing is many of these technologies can only operate with connectivity or are optimized with consistent connectivity. Without connectivity, the tools farmers need are available, but they don't have the option to harness them. That's why rural connectivity, powered by satellite communications, is crucial.

Question: The global south is filled with agrarian economies, and economies that have been majorly

agrarian in living memory. How do IoT efficiencies uniquely stand to benefit them? How does IoT and satellite connectivity benefit farmers in rural areas around the world?

Jonny Spendlove: The lack of connectivity access impacts farmers across the globe. Brazil is a perfect example. The country is responsible for feeding 800 million people worldwide, but just a few miles outside of any major city and you are almost guaranteed to lose service. Satellite communications is changing that.

Farm machines move a lot of data, like the number of seeds planted in certain areas, machine health, and weather conditions. With increased connection speeds from satellite enabled IoT, farmers can access and act upon that data in real-time. Picture three machines being used in a field to plant. With the ability to share data across those machines in real time, farmers can eliminate costly and time-consuming overlap because each machine is telling the others where they've been.

Connectivity also reduces downtime when it comes to machine health and maintenance. If a farmer's machine breaks down, it can take hours for maintenance teams to arrive on-site given the remote nature of farms. Farmers already work upwards of 12 hours a day, so adding multiple hours to the workday isn't an option. However, when connected, farmers can share their machine diagnostics with off-site maintenance teams, giving the technical support staff access to assess and fix many operational issues remotely. This means less downtime and more hours spent on precise crop production.

Question: What are the efficiencies that IoT technology can bring to high-land-use operations like agriculture? Who do these efficiencies help the most globally?

Jonny Spendlove: Between 2019 and 2029, agricultural employment will only grow by 1 percent, slower than the average for all occupations. With farmers already working an average of 12-18 hours a day, they don't have the bandwidth to double their workload. Future-focused



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farmers now face the question: how do I produce more with less time, people, and resources? The answer is technology.

One example of technology that's solving the labour shortage is autonomy. By operating on their own, autonomous machines cut out the need for skilled labour that simply doesn't exist, especially with the seasonal nature of the job. Today, farmers are using Deere's autonomous 8R tractor, which brings autonomy to the tillage process.

By 2030, our goal is that every single one of the trillions of corn and soybean seeds and plants in the US can be planted, cared for, and harvested by autonomous machines.

With autonomy, farmers can remotely monitor their machines, meaning connectivity is a necessity for them to work. Satellite IoT is what will help make this technology more widespread to farmers anywhere. Considering everyone needs to eat, this technology has the potential to impact every single person in the world, and this is just one example.

Question: A big part of IoT technologies comes from the analysis of collected data. What's the hypothetical role of AI/ML solutions in disseminating information gathered by IoT, and how can actionable conclusions be drawn and implemented?

Jonny Spendlove: Artificial Intelligence and machine learning are already disseminating information on today's agricultural machines. An example is Deere's See & Spray Ultimate technology, which uses artificial intelligence, computer vision, and machine learning to view its surroundings and make real time decisions. Trained with millions of photos, the machine can recognize the difference between a weed and a crop – while travelling through a field at up to 12 mph, only spraying the weeds.

Looking more broadly, data is critical to a farmer's ability to analyze their operations year-over-year. By having yearly data, like which areas of land performed best, farmers can tweak their operations for the following year to improve yields.

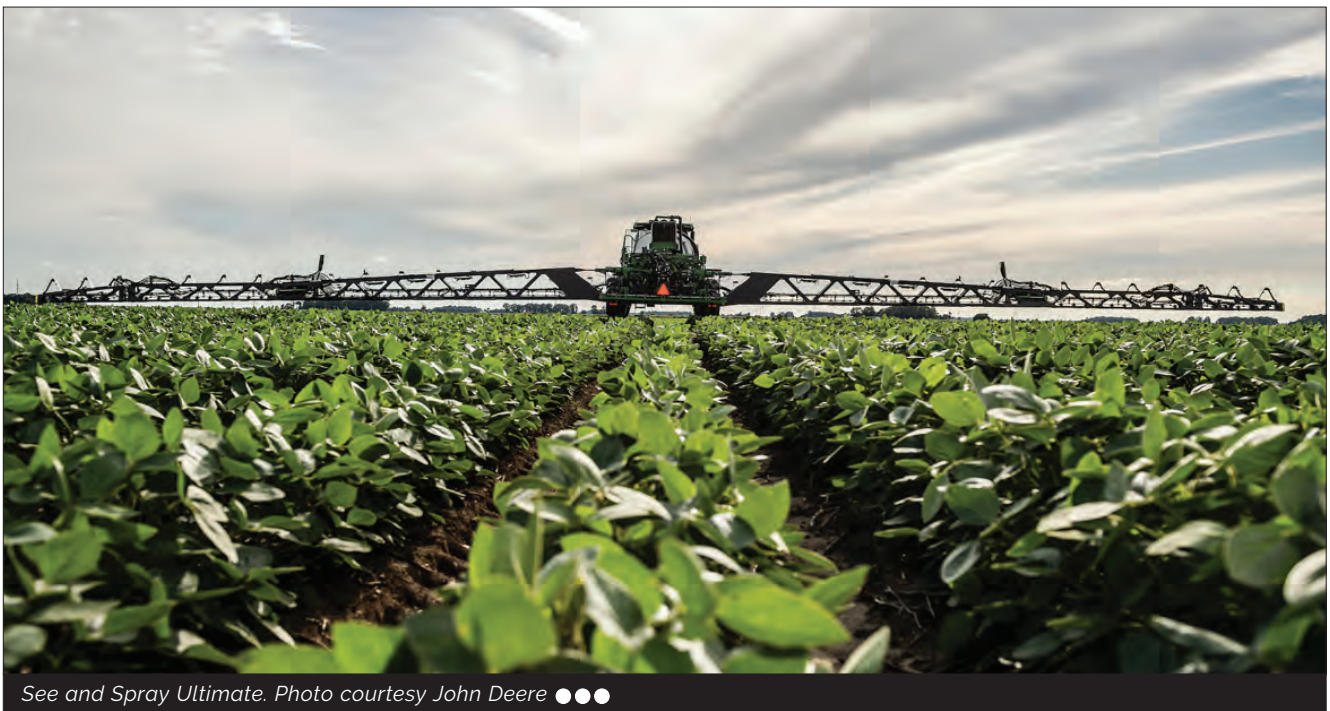
Question: Another complimentary technology to IoT is automation. How can distributed IoT data nodes and their analytics better serve increasingly autonomous agriculture?

Jonny Spendlove: Autonomous machinery relies on data and data processing to operate. Trained via hundreds and thousands of images, Deere's autonomous tractor uses processing power to classify each pixel in the images it captures in about 100 milliseconds. This allows the tractor to recognize its surroundings and stop if an obstacle is in the way. Through every pass in the field, the tractor is collecting and processing this visual data. When connected, this data can be uploaded to an app on a farmers' phone or tablet, where they can start and stop the tractor, monitor a particular job being executed, and determine what to do when the machine encounters something it shouldn't.

Question: What's the future of satellite IoT in agriculture and similar industries?

Jonny Spendlove: The collection and processing of more data at higher speeds on agriculture machines requires evolving satellite technology paired with other agriculture technologies.

The future of satellite IoT ultimately means better rural connectivity to help farmers do more with less, improving their operations and livelihood. With improved connectivity via satellites, they will be able to work more efficiently and productively, reduce downtime, and coordinate among machines for more efficient use of resources. ●



See and Spray Ultimate. Photo courtesy John Deere ●●●



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Shooting for the stars – Advancing Saudi Arabia's space infrastructure and economy

Founded in 2006, global startup accelerator Techstars helps early-stage companies to realize and actualize their potential and to super-charge their progress. The organization's recent collaboration with the Saudi Arabian Communications, Space and Technology Commission saw the establishment of an intensive 10-week program that supported the development of innovative startups looking to expand upon Saudi Arabia's space sector. The work aims to significantly advance the region's space infrastructure and economy.

Oko Davaasuren, Senior Director at Techstars

With the recent completion of the very first cohort of the Saudi Space Accelerator Programme, Saudi Arabia is well and truly shooting for the stars. The 20 selected startups – chosen by an elite group of investors – honed their entrepreneurial skills and gained insights into their target consumer market, as well as the merits of their own ideas. For the Communications, Space and Technology Commission – Saudi's communications authority – the conclusion of the inaugural program represented a momentous milestone in its long-term ambition to further promote the growth of the country's space industry, and to establish a thriving space economy.

The Saudi Space Accelerator Programme is a crucial component of the country's Vision 2030 – a unique transformative economic and social reform blueprint which focuses on opening Saudi Arabia up to the world. The strategic framework aims to diversify the country's economy, while also reducing its dependence on oil. One of the key pillars of this vision is the creation of a collaborative, vibrant society that will provide opportunities for all and support the growth of various sectors throughout the region.

PRIME AREA FOR INVESTMENT

In Saudi Arabia, the space industry has been identified as a prime area for investment, growth and scaling, and is vital to the Government's plans for the future. In fact, the Communications, Space and Technology Commission, formerly the Saudi Space Commission, was established in 2018 to lead its development, and to support its ambitious plans to become a leader in the Middle East's space industry.

By providing a platform from which startups can develop innovative solutions that address the challenges



Oko Davaasuren, Senior Director at Techstars ●●●

of the space sector, Techstars is helping to bring Saudi Arabia closer to its 2030 goals.

Among those on the program is Italian startup KURS Orbital, who expand human activities beyond Earth by providing rendezvous and docking technology for on-orbit servicing, space logistics, and debris removal missions. The company is now closing a seed round with investors from Europe and the US, to support the development and launch of their new rendezvous module.

Of course, KURS is just one of many success stories to emerge from the Saudi Space Accelerator Programme. Saudi-based Space Copy – the company behind a cutting-edge lunar regolith sampling and 3D printing device that analyses lunar soil samples – was part of the original cohort and completely redeveloped their business model as a result. German firm Airmo – a business providing precise and unbiased intelligence about CO₂ and CH₄ emissions globally – also closed a pre-seed round.

In addition, Promin Aerospace – a Ukrainian company developing advanced autophagic rocket propulsion to empower the most efficient small rockets and launch vehicles – built a twice more powerful version of the engine whilst being on the program. Meanwhile Nebula – the first Saudi company specialising in space medicine research and development – confirmed a major international partner.

Techstars believes that enabling entrepreneurs to uplift their communities can scale up to support entire

economies. That's why the Saudi Space Accelerator Programme, in partnership with Techstars and the Communications, Space and Technology Commission, has the potential to position Saudi Arabia as the Middle East's space industry leader.

As a leading global platform for investment and innovation, Techstars is also assisting in the further development of the economy, alongside its technological advancement. The program is supporting the country's goal of developing a knowledge-based economy, where innovation, technology, and entrepreneurship play a central role. As a result of the partnership, and by investing in the space industry and supporting startups in this sector, Saudi Arabia is positioning itself as a regional leader in the development and deployment of space technology and services.

Of course, mentor-driven pre-accelerators and accelerator programs are vital in the startup ecosystem. This is evident not just within the communities where the supported startups operate, but also for the wider global ecosystems that depend on them to advance the economy with job creation and the introduction of new technologies and industries.

MAKING THE PLANET SUSTAINABLE

But what does that look like on a larger, worldwide scale? A recent report from McKinsey indicates that the continued support and financing of the space industry is key to making the planet sustainable and secure for future generations. It also highlights the need for collaboration, widespread funding, and a healthy global marketplace in

the development of innovative space technologies. Currently the total commercial space economy is valued at over £280 billion, but if it follows the trajectory of other major industries, such as the aviation sector, it is projected that the global value of the marketplace could be as high as £2.1 trillion by 2050.

We cannot overestimate the importance of funding and supporting startups, and indeed larger groups who endeavour to unlock the mysteries of space. Work must be done to further support and encourage all areas of the industry – on the science side, in technology, in research and development, and so forth.

The collaboration opens the doors to businesses and creates opportunities in avionics, drones, and geospatial analytics, among others, and undoubtedly, each play a significant role in the development of a nation's space program.

Techstars, in conjunction with the Saudi Communications, Space and Technology Commission, prepares early-stage companies in the space and aerospace fields. This injection of knowledge, time, resources, and mentorship could be one of many crucial moves to strengthen the space and aerospace industries of the Middle East.

If all goes as predicted, and everything thus far suggests it will, Saudi Arabia will achieve its ambitious goals set out in Vision 2030. The country will become a major hub for the commercial space industry and at a time when space exploration and research is at an all-time high, the Kingdom will be advancing the sector in ways that will have a significant global impact. ●

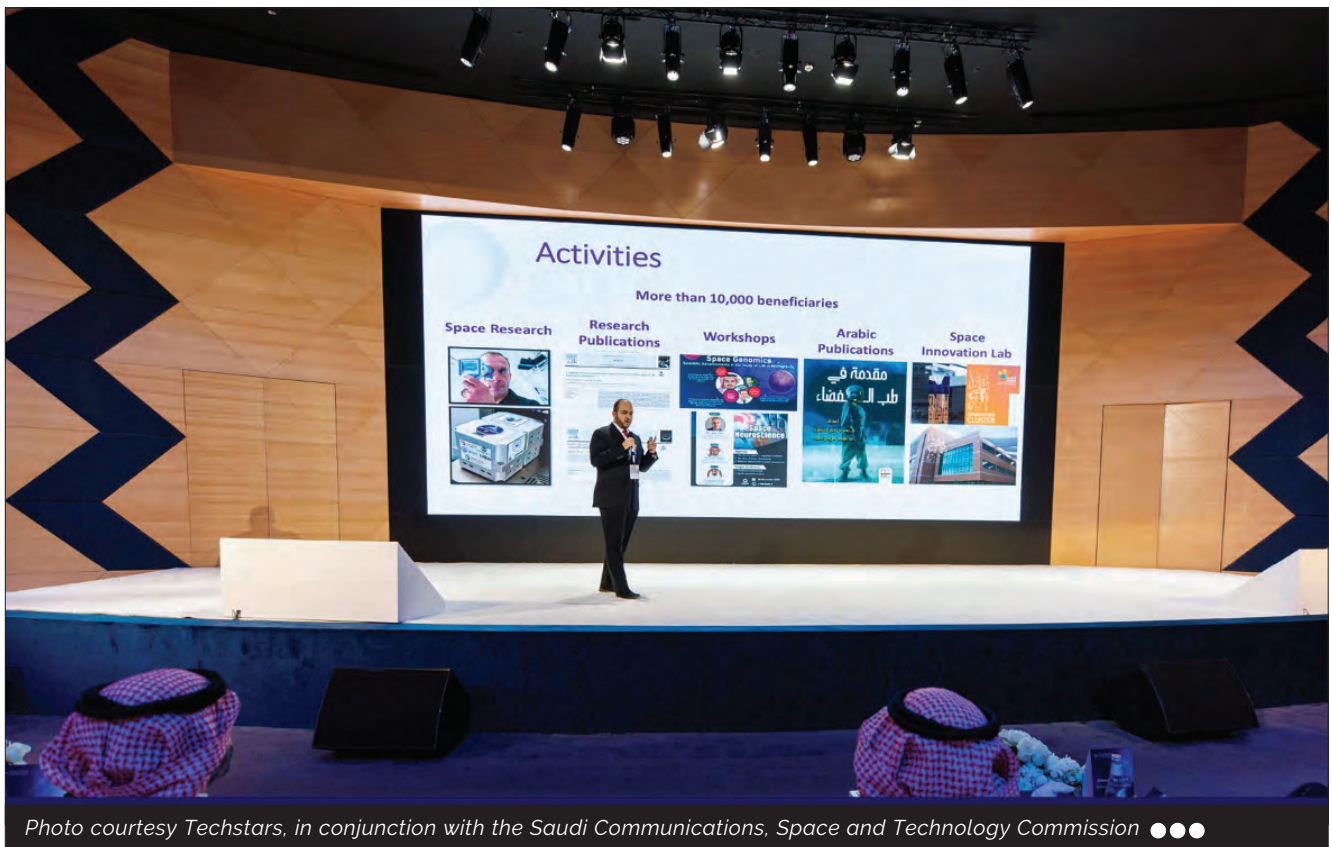


Photo courtesy Techstars, in conjunction with the Saudi Communications, Space and Technology Commission ●●●

Astroscale Holdings strengthens global Board of Directors

Astroscale Holdings has announced the appointment of three distinguished professionals to the Astroscale Board of Directors.

Joining as new External Directors are Gayle Sheppard, Chief Executive Officer of Bright Machines, a prominent software and data led factory automation and production platform company, and Erica Newland, formerly the Chief Financial Officer of Baraja, a global LiDAR sensor technology start-up. Nobuhiro "Matsu" Matsuyama, Chief Financial Officer of Astroscale since November 2021, has joined as an Internal Director. These three new Directors bring invaluable levels of expertise and experience that will further strengthen Astroscale's financial position, sharpen its strategic vision and accelerate its drive for innovation in space sustainability.

"I am so excited to have Gayle, Erica and Matsu join our Board," said Nobu Okada, Founder and CEO of Astroscale. "Their presence immediately makes Astroscale better equipped than ever to revolutionize on-orbit servicing and make significant contributions to space sustainability. Together, we will drive the company's vision forward, ensuring space remains accessible for generations to come."

Gayle Sheppard is a global technology executive with extensive experience leading software businesses and teams worldwide. She brings valuable expertise from several sectors, including aerospace, manufacturing, financial services and national governments. Throughout her career, Gayle has been instrumental in driving organizational transformations by re-engineering core enterprise software, customer relationship management, supply chain management, and discrete manufacturing systems. Her background includes prominent roles such as Corporate Vice President and CTO at Microsoft, as well as Vice President and General Manager of Saffron Artificial Intelligence Group at Intel Corporation.

Erica Newland is a financial expert and experienced board director, possessing deep expertise in international mergers and acquisitions and global manufacturing operations. She brings a strategic perspective and extensive knowledge of sensor technology, hardware goods, and industrial manufacturing industries with global experience living in Eastern Europe and Asia.

Some of her most notable previous roles include serving as a board member of DroneSense, Business Unit CFO at FLIR Systems, and China Strategy Finance leader at Intel Corp.

Nobuhiro Matsuyama is entrusted with leading Astroscale's global financial function. With over 12 years of experience in global finance and banking, Matsu's expertise encompasses financial strategy, capital markets and risk management. Prior to joining Astroscale, he held key positions in the Investment Banking Division of Goldman Sachs in Tokyo and New York over the course of seven years.



Pictured from left to right: Erica Newland, Gayle Sheppard, and Nobuhiro Matsuyama ●●●



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Wiley welcomes Diane Holland

Diane Holland has joined the firm's Telecom, Media & Technology Practice as a partner. Holland most recently served as Deputy Bureau Chief and Special Advisor for the Federal Communications Commission (FCC), where she managed the agency's regulation and oversight of programs ensuring the availability of affordable high-speed broadband service for all Americans. She also previously was Legal Advisor to FCC Commissioner Geoffrey Starks.

"Diane is an innovator who has worked between the FCC and the private sector for more than two decades," said Wiley Managing Partner Peter D. Shields. "Her deep understanding of the agency, and the industries it regulates, will bring value to clients across the firm."

Holland's tenure at the FCC included serving as Deputy Associate General Counsel and Assistant General Counsel for Administrative Law in the Office of General Counsel, where she was responsible for legal analysis and review of all wireline and broadband-related FCC rulemakings and other matters. She held several other positions at the FCC, including serving as Chief of Staff for the Office of General Counsel and the Wireline Competition Bureau, overseeing



Diane Holland, Partner, Wiley ●●●

the North American Numbering Council, and managing the former Network Services Division.

"Since Wiley's founding, the TMT Practice has had a rich tradition of welcoming lawyers who have excelled in public service, including at the FCC. Diane brings to us a breadth of substantive experience and unique insight into how the agency operates," said TMT Practice co-chair Kathleen Kirby. "She is a seasoned lawyer and leader, and we will certainly benefit from having her on our exceptional team. With the recent additions of both Diane and Crystal Tully, we have strategically been growing the practice to best serve our clients."

A large advertisement for the Satellite Evolution Group. The background is a dark blue space scene with a glowing Earth and a network of white lines and dots representing satellite connections. Two hands are shown reaching up towards the network. The text is in white and yellow. The logo is a stylized white cube made of smaller cubes.

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