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## Advances in 3D printing for the space sector

Q&A Intelsat General

Who's ahead in the race for convergence 4.0?

The NewSpace race

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Amy Saunders  
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## Body modifications 2.0!

Since humankind first walked the Earth, we have been modifying our bodies. Contrary to the argument parents might face with their children about why a nose ring might be desired, tattoos, piercings, scarification and surgery have been used for millennia to differentiate ourselves from others or identify with a particular group.

Today, we're facing a new era of body modification, one with inarguably more practical applications than your standard tattoo or piercing. Towards the end of 2018, it emerged that a major UK employer with hundreds of thousands of employees is contemplating implanting microchips into those employees to improve security. Similar to the microchips utilised in pet collars to activate a cat-flap or feeding device, one UK company plans to utilise microchips to allow employees access to offices without the need for a swipe card or other external device.

This microchip technology has been on the rise in certain circles for a number of years now, somehow never becoming fully-mainstream. I can recall when I first heard about the concept of using microchips implanted under the skin to make cashless payments – there was an episode of CSI: Miami back in 2004 where a woman used a microchip implanted into her shoulder as a form of payment and identification when entering a nightclub. Like many things in the past (Smart phones, inflight connectivity, cloud storage), the concept of implanted microchips seemed like pure science fiction.

This sci-fi concept is, however, now entering mainstream reality. The technology, wherein a microchip the size of a grain of rice is implanted under the skin, is already in everyday use around the world; in the USA, Three Square Market's employees have implanted microchips which allow staff to make contactless, cashless payments at on-site vending machines, while Swedish rail company Statens Järnvägar allows passengers to use implanted microchips instead of physical tickets to travel on trains across the country. Other proposed future applications include the storage of medical information and replacing car and home keys.

There are several concerns with the technology, including the fact that some employees may be coerced into having a microchip implanted – if it's a minor surgical procedure versus job loss, what choice will some have? Other concerns include the potential for tracking employee whereabouts, a massive invasion of privacy in a time where privacy concerns and human rights are already teetering on the brink of indecency. And let's not even begin to touch on hacking threats and the need for fool-proof cybersecurity.

We're certainly entering an interesting era when it comes to the implementation of new technologies. Implanting microchips into employees is a slippery first step into the crazy new world where biohacking and cyborgs are ideas that some people are realistically contemplating.

“This microchip technology has been on the rise in certain circles for a number of years now....”



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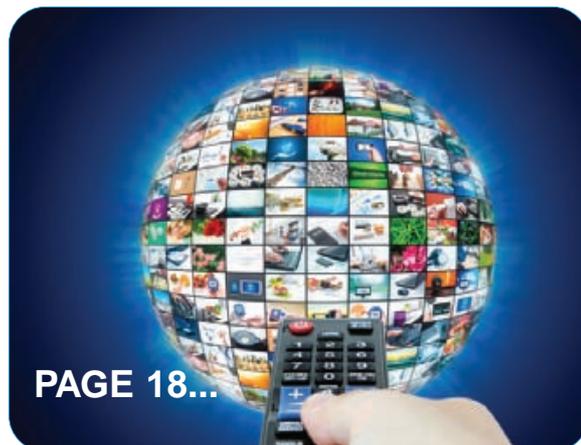
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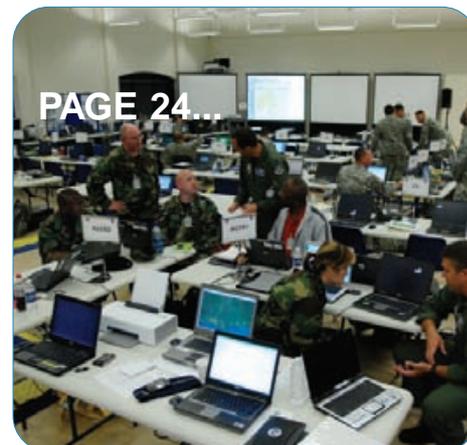
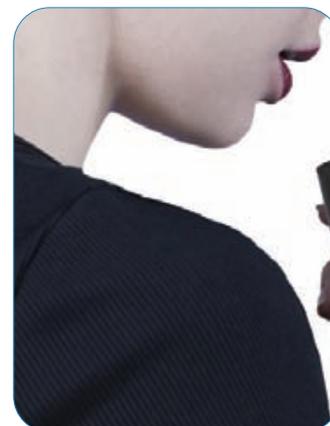
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### ZTE launches its first cybersecurity lab in China to boost ICT industry security

ZTE Corporation, a major international provider of telecommunications, enterprise and consumer technology solutions for the Mobile Internet, has confirmed its commitment to the ICT industry against cybersecurity threats by launching its first cybersecurity lab in Nanjing, China.

Following the establishment of the Nanjing complex, the company is already planning to expand across the globe with cybersecurity developments in Italy and Belgium already in the pipeline. The opening of a new lab represents an important milestone for ZTE as it looks to increase transparency and enhance trust with third parties.

With the vision of “Security in DNA, Trust through Transparency”, ZTE is committed to providing customers with end-to-end security products and services by integrating security considerations and controls into every aspect of the product’s life cycle. The cybersecurity lab aims to provide global customers, regulators and other stakeholders with security assessment and audit services, such as source code reviews on ZTE products including 4G and 5G, security design audit, procedural document review, black box testing and penetration testing.

Furthermore, the cybersecurity lab, functioning as an industry cooperation and research platform, will also facilitate in-depth research and exploration in the security field.

“The security lab is an open and cooperative platform for the industry,” said Zhong Hong, Chief Security Officer at ZTE. “ZTE plans to gradually achieve its cybersecurity goals through three steps: first, meeting the requirements of cybersecurity laws, regulations and industry standards as well as certification schemes; second, conducting an open dialogue to enhance transparency and establishing cooperation with customers as well as regulatory agencies; and third, sustaining the open cooperation mechanism to contribute to cybersecurity standardization.”

ZTE is committed to meeting the security demands of customers and regulators and leveraging the platform of the cybersecurity lab for further transparency, cooperation and communication. Moving forward, the company will collaborate with world-class security organizations to jointly conduct security assessment, certification, training and consulting.

Confronted with the cybersecurity challenges in the 5G era, ZTE will continue to adhere to the company’s vision of “Enabling Connectivity and Trust Everywhere” and bring trustworthy cybersecurity capabilities worldwide. ■

### Maxar selected by NASA to study future space communications architecture and services

Maxar Technologies has been selected by NASA to study future systems that could revolutionize NASA’s space-based communications architecture through innovative technologies and commercial partnerships. The future architecture would be used for scientific and human exploration missions in Earth orbit, at the Moon, and throughout the solar system beginning in the mid-2020s.



Photo courtesy of Shutterstock



NASA's Space Communications and Navigation Program currently offers space-based radio frequency communications services for all of the agency's space communications activities via its Space Network. The Space Network consists of a constellation of geosynchronous satellites called TDRS and ground systems that operate as a relay system between satellites.

Leveraging current and planned commercial communication and navigation infrastructure, Maxar will study concepts to augment the Space Network with more advanced optical communications capabilities and enhanced radio frequency services. Maxar will also study a framework that allows for a transition from government-owned and managed space services to commercially developed and operated services. This future architecture could unlock the promise of human exploration, new and greater scientific discovery, and reduce development and operations costs for future missions through improved communication and navigation services.

"This award highlights Maxar's ongoing commitment to the development of innovative space solutions that will open up a new realm of possibilities for human exploration," said Megan Fitzgerald, Maxar's Senior Vice President and General Manager of Space Solutions. "This future architecture will be designed to yield significant development and operations savings over government-owned systems and will also provide the benefit of frequent technology advancements."

Maxar has decades of experience in developing cutting-edge systems for space communications. The company has built some of the world's highest capacity spacecraft, including

JUPITER™ 1/EchoStar XVII and JUPITER 2/EchoStar XIX – which power HughesNet® high-speed satellite Internet service across the Americas. Maxar is currently building JUPITER 3, which will provide more concentrated capacity over high-use areas than any other satellite. Maxar has also contributed advanced concepts for the U.S. Air Force's next-generation protected satellite communications architecture and has built more than 280 satellites, with 91 commercial communications satellites currently in service.

The operations of DigitalGlobe, SSL and Radiant Solutions were unified under the Maxar brand in February; MDA continues to operate as an independent business unit within the Maxar organization.

**Intellian introduces the all-new 1 metre Global Xpress terminal, GX100NX**

Intellian, the global leader of mobile satellite communication antenna systems, has unveiled an all new 1m Global Xpress terminal - GX100NX.

The Intellian GX100NX offers high-speed data and global operation, and exceptionally efficient RF design for unrivalled link performance on the Fleet Xpress service. It is also future proof, with support for 2.5GHz Wideband Ka networks and optimized reflector and radome. GX100NX users can also unlock even higher levels of bandwidth with a 10W BUC option, which is easy to install and requires no additional components.

Based on Intellian's new NX technology platform, the GX100NX uses a single coaxial cable, which combines Tx, Rx, and DC power, to simplify installation. Its cutting-edge



modular design results in lower cost of ownership throughout the entire lifecycle, while improving reliability and streamlining maintenance.

The GX100NX introduces a new 'All-in-One' GX Below Deck Terminal (BDT) which integrates an antenna control unit (ACU), a modem, a power supply, a 4-port switch and a mediator in a single unit to further reduce the time and cost of installation in Intellian's Fleet Xpress Rack.

Reducing complexity further, Intellian also provides an upgraded antenna management and control platform. The new AptusNX software includes an installation wizard with a step-by-step commissioning guide for easier setup and enhanced diagnostic capabilities, which sends an alert to the operator when predictive maintenance is required.

Eric Sung, CEO of Intellian, commented, "We're delighted to introduce the all new GX100NX to the valued partners and customers at our APAC partner event. With its future-proof and user-friendly design, our new Global Xpress terminal will deliver performance, installation and servicing benefits to diverse customers, especially those in the commercial shipping, oil and gas, and yachting markets."

The GX100NX will be commercially available at the end of June.

### Honeywell selects Gilat's Aero Modem for its JetWave Satellite Communication Solution

Honeywell has selected Gilat's Taurus IFC modem for its JetWave™ satellite communication system.

The integration of Gilat's aero-modem will enable Honeywell to offer its JetWave solution within territories as well as to roam in-and-out of territories where Gilat's ground network is deployed. The Honeywell-Gilat solution will first be deployed in China over China's HTS Ka network for both domestic and flights going in-and-out of China, expanding later to additional regions around the globe.

Gilat's high-performance Taurus aero modem, has a proven global track record of providing unparalleled passenger user experience. Gilat's industry leading IFC solution operates the largest global IFC network with over 1,000 commercial aircraft installed with Gilat's solution.

"Gilat is pleased to partner with Honeywell to offer JetWave in new territories and regions of the world and are looking forward to further expansion and cooperation of this strategic relationship," said Ron Levin VP, Mobility and Global Accounts. "This achievement is another step-in materializing

Gilat's vision of enabling broadband anywhere, as well as a testament of Gilat's recognized global HTS and IFC leadership."



Photo courtesy Arianespace/ESA

### Arianespace to launch the ESAIL satellite for exactEarth on Vega's SSMS POC flight

Arianespace has been selected by exactEarth to launch the ESAIL satellite using a Vega as part of the launcher's Small Spacecraft Mission Service (SSMS) Proof of Concept (POC) flight.

It is the final contract signed by Arianespace for this POC flight, which is now completely booked with 42 payloads onboard.

The ESAIL satellite will be launched in a Sun-synchronous orbit (SSO) at an altitude of 515 km. on a Vega SSMS rideshare flight in 2019 from the Guiana Space Center, Europe's Spaceport in Kourou, French Guiana.

exactEarth is a leading provider of global AIS (Automatic Identification System) maritime vessel data for ship tracking and maritime situational awareness solutions. Using world-leading satellite vessel detection technology – combined with the most advanced constellation of AIS satellites – exactEarth delivers the highest quality real-time information to customers around the world.

The ESAIL microsatellite has a mass of 110 kg. and features an enhanced multiple antenna-receiver configuration for global detection of AIS messages and high-resolution spectrum capture, which will enable the demonstration of advanced future services such as VDES (VHF Data Exchange System) message reception.

After launch and commissioning, the ESAIL satellite will be integrated into exactEarth's global constellation – which currently consists of more than 60 high-performance maritime monitoring payloads.

The ESAIL satellite was supported by European Space Agency (ESA – ESTEC) through the ARTES 21 SAT-AIS (SATellite Automatic Identification System) program and was developed and built by a European manufacturing team led by the satellite prime contractor Luxspace.

Vega's POC flight will be the first mission for SSMS – a program initiated by ESA in 2016 with the contribution of the European Commission. For all European partners involved, its purpose is to perfectly address the burgeoning microsatellite market for both institutional and commercial needs with a new rideshare concept on the Vega light-lift launcher.

Vega is part of the Arianespace launcher family, along with the Ariane 5 heavy launcher and the medium-lift Soyuz;



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all three are operated from the Guiana Space Center. The industrial prime contractor for Vega is Avio, based in Colleferro, Italy.

“exactEarth is happy to collaborate with Arianespace and participate in the Vega SSMS mission to deploy the ESAIL satellite,” said Peter Mabson, the exactEarth CEO. “We would also like to thank ESA and the supporting national delegates and the Luxspace team for helping to create this advanced technology microsatellite and we look forward to adding it to our global fleet.”

Following the signature of this contract, Stéphane Israël, CEO of Arianespace, said: “We are thrilled to welcome exactEarth among our customers and as the last passenger coming aboard the Vega SSMS POC flight, which is now completely booked. Everything is now set for this summer’s targeted launch of the first Arianespace mission dedicated to ridesharing! Arianespace will keep on offering competitive solutions to all satellites regardless of their masses and volumes, to the benefit of a better life on Earth.” ■

**PSN Consortium signed a Public Private Partnership Agreement with Government of Indonesia**

PSN Consortium signed a Public Private Partnership (PPP) agreement with the Government of Indonesia represented by Ministry of Communication and Information Technology (MCIT) for the Multifunctional Satellite (MFS) called SATRIA.

The SATRIA satellite is a 150 Gigabytes per second (Gbps) Very High Throughput Satellite (VHTS) to cover the whole Archipelago of Indonesia, providing high speed internet to serve 98 thousand schools, 40 thousand district and subdistrict administration offices, community health centers and other local government offices. The SATRIA satellite is planned to be launched at the end of 2022 or early 2023.

The 15 years PPP contract is valued about US\$ 1,47 billion to provide a satellite, launch vehicle, 11 gateways, a start-up hub as well as 15 years operational cost.

PSN Consortium consist of Pasifik Satelit Nusantara (PSN), PT Pintar Nusantara Sejahtera (financial holding company of PSN), PT Dian Semesta Sentosa, and PT Nusantara Satelit Sejahtera will provide the full SATRIA network.

“The PSN consortium is privileged to provide such key infrastructure for the development of Indonesia and we hope this network will make internet accessible to all Indonesian wherever they are in the Archipelago,” Adi

Rahman Adiwoso, CEO of PSN said.

Meanwhile for the interim solution, PSN through the recently launched Nusantara Satu satellite will provide the largest portion of the requirement satellite capacity to BAKTI (Agency for Accessibility for Telecommunication and Information Technology). This interim solution together with other current users will provide a substantial load to the Nusantara Satu satellite.

PSN and its partners is planning to launch Nusantara Dua satellite in early 2020 to anticipate the ever-rising demand of satellite capacity in Indonesia. PSN and its partners with Nusantara Satu, Nusantara Dua and SATRIA satellite will become one of the largest regional player in Asia-Pacific region. ■

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Universal remote control. Photo courtesy of Universal Electronics

## Who's ahead in the race for convergence 4.0?

As the Internet of Things (IoT) heats up, consumers are facing an ever-increasing number of smart devices in their homes. These devices remain fragmented, not working together to their full potential. Kuldip Singh Johal, Vice President of sales for subscription broadcasting at Universal Electronics, outlines the race towards convergence 4.0 and the implications for device manufacturers.

**The remote control was one of the first devices** to find its way into our homes. Now it could be given a new lease of life as our homes become smarter and our TVs become the portal connecting all the devices that help support our day-to-day lives. As the technology in this field has developed, so too have the remote's capabilities improving the user experience.

Most of us will remember a time when changing the channel meant pointing the remote control directly at the television and lining it up precisely. This was due to the use of infrared (IR) technology needing devices to be in the direct line of sight in order to communicate with each other. Needless to say, this could be a frustrating experience, particularly if something was blocking the view. Now, thanks to the move from IR to radio frequency (RF), specifically RF4CE, and the use of Bluetooth, this is no longer the case. This technology means users no longer have to point the remote control at a device in order to perform a function. In fact, the device doesn't even have to face the same way. The use of RF also means that more data can be passed between

the remote and the television, which has allowed for the integration of voice technology in remote controls. With these developments, remote controls could now be at the heart of convergence, providing users with a single device with which to perform synergised functions, controlling everything from the television to your home's temperature, security and lighting.

### Growing integration

As the Internet of Things (IoT) continues to develop, smart technology is becoming increasingly integrated and the race to fully converge smart devices is heating up. However, with established technology manufacturers competing against smaller, yet more agile, counterparts, who will win convergence 4.0?

With more and more smart devices appearing in the home, you might think consumers would welcome convergence. In reality, many consumers are currently turned off by the idea due to the difficulties they face when configuring and setting

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*Kuldip Singh Johal, Vice President of sales for subscription broadcasting at Universal Electronics*

up smart devices. For the average person, configuring multiple devices can seem daunting and like it may require some engineering know-how, deterring consumers from buying new devices or attempting to integrate them. Difficulties with configuring, discovering and controlling devices are among the biggest pain points for consumers of smart devices and is something that needs to be considered in relation to convergence.

For increased uptake, these pain points need to be address by manufacturers and industry leaders. It is vital for the end users that convergence and configuration is a frictionless and simple process. Users require intuitive devices which are capable of automatically recognising new devices and help the user to configure them. However, many of the key players within the industry are yet to offer devices capable of this. Should manufacturers, and the bigger market challengers such as Amazon and Google, want to attract audiences, the need for end-to-end solutions which simplify the process of migration to the smart home for the end user need to be considered. For example, devices should offer simplistic, voice-based processes to increase ease of use.

In addition to this, the winner of convergence 4.0 will produce devices which are capable of 'learning' set skills. These devices need to not only be intuitive in recognising other devices but must also intuit what a user requires when they perform certain commands. For example, ultimate convergence will come when users are able to ask their device to enter 'movie mode,' for instance, and the device will not only play a movie, but will also draw the curtains and dim the lights.

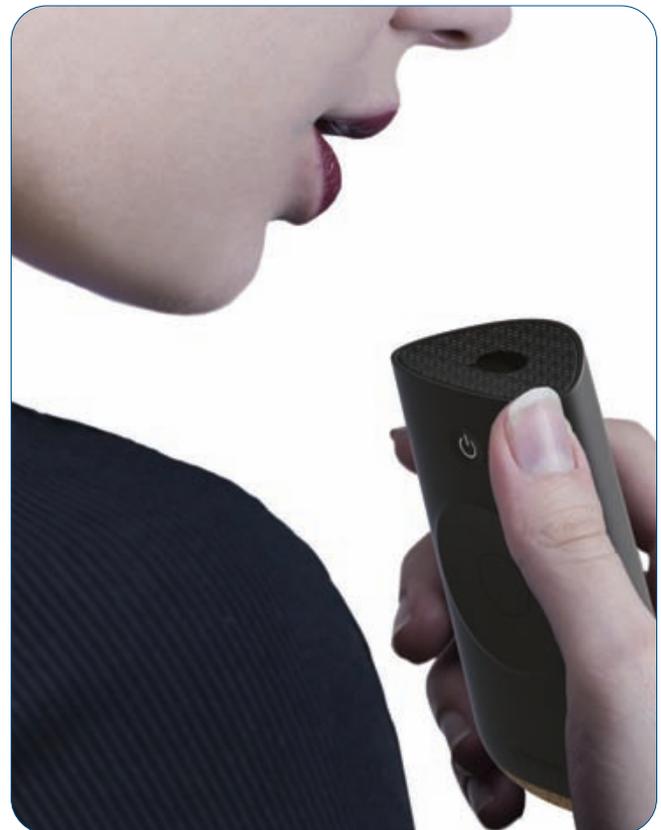
While there are a handful of manufacturers most of us will associate with smart home technology, many paid TV operators and telecommunication companies are turning their backs on these devices, thus creating space for some of the smaller brands to rise to the top. Not only are devices created by these big brands more expensive for paid TV operators to deploy, but they are also less adaptable for their needs. Conversely, by partnering up with smaller manufacturers to create bespoke solutions, paid TV operators can be in control of their own destiny and create their own eco-system on which they can build in the future. This is a fluidity that isn't offered by larger branded devices where the roadmaps for

convergence are already set out for them. Solutions developed with telcos and paid TV operators in mind also allow them to have more autonomy in their approach to the market, rather than following the trends as dictated by large manufacturers. This is a key issue in convergence as with paid TV operators on side, the smaller manufacturers have the potential to tap into different insights and develop new capabilities.

The battle to win convergence 4.0 also goes hand in hand with the fight for the voice-assistant market. As many smart devices make use of voice-control, the two issues are intrinsically linked. The number of voice-controlled devices is growing significantly as user demand increases. A recent study found that 1 in 6 adults in the US now owns a voice-activated smart speaker and 65 percent say they wouldn't want to go back to a life without these devices. Their popularity and their ease of use show that this technology should be a key feature for the future of convergence.

### **A pre-emptive strike**

It is fair to say that convergence is currently driven primarily by the market as a pre-emptive strike to anticipate the needs of consumers. Consumer demand is yet to catch up with this due to the difficulties associated with configuring devices. As such, the real winner of convergence 4.0 will be the company that can make it as easy and seamless as possible to integrate these devices into the home. That said, while the big names currently have a monopoly on this market, convergence 4.0 could be a case of the tortoise and the hare as smaller manufacturers step up their approach to the market. With a more insightful view of the requirements of not only the user but also telecommunication companies, these brands could be better able to tailor their offerings more precisely to suit the users' needs. ■



*Voice remote convergence. Photo courtesy of Universal Electronics*

# 5G

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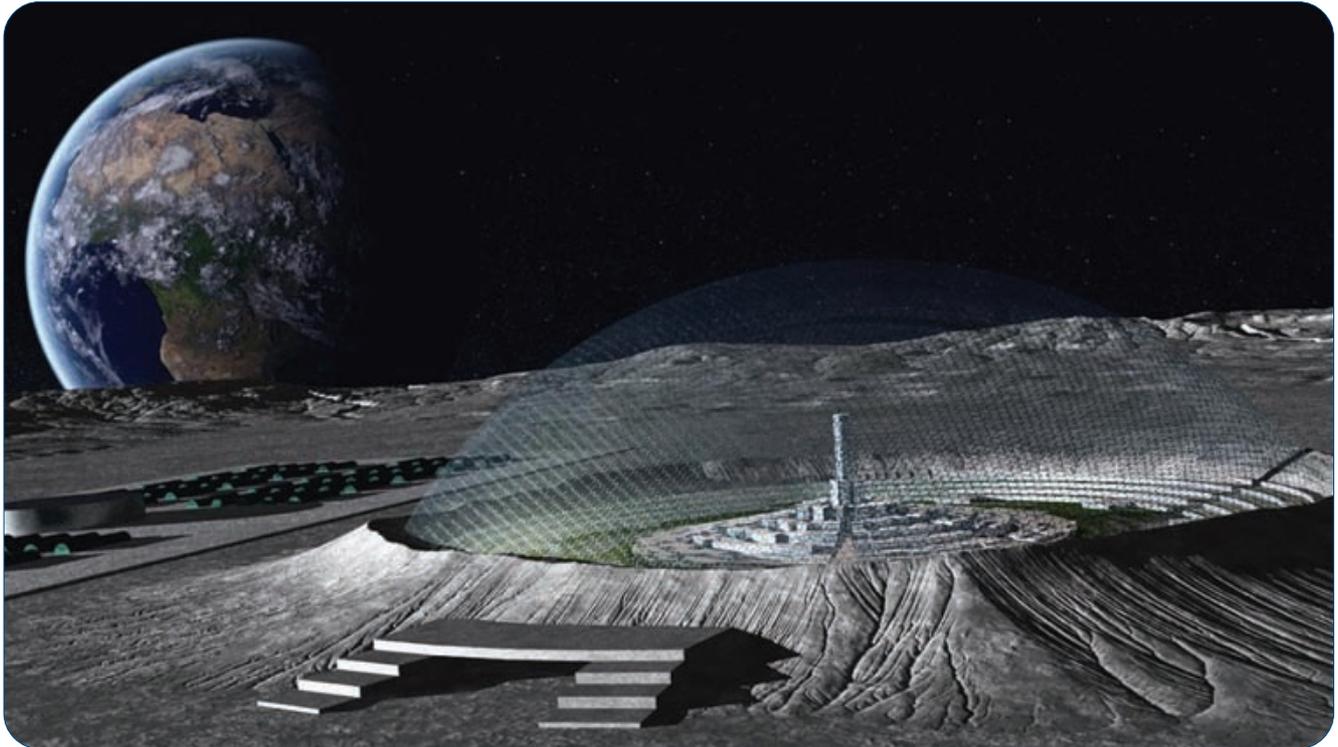
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ESA's 3D printed moon base

## Advances in 3D printing for the space sector

3D printing has come on in leaps and bounds in recent years, as developments have resulted in technology that is more readily-available, cost-effective, and sophisticated, than ever before. Today, 3D printing is being utilised by industries far and wide, and, naturally, the space sector is not one to be left behind.

**3D printing, or additive manufacturing, has been big news** in recent years. There's been a flurry of interest in the ability to print anything and everything, from guns to lampshades, that has really captured the imagination of the masses. Essentially, 3D printing enables the production of a 3D object based on a digital model, in a huge variety of materials, including plastic and metals.

The applications of 3D printing are many and varied. Clothes designers are experimenting with 3D printed shoes, dresses and bikinis, while food companies are using 3D printing to form chocolate and sweets to develop exciting new products. Manufacturers are seeing the benefits of being able to develop prototypes much faster and more cost-efficiently in a whole host of sectors, including the production of land and aerial vehicles. Meanwhile, the medical sector is making great strides in utilising 3D printing to create customised implants, for orthopaedics and splints, for example.

Within the space sector, the possibilities are endless. 3D printing is being used across the world to create CubeSats, ground equipment, launch vehicles and their components.

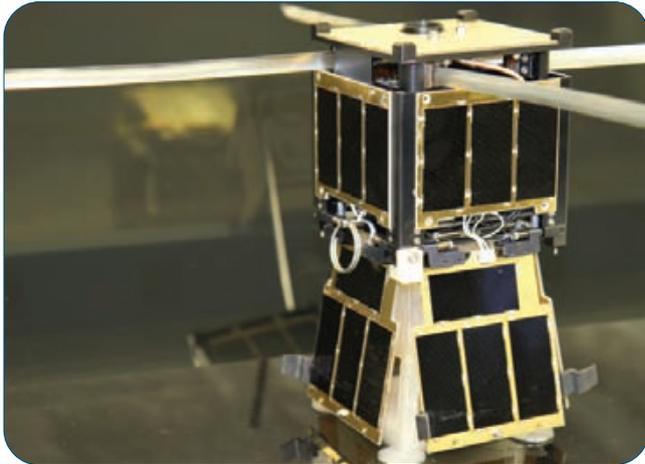
As for other industries, the benefits include rapid lead times, cost-efficient prototyping, and incredible flexibility. As the technology matures, 3D printing is expected to have a significant impact on all aspects of the space sector, including off-world and deep space missions.

### Earth-based 3D printing

With the growing popularity of 3D printing in such a vast array of industries, the barriers to entry are falling. Indeed, students at universities across the world have been getting in on the action, developing 3D printed CubeSats for launch on rideshare missions. A variety of traditional and NewSpace sector entities are now seeing the value in utilising 3D printing technology to advance their long-term goals in producing spaceflight technology here on Earth.

### Blue Origin

Like SpaceX, Blue Origin is working on providing commercial access to space at much lower costs than are possible today, by developing new launch vehicles technologies, including reusable rockets.



CRP USA's KySat2 in Windform XT2

Blue Origin began working on its fourth rocket engine, the BE-4 engine back in 2011. Designed to reach orbital space and beyond, the BE-4 will be the company's first engine to burn liquid oxygen and methane propellants. In September 2018, United Launch Alliance (ULA) selected the BE-4 engine to power its Vulcan launch vehicle, and according to Blue Origin, the BE-4 engine will be flown on both the Vulcan and its in-house New Glenn orbital vehicle in 2020.

The BE-4 features an Ox Boost Pump (OBP) to enhance performance; it is the component parts of the OBP which Blue Origin has opted to produce using 3D printing. The housing is a single printed aluminium component, while all

the stages of the hydraulic turbine are printed from the nickel alloy Monel. According to Blue Origin, this manufacturing approach enables the integration of complex internal flow passages in the housing that would be more difficult to make using traditional methods. The turbine nozzles and rotors are also 3D printed, requiring only minimal machining to achieve the perfect fit.

### Relativity Space

A relative newcomer to the space sector, Relativity Space was founded in 2015 with the mission of developing its own launch vehicles and engines for the commercial satellite sector, but utilising 3D printing much more heavily – apparently accounting for 95 percent of its launch vehicle components, engines included - than its competitors. In addition, with a particular focus on future missions to Mars, Relativity Space asserts that intelligent automation and lightweight, compact 3D printing are fundamental technologies required to build a new society with scarce resources.

The company has developed Stargate, reportedly the largest metal 3D printer in the world, to further its goals. Stargate is the backbone of Relativity Space's vertically integrated factory, capable of going from raw materials to flight within 60 days, for new and existing rocket designs alike. According to Relativity Space, Stargate is constantly getting smarter and faster using sensors and reward-based learning.

With Stargate, Relativity Space is developing the Aeon 1 engine, which can be produced within 15 days compared to the industry standard of 180, and featuring just 100

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Aeon 1 engine

components, where competitor engines typically have 2,700. The future looks pretty good for Aeon 1, which has completed more than 100 test flights to date. Ten of the liquid oxygen/liquid methane propellant Aeon 1 engines will be used to launch Terran 1, Relativity Space's two-stage 3D printed expendable launch vehicle, which is currently under development. Terran will be produced using a proprietary printable metal alloy and is uniquely designed for satellite constellation deployment and resupply missions. The company's website details launch prices at US\$10 million for a dedicated mission, US\$11,000/kg for SSO, and US\$8,000/kg for LEO, making it one of the most cost-effective launch vehicles yet.

### CRP Group

High-technology company CRP Group has spent considerable time developing its 3D printing capabilities for a variety of industries, including the space sector. The company specialises in the production of small satellites and their propulsion systems using 3D printing methods.

At the end of 2017, CRP Group launched the first fully-3D printed satellite from the International Space Station (ISS). The Tubesat-POD (TuPOD), a tube-shaped CubeSat, served as a deployment platform for smaller TubeSats, and was produced in collaboration with Teton Aerospace, Morehead State University and JAXA. The platform deployed TubeSats created by TanCREDO and ONSAT teams. TuPOD was 3D printed using CRP Technology's Windform XT 2.0 material, which is also used for wind tunnel and track testing for Formula One racing. The electrical components were added

to the satellite after it was printed. CRP Group has also used Windform XT 2.0 to 3D print the KySat-2 CubeSat in 2013.

The company has been ramping up its presence in the aerospace sector in recent months, so we can expect to hear a great deal more in the years to come.

### Aerojet Rocketdyne

Aerojet Rocketdyne is one of those long-standing aerospace and defence companies investing heavily into innovation on all fronts, including 3D printing. Following two decades of investment and research into the production of rocket engine and defence system applications via 3D printing methods, the company is now benefitting from more affordable technologies with significantly reduced lead times.

In recent years, Aerojet Rocketdyne has successfully hot-fire tested engines and propulsion systems made entirely with 3D printing and counts small satellite propulsion systems such as its MPS-120, the small and medium boosters making up its Bantam engine family, and the larger rocket engines like the RL 10 and the upcoming AR1, among its notable achievements. The company highlights the reduced costs, reduced lead times and increased flexibility among the advantages of 3D printed space components.

In October 2018, Aerojet Rocketdyne thrusters with 3D printed components were qualified to fly humans on NASA's Orion spacecraft. The reaction control system (RCS) is the only means of guiding the Orion crew capsule after it separates from its service module in preparation for atmospheric re-entry and splashdown. Aerojet Rocketdyne utilised 3D printing technology to produce the RCS engine nozzle extensions. The year-long qualification test programme saw a single engine subjected to shock and vibration that exceeded the maximum stresses expected during the upcoming Orion launch, wherein the vehicle will be launched around the Moon on NASA's Space Launch System (SLS) rocket.

### Lockheed Martin

Lockheed Martin, another satellite industry long-timer company, is pushing the limits of additive manufacturing technology to build space-qualified components that could not previously be built. The company famously launched the first-ever printed parts into deep space on board NASA's Juno spacecraft in 2011 and has made great advancements in technology since then.

In July 2018, Lockheed Martin completed a multi-year development programme resulting in the 3D printing of a 46inch diameter satellite fuel tank made from titanium. The tank consists of two 3D printed domes that serve as caps, produced using Electron Beam Additive Manufacturing, and a variable-length, traditionally-manufactured titanium cylinder that forms the body.

Satellite fuel tanks, which must be both lightweight and strong enough to withstand the vacuum of space for decades, are notoriously hard and expensive to produce; traditional manufacturing methods take around one year per tank, and 80 percent of the material goes to waste. With 3D printing, Lockheed Martin has cut out the waste, and significantly reduced the production timeline.

"Our largest 3D printed parts to date show we're committed to a future where we produce satellites twice as fast and at half the cost," said Rick Ambrose, Lockheed Martin Space Executive Vice President. "And we're pushing forward for even better results. For example, we shaved off 87 percent



of the schedule to build the domes, reducing the total delivery timeline from two years to three months.”

Later in October, Lockheed Martin and the Office of Naval Research announced a new two-year US\$5.8 million contract to explore how to apply artificial intelligence (AI) to train robots to independently oversee and optimise the 3D printing of complex parts. Technicians currently spend many hours per build testing quality after fabrication; this research will enable robots to make decisions based on previously verified analysis for the production of common types of microstructures much more efficiently than is achieved today.

“When you can trust a robotic system to make a quality part, that opens the door to who can build usable parts and where you build them,” said Zach Loftus, Lockheed Martin Fellow for additive manufacturing. “Think about sustainment and how a maintainer can print a replacement part at sea, or a mechanic print a replacement part for a truck deep in the desert. This takes 3-D printing to the next, big step of deployment.”

### Space-based 3D printing

3D printing is also becoming big business in space, with a number of entities, both commercial and association alike, keen to get in on the action. The possibilities of 3D printing in space are incredible; there are significant cost savings to be made by not having to launch tools and equipment from Earth, not to mention the time saved by simply printing whatever is needed, in space. Providing astronauts with the ability to print the things they need, when they need them, makes long-duration space travel, such as missions to the Moon, Mars and beyond, much more viable, not to mention much safer.

### Made in Space

Until recently, Made in Space (MIS) was the only commercial company working with 3D printing in space. The MIS Additive Manufacturing Facility (AMF) was launched to the International Space Station (ISS) in 2014, having been developed to operate in a microgravity environment. Since its installation, the AMF has been utilised by NASA, the US National Laboratory and commercial partners to carry out



Completed dome exiting printer

repairs, upgrades and installations, as well as complete novel experiments.

MIS is also working on some exciting new projects, including the Archinaut Technology Development Project (ATDP), an in-space additive manufacturing and robotic assembly platform. The project was extended by 12 months at the end of 2017 following a successful first year which saw the core technology, Archinaut's Extended Structure Additive Manufacturing Machine (ESAMM), developed and ground tested. The next step in ATDP focused on testing the Ground-Based Manufacturing and Assembly System Hardware (GBMASH), which combines additive manufacturing with robotic assembly. GBMASH paves the way for potential flight demonstrations of Archinaut's additive manufacturing and robotic assembly capabilities in space. Meanwhile, in July 2018 it was reported that MIS is using the Archinaut system to develop high power systems for small satellites, taking them from a typical 1kW power system up to 5kW. Archinaut-based solar array systems utilize space-manufactured structures and robotically-assembled state-of-the-art solar cell blankets to provide up to 20m<sup>2</sup> of solar array

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for small satellites that launch from ESPA rings or small launch vehicles. For small satellites, Archinaut's power system is able to provide up to five times the power of state-of-the-art systems by launching the system with raw material and tightly packed solar arrays, rather than folded up booms and complex deployment mechanisms. On orbit, Archinaut manufactures the core array lattice structures and robotically, physically and electrically, integrates solar array blankets, completing the solar array wing.

In other news, May 2018 saw NASA select MIS to develop VULCAN, a next-generation metal space manufacturing system. VULCAN will fabricate precision parts which require the strength and durability of aerospace-grade materials, such as housings for life support systems, that can't be made with current systems, from more than 30 aerospace-grade metals and high-grade polymers, and hybrid components that combine multiple materials. The technology is being developed for a demonstration on the ISS to example its usefulness in future human spaceflight operations, such as on board the Lunar Orbiting Platform Gateway. VULCAN will be the first of its kind to bring machined parts to space, enabling more critical parts to be manufactured off-world. The system's hybrid technique utilizes both additive manufacturing to create the desired near net-shaped part, and traditional manufacturing methods to create the finished product. The system manufactures, refines, and performs quality checks in a streamlined, automated process, eliminating the need for a human in the loop during manufacturing. VULCAN is expected to be ready for launch in the mid-2020s.

### The Refabricator experiment

Following on from MIS' world-first foray into space-based 3D printing is the Refabricator experiment, which was developed by Firmamentum, a division of Tethers Unlimited, Inc. (TUI) under a NASA Phase III Small Business Innovation Research (SBIR) contract. The experiment combines a recycling system with a 3D printer, producing a closed-cycle space-based manufacturing process. The Refabricator will accept plastic materials of various shapes and sizes and transform them into feedstock for the 3D printer.

"When we begin launching humans to destinations beyond low-Earth orbit, space will be at a premium," said Niki Werkheiser, Manager of In-Space Manufacturing at NASA's Marshall Space Flight Center in Huntsville, Alabama. "It simply won't be feasible to send along replacement parts or tools for everything on the spacecraft, and resupplying from Earth is cost and time prohibitive. The Refabricator will be key in demonstrating a sustainable logistics model to fabricate, recycle, and reuse parts and waste materials."

Closed-loop materials recycling, enabled by 3D printing, is expected to reduce the cost and risks for NASA and other space exploration missions going forwards. The Refabricator will be the first integrated recycler-manufacturer in orbit and may eventually be able to recycle and print, using metal as well as plastic, with very little monitoring from the station crew members.

By 2020, NASA wants to create a Fabrication Laboratory, 'FabLab,' to test an integrated, multi-material, on-demand system.

The Refabricator was launched to the ISS in November 2018 on board Northrop Grumman's Cygnus spacecraft's 10<sup>th</sup> commercial resupply services mission.

Firmamentum is also developing a revolutionary suite of technologies called SpiderFab, which will enable on-orbit

fabrication of large spacecraft components like solar panels and antennas, including kilometre-scale antenna reflectors. Under a NASA/LaRC SBIR contract and a follow-on NASA Tipping Point Technologies Public-Private Partnership, TUI is working on the first step in the SpiderFab architecture; the Trusselator uses 3D printing techniques and robotic assembly to create long, high-performance truss structures.

### The European Space Agency

The European Space Agency (ESA) is also exploring its 3D printing options. The agency launched an investigation in July 2018 to establish how 3D printing could be used to create and run a habitat on the Moon. The ESA opined that additive manufacturing could be used to create everything from building materials to solar panels, equipment, tools, clothes, and even nutrients and food ingredients.

One of the ESA's greatest priorities for future Moon-settlement missions is that they be self-sufficient, that personnel are able to utilise things that are already there or were brought on the original mission, rather than continually sending back and forth to Earth for more supplies, which would be extremely costly and time-consuming. As such, 3D printing is expected to allow on-demand production of key items and enable the routine recycling of materials available within the base, increasing sustainability. The ESA's research continues, being complemented by various public outreach programmes, including a 2018 call for ideas from the general public on the one item they would like to have 3D printed to keep in a lunar home. ■



Lockheed Martin Metal 3D printer

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## Using ABR-based high quality video delivery over satellite

Damien Sterkers, Product Manager at Broadpeak explains how satellite operators can utilize adaptive bit rate (ABR) streaming formats such as HLS and MPEG DASH as an addition, and even a possible alternative in future, to traditional transport stream broadcasts without facing any of the QoE issues, including latency, buffering, bitrate and video quality limitations, which typically are associated with OTT services.

**Video consumption on second screens, such** as smartphones, tablets and PCs, is increasing dramatically, and satellite pay-TV operators must respond to this market demand. Offering live over-the-top (OTT) video services to their subscribers by leveraging the broadband connection is an obvious but costly option, so in order to stay competitive, it's imperative that they find a more cost-effective way to deliver such video streaming services, addressing the broadest audience with the highest quality of service, which in most cases OTT streaming does not permit.

A key focus of this paper is how a transition to a full ABR distribution workflow that delivers the same video quality as



Damien Sterkers, Product Manager at Broadpeak

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broadcast is possible. Additionally, we examine how, by carrying ABR rather than traditional MPEG2-TS, satellite operators can easily and cost-effectively extend their offering, beyond live TV, to all other types of streaming services, including pause and time-shift, catch-up, start-over TV and VOD, delivered to connected devices for increased monetization, outlining the benefits of an hybrid satellite/OTT distribution and the new business opportunities this approach enables.

**Challenges facing satellite operators**

Today, competition is fierce in the pay-TV market and churn is a significant concern. According to Leichtman Research Group, the number of cord cutters in 2018 reached 2.9 million video subscribers, nearly double the 1.5 million in 2017.

In emerging countries, consumers prefer streaming services as opposed to free-to-air TV. A recent study by research firm Hub found that 56 percent of consumers say they use streaming platforms over pay-TV services to watch their favourite content. Since streaming services are typically available at a lower monthly subscription rate than traditional pay-TV offerings, they are driving advertising and subscription revenues down for satellite operators.

All these challenges mean satellite operators now need to find additional ways to make their most popular live content available on all their subscriber devices, not just the main room TV.

**How satellite operators have addressed the multiscreen challenge to date**

Two different approaches have been so far explored by several satellite operators who wanted to deliver a true multiscreen live TV experience.

The first one leverages the main room satellite set-top box which behaves as a video hub implementing a complex processing of multiple stream content decryption (Conditional Access termination) for all selected live channels, re-encryption (link encryption such as DTCP-IP or some form of DRM), stream re-packaging, a content description server and a streaming protocol so that the content is delivered to

the companion devices over the consumer local network. The client application includes a content discovery process and a bespoke player tailored to the characteristics of the packaged stream.

The second and more recent approach leverages the consumer's broadband connection to deliver the most popular live TV channels using OTT unicast ABR streaming, whereby the content is protected using a commercial DRM solution. This is usually deployed as a completely separate workflow which overlays the existing satellite head-ends.

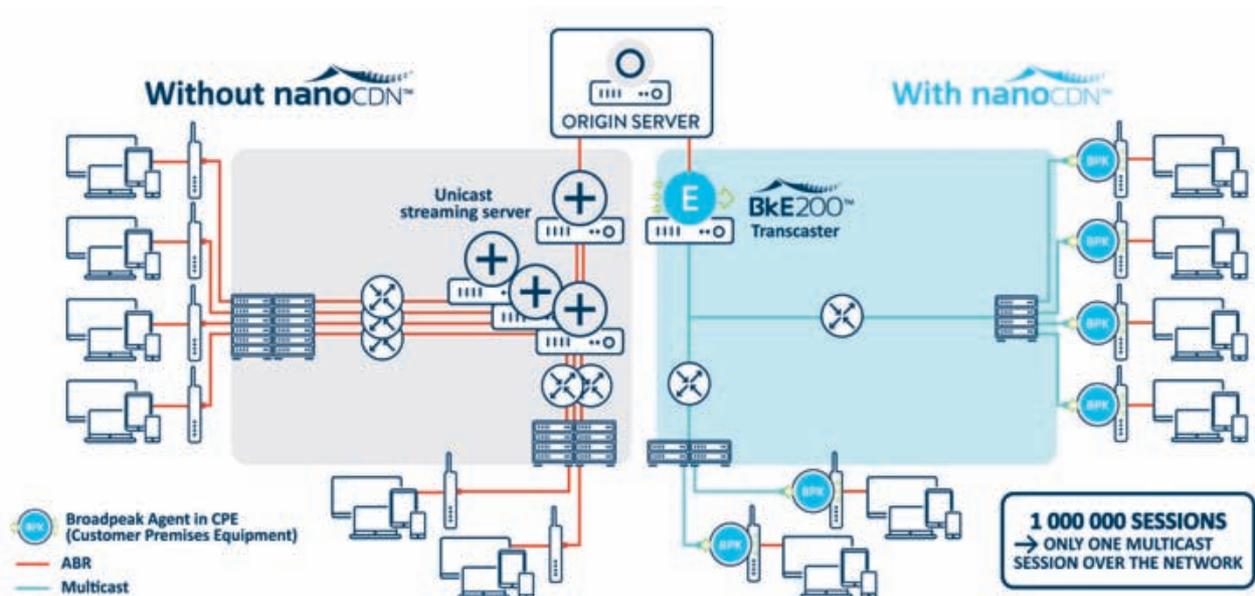
But both approaches have shown their own limitations. The former is costly and complex to develop and maintain, both on the satellite video hub side and the client applications side. It may support added value features such as time shifting, recording or catch-up on the conditions that the hub also features local recording, thus further increasing cost and complexity. The latter has limited reach since it requires a live video capable broadband connection, provides a lower quality video experience, and results in very high content delivery costs for the most popular live TV events, such as sports, because of the unicast transmission, a cost borne by the operator.

As we explain below, ABR streaming is poised to address these challenges and limitations.

**What is ABR live video delivery over satellite?**

Multicast ABR streaming has recently gained in popularity as it dramatically reduces the data traffic needed to deliver live OTT TV channels across the broadband delivery networks. But interestingly, because of its broadcast nature, a Multicast ABR stream can also be conveniently encapsulated and distributed over a one-way broadcast network, typically a satellite link. Using multicast ABR technology, satellite operators can now mix together IP streaming with regular satellite broadcast.

To achieve this, a transcaster server located in the headend retrieves existing OTT live TV streams and encapsulates them before they are sent via the satellite link to the target reception devices, i.e., satellite gateways or set-top-boxes. The satellite reception equipment at the consumer



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premises embeds a software agent, which simply performs the de-encapsulation of the live stream and its conversion to unicast before the chosen live TV service is delivered to any companion device attached to the home network. This delivery method is totally secure, as the content encryption is done before the multicast encapsulation step.

### Advantages of using ABR on satellite

Satellite operators can reap several benefits from the combined use of multicast ABR and satellite broadcast.

Firstly, ABR live video delivery over satellite dramatically increases the satellite operator reach, addressing at once all the companion devices of their entire customer base, making the popular live TV channels ubiquitous.

Secondly, thanks to the use of a standardized ABR solution, the operators can also take advantage of certain aspects of ABR technology, such as offering to the consumer the ability to seamlessly switch to non-linear (i.e., timeshift, catch-up) and personalized (i.e., targeted ads, regional programming) content which is then delivered as a regular OTT service.

Thirdly, adopting an ABR protocol for delivering live content to companion devices over satellite paves the way for a technology convergence, encompassing content protection and a unified transport layer. As mentioned before, for the time being satellite operators have to setup a separate OTT workflow for live video streaming services, thus supporting the cost of two different transport layers and two different content protection solutions, or alternatively implement a complex and costly processing in their set-top boxes. In future, once the multicast ABR technology is adopted, the entire ABR workflow can be used for addressing the companion devices as well as become the reference implementation of the set-top box internal decryption and video decoding processes.

Compared with unicast, the delivery scheme traditionally used in the OTT world, multicast ABR offers better scalability and quality. It also offers a unified delivery mode via the internet. Furthermore, with multicast ABR, satellite operators stand to gain all of these benefits without compromising on the quality of service.

### Monetization opportunities

Multicast ABR technology opens up new monetization opportunities for satellite operators by enabling them to reach new customers, provide a higher quality service and reduce churn. By adopting an IP streaming paradigm, satellite operators can cost-effectively appeal to consumers who like to watch news, entertainment, and live sports on their mobile devices.

Beyond linear TV, operators can implement VOD and catch-up pre-caching through satellite, the most popular content from a specific content provider can then be stored on the receiving device. Viewers can instantly access popular UHD and 4K content, which is pre-cached locally, even when streaming bandwidth resources are limited. Offering UHD and 4K premium content on connected devices is a great way for operators to differentiate themselves in a crowded marketplace and address the demand for higher quality content.

Advertising is a prime revenue generator for operators, and multicast ABR enables targeted advertising on the same model as OTT, giving operators an extra monetization boost. For local ad insertion, ads are either streamed directly from

the network, in a seamless transition from satellite to IP network, or pushed via satellite to local devices in advance, whenever they have the relevant tag related to the user profile, to be seamlessly inserted when the ad insertion trigger comes.

### Conclusion

Traditional satellite broadcast has distinct advantages; its reach is unparalleled compared with any other technology, and it's generally reliable. But more and more satellite operators are starting to capitalize on the power of multicast ABR technology as a natural extension of their advances in the field of OTT. With multicast ABR, operators can smartly address the scalability issues of OTT unicast delivery while reaping its benefits.

Creating a multicast ABR network over satellite is perfect solution for today's operators that are looking for growth, as it enables them to continue serving their traditional pay-TV customers and offer OTT services to today's mobile-driven consumers while preserving the exceptional quality, low latency, and superior QoE provided by satellite, even better than what ISPs can offer. ■



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## Supporting government with commercial solutions

Hughes prides itself on being the global leader in broadband satellite technologies, services, and managed network solutions. The company's Defense and Intelligence Systems Division has long served the government and military sectors, delivering secure and reliable services in an increasingly contested and congested space. Rick Lober, Vice President of Defense and Intelligence Systems Division at Hughes Network Systems, LLC, opines on the latest developments in commercial, government and military satellite communications solutions, and the potential for cross-over among them.

**Question: The government and military sectors are both complex markets to serve, with very specific demands. What are the unique challenges in serving these markets, and how does Hughes meet this demand?**

**Rick Lober:** Commercial industry moves pretty quickly, and government tends not to move quite as fast, so we're working hard to make sure that government customers, including MoD and DoD, stay up to date with the latest in communications technologies. We need to demonstrate the many advantages of adapting and deploying

advanced commercial satcom systems and solutions.

For example, one of the biggest ongoing challenges is resiliency. In the past, our adversaries in Iraq, Afghanistan and elsewhere in the region, were not very sophisticated when it came to communications technology, and jamming instances remained low. The reality now is that if the US or its allies get into a military conflict with a near-peer adversary, we should expect to see our systems get jammed and face serious operational threats and disruption. What we call resiliency is all about having a system

that can hold up to these modern threats.

**Question: There's a lot of change in the commercial satellite sector right now, with new technologies being rolled out across the board. Which of these do you feel will have a positive role in supporting the military and government spheres?**

**Rick Lober:** The government has always used commercial satellite bandwidth to supplement their purpose-built satellites or pure military satellites. Government leaders are now pushing to move to the managed services



*Rick Lober, Vice President of Defense and Intelligence Systems Division at Hughes Network Systems, LLC*

model, in which a trusted industry partner manages the network, saving costs by reducing dedicated manpower, while improving reliability, efficiency, and most importantly, staying ahead of technology developments before our adversaries.

Many significant changes are afoot right now in satellite and space in general. Commercial satellite operators globally are moving to high throughput satellites (HTS), which utilise spot beam technology to concentrate power and capacity over a defined region to support operations on the ground. And we are seeing the early rollout of non-geostationary satellites (NGSO), starting with low Earth orbit (LEO) constellations. Hughes is working very closely as a partner and supplier of the ground network for OneWeb, one of the leaders in this emerging segment. It's going to be a real game-changer for government applications because it will allow for polar coverage and reduced latency, as orbits are in the 1,000km range, 40 times closer than GEOs. These LEO constellations will also help increase resiliency because each satellite's coverage beam has inherent properties that resist jamming and there are hundreds in orbit simultaneously, making it difficult to disrupt an entire fleet.

Another area we're advancing is network interoperability. The idea is to open up some of the interfaces in the system, from the modem to the antenna, for example, or from the modem to the network operations centre, such that we can use best of breed equipment, different technologies

from different suppliers, thereby raising the competitive bar and yielding higher performance and more secure solutions.

We also need to work on interoperability standards between the government and commercial networks, moving past just general understandings. For example, you can talk to someone on a Voice over IP (VoIP) network or a terrestrial phone network using your cell phone, and it all interconnects at higher network layers. However, there's some interface definition that could be added to military SATCOM systems to help that interoperability along.

There have also been vast improvements made in network management techniques. Probably the 'lowest hanging fruit' for the government to improve on its networks is to apply commercial network management techniques and best practices. Hughes runs one of the largest networks in the world, and we're running five generations of GEO satellite technology plus terrestrial wireline and wireless technology, and soon we'll be folding LEOs into the mix. We do all of this in one network operations centre using commercial tools and software we've developed over the years. Unfortunately, the government still plans a lot of their



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network usage using a fairly manual process. It can take days to make a bandwidth assignment, instead of the seconds it takes on a normal commercial network.

These are some of the things we feel we can bring to government networks to help improve reliability and efficiency.

**Question: How will governments incorporate LEO constellations into their operations in the future?**

**Rick Lober:** I think that over time, as the terminals become more developed, we'll see LEO satellites become well-utilised within the government and military areas. With the full coverage and latency savings these systems will bring to the table, governments will benefit from faster response times, built-in resiliency, and if there are 600-800 LEO satellites in orbit, if one satellite goes down, the next is only a couple of minutes away.

It's going to be the terminal development that will be key. I think one of the technologies that the terminals will require is electronically steered arrays (ESAs). Compared with mechanically-pointed antennas, these

new ESA systems will enable the LEO constellations to reach their potential.

This 'shielding effect' (where LEO satellites eclipse signals being transmitted between GEOs and the Earth) that some people are talking about will not be a problem. It's part of the licencing process that's currently underway. LEO operators are working very closely with GEO operators and regulators to ensure that there are no interference problems. The shielding problem was considered very early on, and it is being addressed.

**Question: What are your expectations for the military and government markets going forwards, and what is Hughes working on in these areas?**

**Rick Lober:** Commercially, we're seeing strong demand in our consumer and enterprise networks; there's more and more demand for higher speed connections and bandwidth. We see the government having the same issues. There's an insatiable demand for bandwidth and they're not going to be able to fulfil requirements on their own without commercial industry working

closely with them to meet their goals.

In supporting military customers, we have a significant focus on airborne ISR. Hughes was selected by General Atomics to work on their next-generation Predator UAV under a programme for the UK MoD, which will operate on the Skynet 5 X-band satellite that the MoD uses. We're also looking at other platforms, such as Class 3 UAVs, and we've developed advanced solutions for beyond line of sight rotary wing communications, with the antenna mounted on the fuselage and enabling reliable transmissions through the blades.

An exciting area we're working on is helping the DoD utilize the best of commercial satellite communications by improving interoperability. For example, we've developed a flexible modem interface and are working on pilot programmes with the USAF to prove out the interoperability technology. Finally, we feel that our 30-plus years in managing global networks using multiple generations of satellite and terrestrial technology can be applied to military networks and will result in improved efficiency and cost savings. ■



Hughes HeloSAT solution. Photo courtesy of Hughes Network Systems

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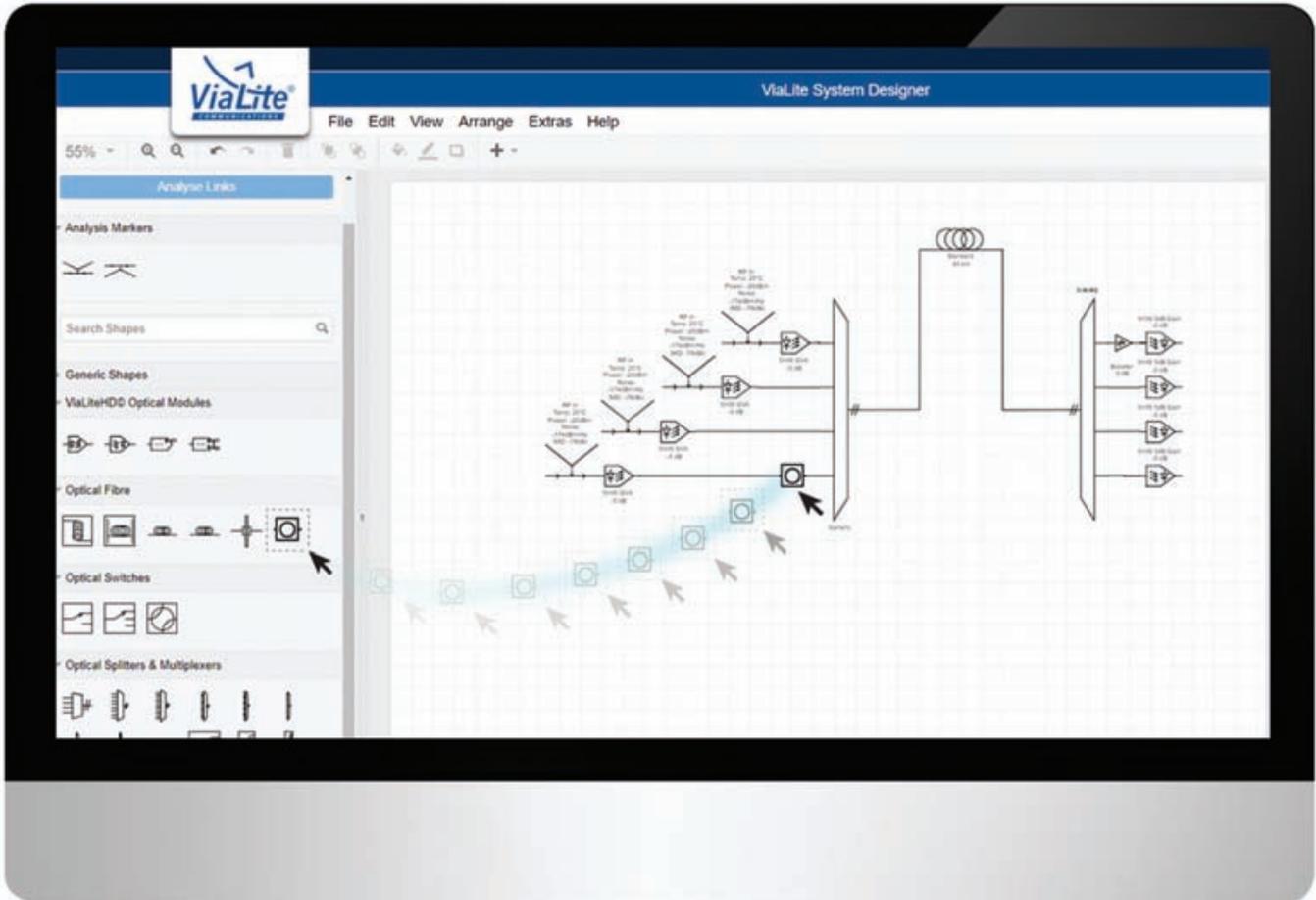
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## Planning for the future

*ViaLite* Communications, a division of Pulse, Power & Measurement Ltd (PPM), designs and manufactures RF over fibre links and systems to meet a wide range of applications, including satellite teleports, downlinks, VSAT, interfacility linking, cellular networks, broadcast and GPS timing signal distribution. John Golding, *ViaLite's* recently-appointed new Product Manager, discusses the state of the satellite market and the company's plans for the future.

**Question:** As a recent new addition to the *ViaLite* team, what experience and expertise do you bring with you to your new role?

**John Golding:** With over 25 years of experience in RF and exposure to many different industry verticals outside of areas previously covered by *ViaLite*, I'm able to add some exciting and new product direction to the mix. For the last decade most of my time was spent working with mmw (millimetre wave) products in V and E-band (60 & 80

GHz); this is extremely useful considering the satcom industry is moving in this direction.

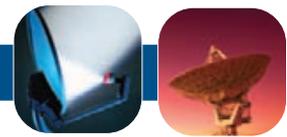
**Question:** What's your assessment of *ViaLite's* market position, and where do you see the most opportunities going forwards?

**John Golding:** *ViaLite's* products are considered to be at the premium end of the spectrum, and with a 25-year heritage are known for their quality and reliability within the broadcast and

Teleport sectors. We will be continuing to further improve our products and exceed customer requirements by having superior dynamic range (SFDR) and quality.

This approach is particularly interesting to more demanding sectors such as Aviation, Space and Security. But *ViaLite* has moved beyond simple point-to-point links by introducing LDL (Long Distance Links), DWDM, Optical amplifiers, Optical switches, Delay lines, DCF's and many other accompanying products. One of the biggest issues is pulling all these new options together into a system design which the customer can evaluate properly, up until now this has not been easily possible. However, with the release of *ViaLite's* System Designer software, this task has become much easier.

**Question:** *ViaLite* plays a key role in the global satellite sector, but there's a lot of change going on right now, with spectrum access, extreme throughput satellites (XTS) and mega-constellations all coming into play. What impact will these fast-



John Golding, *ViaLite* Product Manager

**next couple of years. What can you tell us about *ViaLite*'s plans for Q and V-band?**

**John Golding:** We have plans to cover these emerging areas, starting with Q-band and working towards V-band over the next couple of years. As frequencies get higher the physics gets more challenging and thus making a cost-effective product becomes much harder. This is a very interesting area and we have some of the best industry veterans working on this challenge.

**Question: What can you tell us about recent product developments, and what can we expect to see from *ViaLite* over the next 12 months?**

**John Golding:** We have recently

released two new high-performance C-band products and a tri-band product covering from 500MHz, right through to 7.5GHz. This massive bandwidth opens up many new market areas: Radar, surveillance, drone tracking etc.

We are seeing a big uptake in our DWDM products and our System Designer tool, which is enabling customers to specify, design, validate and build an end-to-end solution themselves.

It also allows them to create a full Bill of Materials. If the customer desires, we can offer them a design service where the finished design is then verified by *ViaLite*. This ensures the design is fit for purpose and meets all performance criteria. ■

**paced developments have on *ViaLite*'s success?**

**John Golding:** We have already started to adapt, change and plan our products in differently to cover these evolving markets and secure the future of the business. *ViaLite* has a great range of products covering the lower and midrange bands, and some with very wide bandwidth requirements. We already supply many Teleport operators globally and are already prepared for the introduction of MEO and LEO constellations due to be launched in the near future.

**Question: The first commercially-available Q/V-band products are now available, and we can expect to see the first satellites launched in the**



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Blue Origin's orbital rocket New Glenn

## The NewSpace race

NewSpace is the proverbial gold mine of the spaceflight industry right now. This hot topic is raising eyebrows all over the world, and anyone who's anyone wants to get in on the action. The world's billionaires are getting in on the ground floor of what is expected to become a long-standing multi-billion-dollar industry, where there's literally something for everyone with opportunities as diverse as off-world settlements, additive manufacturing and deep space mining.

**NewSpace or Space 2.0 - the emerging private** spaceflight industry - is coming on in leaps and bounds and is already having a major impact on the global satellite sector. The days when the space domain was purely in the hands of governments and defence groups around the world are gone; today, private companies dominate the sector, helping spaceflight technologies to develop more quickly, more efficiently, and more cost-effectively than ever before.

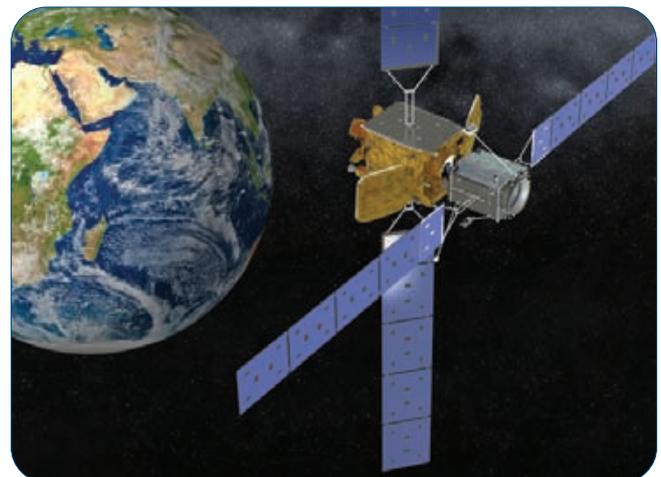
### What is NewSpace?

Here at *Satellite Evolution*, we're often asked questions about NewSpace: What exactly is NewSpace? What does it mean for me? How is it different from old space? There is no simple answer – although our dedicated NewSpace platform can keep you up to date on all the latest news and developments at <https://www.newspaceinternational.com/>.

The NewSpace movement is incredibly varied and wide-reaching, encompassing a whole host of sub-sectors. Some of the more traditional satellite segments have been evolving in recent years to accommodate the increased focus on the commercial side of the industry and the myriad of new applications coming into play:

### Launch services

Launch services, something all of us in the satellite sector are well-versed on, are seeing a revolution from within with the NewSpace movement, with fantastic new ideas taking



MEV. Photo courtesy of Northrop Grumman



Mission to Mars. Photo courtesy of SpaceX

hold. There are the industry old-timers such as Arianespace, which is enabling a lot of NewSpace satellite launches through rideshare models and more flexible payload options, as well as the more recent ventures such as SpaceX and Blue Origin, arguably the most advanced in their efforts towards developing reusable launch vehicles, with their Falcon 9, Falcon Heavy, BFR, New Shepard and New Glenn rockets. Virgin Galactic is exploring in-air launch capabilities for small satellites with its LauncherOne and SpaceShipTwo vehicles, while NanoRacks is launching CubeSat missions from on board the International Space Station (ISS). Rocket Lab, the owner of the world's first private orbital launch complex, completed the first commercial flight of its small satellite launch vehicle, Electron, at the end of 2018, while fellow small satellite launch start-up Orbex is preparing for its first launch.

**Satellite manufacturing**

Going hand-in-hand with next-generation launch capabilities is the production of an entirely new generation of satellites; small satellites (including mini, micro, nano, pico, femto, and of course, CubeSats) are enabling a whole host of new space-enabled applications, while the world's first software defined satellites are improving existing satellite applications with enhanced cost-efficiency, lead time, and on-orbit flexibility. Satellite manufacturing is becoming more specialized than ever before; Clyde Space, Boeing, Surrey Satellite Technology Ltd (SSTL), Lockheed Martin, Mitsubishi Electric Corporation, Orbital ATK, SSL and Thales Alenia Space are all heavily invested in small satellite manufacturing, while Airbus Defence and Space has made spectacular progress with the inauguration of several serial production lines in France and the USA for the assembly, integration and testing of OneWeb's small satellites. Meanwhile, production of the world's first software-defined satellite, Eutelsat QUANTUM, has been completed by Airbus Defence and Space.

**3D printing**

3D printing or additive manufacturing has become increasingly advanced in the last ten years, with new technological developments rendering it a cost-effective alternative to traditional manufacturing methods, enabling low lead times and incredible flexibility. 3D printing is being utilised in a number of industries, including the space sector, where it is being utilized to create ground equipment, satellites and

their components, launch vehicles and their components. Blue Origin's BE-4 engine is being developed with 3D printed Ox Boost Pump (OBP) components, while CRP Group has launched several small satellites utilising 3D printed components. Relativity Space has developed the world's largest metal 3D printer, Stargate, to produce its all-3D-printed Aeon 1 engine, which will power its all-3D-printed Terran 1 launch vehicle. Aerojet Rocketdyne now has a line of 3D printed engines and propulsion systems, while Lockheed Martin is creating 3D printed satellite fuel tanks and is exploring the integration of artificial intelligence (AI) and additive manufacturing technologies. *See 3D printing focus in this issue.*

**Satellite constellations**

Satellite constellations have been big news in recent years, with existing systems such as the Iridium network, Globalstar and O3b Networks demonstrating the possibilities. Medium Earth orbit (MEO) and low Earth orbit (LEO) have remained largely unused to date, with the majority of satellites launched throughout history being placed into geostationary orbit. All that is about to change with the planned Iridium NEXT, O3b mPOWER, OneWeb, LeoSat, Telesat, Boeing, Fleet, Samsung, Kepler Communications, SpaceX and Facebook constellations edging closer to becoming reality. It's broadly expected that around 2,000 new commercial small satellites

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will be launched by 2026, including almost 1,000 for OneWeb. Most of the planned constellations will target the global connectivity market, delivering low-cost high-speed Internet services, and are expected to help bridge the digital divide. Earth observation is the next biggest market for these satellite constellations.

Moving on from the evolution of the traditional space and technology sectors, the NewSpace movement is also opening up doors to entirely new industries:

### On-orbit satellite servicing

We've been hearing about on-orbit satellite servicing for a few years now, and these services are set to remove the single biggest lifetime limiter of satellites today; fuel supplies. A typical geostationary telecommunications satellite is retired after 15-20 years, not because any of the components cease to operate, but because they no longer have enough fuel to maintain station-keeping duties and attitude control. Now, several companies have announced upcoming services to meet this niche market.

Possibly the biggest name in on-orbit satellite servicing, Orbital ATK (since absorbed by Northrop Grumman) has plans for two Mission Extension Vehicles (MEVs) – one due for launch this year, the other due for launch in 2020, both of which will service Intelsat satellites – and Mission Robotic Vehicles (MRVs) that will transport 10-12 Mission Extension Pods (MEPs), which will offer on-orbit robotic servicing capabilities – due for launch in 2021. Meanwhile, Effective Space Solutions Ltd is developing the SPACE DRONE, a satellite servicing spacecraft which docks to a host satellite to provide station-keeping and attitude control capabilities; the first two SPACE DRONE spacecraft are due for launch in 2020. In an example of the type of public-private partnership

that is expected to become increasingly ubiquitous in the NewSpace era, the US Government's DARPA has selected SSL as its commercial partner for its own Robotic Servicing of Geosynchronous Satellites (RSGS) programme, which will develop technologies for cooperative inspection and servicing in GEO. NASA is working on its own robotic satellite servicing plan with the Restore-L mission – due for launch in 2022 - but with a focus on servicing satellites in LEO.

### Off-world mining

As we edge closer to reusable launch technologies and cost-effective deep space travel, the prospect of off-world mining becomes ever closer to reality. The extraction of valuable raw materials from planets, moons or asteroids can provide renewed access to elements depleted on Earth, as well as supporting deep space missions of the future.

Planetary Resources is refining its deep space mining technologies, starting with the 2018 launch of its Arkyd-6 CubeSat, which will detect water resources in space; the company ultimately aims to identify, extract and refine resources from near-Earth asteroids. Meanwhile, Deep Space Industries (DSI) is exploring deep space resource utilization with the development of cost-effective access to space via new spaceship technologies, while Moon Express is focusing on the extraction of minerals and water from the Moon, for conversion into rocket fuel.

Asteroid Mining Corporation (AMC) has ambitious plans for a prospector satellite, a space-based additive manufacturing system, and an asteroid-mining probe, and TransAstra Corporation wants to see thousands of asteroids transformed into refuelling stations and plans to supply asteroid mining, space solar power, space tourism and space-based manufacturing processes.



Axiom Station forward view. Photo courtesy of Axiom Space



**Manufacturing in space**

Hand in hand with deep space mining and 3D printing is space-based manufacturing. There are several advantages to manufacturing items outside a planetary atmosphere; the unique environment of space can enable industrial processes that cannot be readily reproduced on Earth; potentially hazardous processes can be performed in space with minimal risk to Earth's environment; raw materials, mined off-Earth, can be used in space instead of being transported back to Earth at great expense; items too large to be launched into space economically can be assembled there instead; equipment and tools can be rapidly and cost-effectively be manufactured in space instead of being shipped from Earth at great expense and with delay.

The Made In Space (MIS) Additive Manufacturing Facility (AMF) was launched to the ISS in 2014, since when it has been demonstrating closed-cycle manufacturing, carrying out repairs, upgrades and installations, and exploring the possibilities of 3D printed food, among other tasks. Meanwhile, Firmamentum, a division of Tethers Unlimited, Inc. (TUI), launched the Refabricator experiment, a 3D printer which will accept plastic materials of various shapes and sizes and transform them into feedstock, at the end of 2018.

**Space tourism**

One of the most widely-discussed NewSpace applications is the possibility of space tourism. What's news to many people is that there was actually a space tourism programme operating in the 2000s – Space Adventures transported seven commercial astronauts to the ISS before the means of transportation became unavailable. Space Adventures plans to enable new space tourism opportunities within the next ten years, including orbital spaceflight missions to the ISS, zero gravity flights, cosmonaut training programmes,

spaceflight qualification programmes, circumlunar missions around the Moon, and is taking reservations for future suborbital spacecraft.

Plans for commercial space stations are rife: Roscosmos has started work on its own space tourism programme, with plans for a luxury space hotel module on the ISS in 2022, in partnership with contractor RKK Energia. Similarly, Bigelow Aerospace, the only company commercializing NASA expandable module technologies, aims to create a modular set of space habitats for creating standalone or expanding existing space stations, for the realisation of commercial space station habitats starting in 2022.

In competition with Bigelow is Axiom Space, which plans to manufacture the world's first commercial space station, linking a module with the ISS in 2019, and expand it with additional modules upon the retirement of the ISS in 2028. Orion Span, too, has announced plans for the Aurora Space Station, a six-person capacity private space station reportedly due to accept its first guests in 2022.

On the non-space station space tourism front, Elon Musk has been very vocal in his plans for SpaceX to enter the commercial spaceflight sector by bringing humans to Mars; he plans to send the first cargo mission to Mars in 2022, with a crewed mission on the cards for 2024.

The lesser-known Blue Origin is also developing new launch vehicles to provide commercial access to space, and the company plans to release tickets shortly for eight-minute flights some 307,000ft above the Earth on board its sub-orbital crew capsule. Virgin Galactic, alongside sister companies The Spaceship Company and Virgin Orbit, is developing a new generation of reusable space vehicles to open space to the masses and plans to run a regular schedule of spaceflight for private individuals from its operational hub at New Mexico's Spaceport America, the world's first purpose-built commercial

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spaceport. KosmoKurs is another start-up with plans for a reusable suborbital space complex (MSCC) consisting of a reusable suborbital rocket (MSRN) and reusable suborbital spacecraft (MSCA); commercial flights are expected to begin in 2025.

#### Off-world settlement

Another topic straight out of science fiction, off-world settlements is something several entities are actively working towards. The primary argument for colonisation is the long-term survival of human civilisation, although there are many challenges to overcome before it becomes a reality; transportation, sustainable habitats, settler health and well-being, energy, resources, terraforming, communications with Earth, etc., the list goes on and on.

SpaceX's Elon Musk has stated that one of his longer-term goals is the colonisation of Mars, while the Mars One project, headed by Bas Lansdorp, is aiming for a permanent manned Mars landing in 2032. Lockheed Martin has outlined its Mars Base Camp concept, a crewed Mars laboratory orbiter, for NASA; the company is also working with NASA on the Lunar Orbital Platform-Gateway (LOP-G), a planned lunar-orbit space station. NASA is also targeting the Moon with Exploration Mission-1 (EM-1), which will be the first

integrated unmanned test of its SLS rocket, Orion spacecraft and ground systems in 2020 – manned missions will follow soon after.

In other news, Japan's JAXA is working on a Smart Lander for Investigating Moon (SLIM) project, which will essentially land wherever desired, rather than wherever is easy; the first launch is expected in 2021. China, too, is getting in on the action, with the 2018 launch of the Queqia relay satellite and the Chang'e 4 rover, to the far side of the Moon. In other news, PTScientists is also targeting lunar exploration with plans for the world's first private mission in the second half of 2019, while Moon Express plans to offer commercial lunar robotic transportation and data services with a long-term goal of mining the Moon for resources.

#### A time for change

NewSpace is as varied a sector as any other, and more so than many. The opportunities available today for traditional spaceflight companies and start-ups alike are incredible, and private sector and venture capital investment is at an all-time high.

We're at a time of great change, with new pressures and new possibilities emerging after decades of industry stagnation. Now is the time to strike. ■



Mars Express. Photo courtesy ESA/TG medialab: Mars: ESA/DLR/FU Berlin



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## Advanced high power GaN SSPAs for very high data rates over satellite

The satellite communications amplifier market has come on in leaps and bounds in recent years, as new applications have demanded new innovations from manufacturers across the board. With 5G and Internet of Things (IoT) coming to fruition, Cristi Damian, VP Business Development at Advantech Wireless Technologies, outlines how the company has responded with products to fulfil every niche.

**The SATCOM industry is currently in a state of flux.** There is an excess of capacity worldwide, a significant customer migration to cellular carriers, and massive deployments of fibre, among other challenges. At the same time, there is great opportunity for those who want to demonstrate leadership in the industry. The solution will be facilitating much higher data rate transmissions at a fraction of current costs.

Advantech Wireless Technologies introduced Gallium Nitrate (GaN) technology into Solid State Power Amplifier (SSPA) design in 2010. This technology has been successful in the past and will represent significant potential for the entire SATCOM market in 2019 and beyond.

### **Tremendous opportunities are imminent**

Tremendous opportunities are imminent within the satellite mobility market today. Small form factor SSPAs can be placed

in SATCOM on the Move (SOTM) terminals on airplanes, drones, trains, ships and any terrestrial vehicles. Powerful man pack terminals, with the ability to deliver high data rates, are available, and very large SSPA systems that are revolutionizing the way today's teleports are built are also at hand. Advanced high power GaN SSPA systems can provide exceptionally high data rates for teleports with dramatically reduced costs.

Current international digital video broadcasting (DVB) standards are providing additional guidelines to address the need for increasing data rates without adding costs. Currently modems with very high data rates and very high order modulations exist such as 256APSK. Efficiency gains of up to 51 percent can be achieved with DVB-S2X. Higher data rates as well as higher modulations demand more RF power, however.

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This is where the need for advanced GaN systems is evident.

### Evolving technologies

GaN technologies have been evolving steadily over the last decade. In 2008, Advantech conducted several trials over satellite to close a link with 64QAM modulation. The trial was successful using 30m antennas and 800W SSPAs. However, the trial demanded such a large carrier-to-noise (C/N) ratio that it consumed the entirety of the transponder's power. Since the costs of the transponder could not be shared with a partner, in this instance there were no efficiencies derived from 64QAM.

By 2013, sizable advancements were made including this example. Two new teleports were equipped with Advantech's 2.5kW modular GaN systems and 13m Ku-band antennas. This resulted in several sizable milestones:

- For the first time, Ultra HD 4K sporting events were transmitted worldwide.
- 48 transponders were uplinked from a single antenna and an entire satellite was saturated. This effective use of satellite capacity achieved more than 5Gbps of data rates.
- Four antennas were replaced by a single antenna and an all outdoor solution was executed.
- With availability close to 100 percent, there is no single point of failure. This modular system can allow for two consecutive failures with no impact on transmission performance. Additionally these teleports are unmanned, further reducing the costs to operate them.
- OPEX cost savings exceed US\$200,000,000.

### Opportunities in 5G

Today, the technology has advanced even further. A satellite link with 256APSK can now be closed using a 4.5m antenna and a 400W C-band GaN SSPA. Due to these significant developments, the 5G opportunities that are presenting themselves around the world can be successfully addressed by the SATCOM industry. The 5G market will require 8 Bits/Hz, and the RF technology in the SSPA will allow for that. Internet of Things (IoT) technologies alone will require very large bandwidths, and the new generation of GaN SSPAs from Advantech allow for very good AM/PM performance which minimizes the impact of amplitude modulation on phase modulation when transmitting 256APSK.



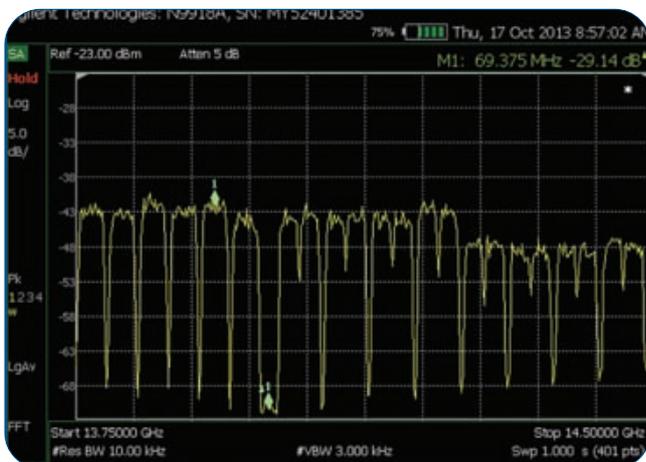
Photo courtesy of Shutterstock

Another opportunity surrounding 5G will occur because very high linearity, in terms of intermodulation, will be required in order to transmit multiple carriers. Additionally, Advantech engineers have solved the challenge of addressing memory effects in their GaN design.

The system design was reworked to solve the problem of very high noise levels created by mistake or by the incorrect use of technology. In order to compensate for the high noise levels, more carrier power is needed in order to achieve the same C/N ratio. The resulting Advantech modular GaN system that has been developed has very low noise generated levels and generally that translates into lower RF transmitted power most of the time.

As an example, two teleports whose designs were experimented on achieved 3dB more in power efficiencies than the link budgets originally suggested. Furthermore, a recent 4kW Ku-band system installed at a major International TV Broadcaster produced almost three times more linear power than expected. This accomplishment allowed the end customer to use a 9m antenna, instead of a 13m antenna, resulting in further significant cost reductions.

This critical technology will allow the SATCOM industry to successfully address needs in the IoT and 5G markets. With these advancements, uplinks in excess of 20Gbps of data are possible in a very cost-effective way. The low satellite bandwidth cost and advanced modem technology can now be taken advantage of. GaN SSPAs do bridge the gap and create successful business outcomes. This is an ideal opportunity for the satcom teleport market to capitalize on. ■



Multicarrier transmission on high power GaN system



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## High performance network

Intelsat General (IGC) is a wholly owned subsidiary of Intelsat, operator of the world's first Globalized Network. IGC provides secure satellite communications services to the world's militaries and the US Government. Skot Butler, President at Intelsat General, discusses the company's latest advances, as well as recent developments in the field of government and military services.

**Question: What has the response been to Intelsat Epic<sup>NG</sup>? How has that changed what you can provide to government customers, particularly now that your fleet is now fully global?**

**Skot Butler:** We've had a positive response to Intelsat Epic<sup>NG</sup>. In September 2018, we successfully launched the sixth and last of our first-generation Intelsat Epic<sup>NG</sup> satellites, Horizons 3e. Horizons 3e entered service in January 2019, and with its coverage of Asia-Pacific and the Pacific Ocean region, our global high-throughput fleet is complete. Our government customers are already realizing the benefits of the higher data rates, availability, resiliency and redundancy of the Intelsat Epic<sup>NG</sup> fleet.

From a performance perspective, the Intelsat Epic<sup>NG</sup> high throughput

satellite (HTS) constellation far surpasses the bandwidth speed and throughput possible with previous, wide-beam satellites. Tests conducted in 2018 on a Gilat 6" flat panel antenna on an Intelsat Epic<sup>NG</sup> satellite demonstrated throughput rates of 3.9Mbps with an efficiency of 0.26bits/Hz. This compares to an uplink rate of 1.8Mbps and an efficiency of 0.09bits/Hz achieved with a conventional wide-beam satellite. The HTS link was effectively twice the data rate and almost three times more efficient than traditional wide-beam satellites.

So, what does this mean from a customer perspective? It powers new applications and services for government users. For example, the Marine Corps demonstrated the power of Intelsat Epic<sup>NG</sup> to support their Networking-on-the-Move (NOTM)

requirements. And a variety of users can now support high-definition full-motion video (HD-FMV) over small, Class III unmanned aircraft systems (UAS), something never before possible.

It is also important to note that as our Intelsat Epic<sup>NG</sup> fleet evolved, so has our technology. For example, Intelsat 37e has steerable Ku and Ka-band beams, which can be positioned as needed to increase network access and support high-demand areas for government applications. Horizons 3e is the first Intelsat Epic<sup>NG</sup> satellite to feature a multiport amplifier that enables power portability across all Ku-band spot beams. With the multiport amplifier, power can be adjusted to each beam to meet customer throughput demands. By matching satellite power usage to traffic demands, government customers can leverage the additional efficiency improvements to expand their network and applications across the Asia-Pacific region.

**Question: Where do you see the government heading in terms of commercial satcom this year?**

**Skot Butler:** In the 2019 financial year, defense appropriators provided explicit guidance to develop an integrated, interoperative wideband and narrowband architecture and



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Skot Butler, President at Intelsat General

space mission recapitalization efforts, COMSATCOM investments and development of a flexible, fully-integrated, resilient satellite communications architecture manifested in the creation of a dedicated program element in the FY19 DoD budget for COMSATCOM integration into the future DOD satellite communications architecture.

We are encouraged by Air Force Space Command (AFSPC), tasked in the FY18 NDAA with sole acquisition authority for all COMSATCOM (by integrating DISA's COMSATCOM team), is demonstrating to industry its plans to move forward with a "core-network" acquisition strategy.

**Question: What are their most pressing and urgent communications needs?**

**Skot Butler:** Government customers across the board need higher data rates to ever smaller user terminals, availability whenever or wherever it is needed, security and flexibility.

**Question: How has that changed**

**your approach? Are you moving toward providing more end-to-end services?**

**Skot Butler:** Our announcement of FlexAir in December 2018 is a great example of how we are responding to the changing needs of our government customers. It is a managed terminal service based on our seamless, multi-layered Ku-band network. It delivers high data rate transmissions; redundancy and security needed for government aviation missions. What is unique about FlexAir is that it allows government users to select from a number of service plans that meet their data and geographic needs; without an upfront commitment.

The service was designed with our government customers in mind. They need services that provide them with on-demand availability whenever and wherever they need it; consistency of service; high performance and the utmost resiliency. It also provides them with a flexible and efficient service package.

They are not always on the move and the flexibility enables them to obtain

acquisition strategy that should include "government and commercial space systems" and "be based on flexible operations, open standards, and commonality that has communications path diversity."

Congress' years-long concern with the pace, progress and innovation of



A Government Gulfstream FlexAir Tail Mount 45cm 18" Antenna. Gulfstream aircraft are in use today for enroute comms, ISR and VIP applications.

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the broadband connectivity that they need on demand; in a much more efficient and cost-effective manner.

**Question: What does the commercial satellite industry need to bring to the table to meet the explosive demands of comms on the move?**

**Skot Butler:** For comms on the move—whether it be on land, sea and air, government customers need high data rate transmissions; on-demand availability wherever and whenever they need it; highest level of security; resiliency and redundancy of the communications network to ensure the consistency and reliability of service. Given the current budgetary constraints, it also needs to be efficient, affordable and have a more predictable cost structure.

Our Intelsat Epic<sup>NG</sup> and global network delivers higher performance and a total lower cost of ownership today. We expect that only to improve as we bring more software-defined satellites to market which will enable

faster time to market, more flexibility and continued improvements in performance.

**Question: Do you think there is potential for more public/private partnership to meet those demands? What have been the barriers to date?**

**Skot Butler:** Absolutely. However, one of the barriers playing out right now in Europe is the hardened “European autonomy” stance being taken in the EU Space Programme negotiations. We do not believe that this position will enable the attainment of the objectives of this programme i.e. make available to customers the best technologies at the best price and as such, urge the European Institutions to adopt a policy framework which will enable the achievement of the stated objectives.

Intelsat, as a global communications company headquartered in Luxembourg, is ready to help and participate in the EU Space Programme notably in the GOVSATCOM program.

**Question: As cybersecurity concerns have been a barrier, what has Intelsat done to mitigate your government customers concerns?**

**Skot Butler:** Cybersecurity, or information assurance, is rightly a concern for our government customers, we have found it to be a discriminator for us rather than a barrier. We have a mature and robust security program that was started over a decade ago; which we continue to invest in and improve. We put uplink command and downlink telemetry encryption on all of our satellites and our ground network is tested regularly by expert third-party auditors to ensure we meet the strictest government and commercial information assurance standards

Furthermore, the security enhancements of Intelsat Epic<sup>NG</sup>'s advanced digital payload enables us to quickly identify when someone is trying to jam a signal and then quickly switch the user to a different beam, mitigating any impact from the interference attempt. ■



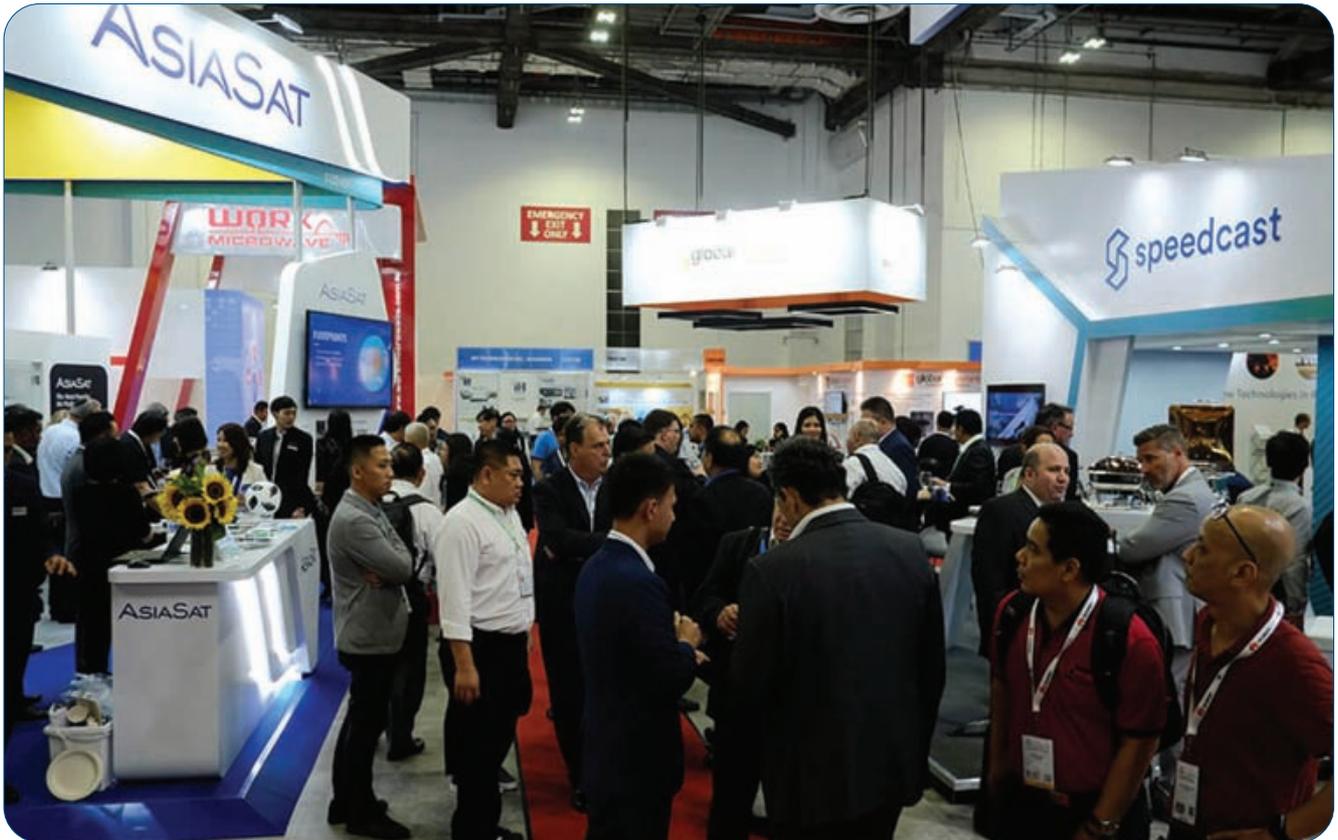
*A Government C-130 FlexAir Hatch Mount 45cm 18" Antenna. C130 aircraft are used for ISR and more often for enroute communications.*

# GVF

**GVF brings together organizations from around the world across the breadth of the satellite ecosystem.**

**Our members are on the forefront of the satellite industry creating the path for others to follow.**

Photo courtesy of UBM



## The region's TMT platform for networking and business intelligence under one roof

With transformation at the top of their agenda, business leaders are meeting at ConnectTechAsia, held in Singapore from 18 – 20 June 2019, to showcase and discover the latest technologies that promise to ready businesses for the future. Satellite Evolution has a look at some of the companies attending.

**“Connectivity infrastructure is a key enabler** for Digital Economies worldwide, including Singapore’s. ConnectTechAsia has always been a key telecoms calendar highlight, bringing the world’s leading players to Singapore to exchange insights, share best practices, and build the capabilities that will be necessary to bring about next generation networks. We expect ConnectTechAsia to be an exciting platform to learn and experience the cutting edge developments in the technologies that will shape our lives, and wish the event every success,” says Howie Lau, Chief Industry Development Officer, Info-communications Media Development Authority, Singapore.

Among a congregation of 1,800 exhibitors and 200 thought leaders at the Summit, an estimated 40,000 attendees will be looking to truly transformative technologies and solutions to get an edge up in automating business processes and exploring fresh revenue streams in this digital era.

ConnectTechAsia comes out the gate in 2019 as the region’s newly minted telecom, media and technology (TMT)

knowledge powerhouse, leveraging new partnerships with leading business intelligence and research affiliates such as Accenture, Deloitte, KPMG, Light Reading, McKinsey, Ovum and Tractica, to provide expert insights to all event stakeholders, not just during three event days, but throughout the year.

### Top brands

Top brands including Amazon, Axiata, Ericsson, Google, Grab, Huawei, IBM, iflix, Intel, Microsoft, Netflix, NHK, NTT DoCoMo, RedHat, Singtel, Verizon and VMW are among many others that will bring with them the latest innovations, new business opportunities and networks, and thought leadership to the show floor and Summit.

“Knowledge has always been the most powerful asset to have, and today’s enterprises need additional clarity to optimise business decisions and harness opportunities. ConnectTechAsia will bring the combined value of its new knowledge partnerships providing TMT intelligence to our stakeholders throughout the year, culminating over three

# Satellite Industry Forum 2019

17 June 2019, Four Seasons Hotel Singapore  
#aviasif

As 2019 progresses, it will be of interest for many to find out what trends the satellite industry will see play out this year, as well as what the key drivers of growth will be for operators and customers alike.

Gearing up with new discussion topics, AVIA Satellite Industry Forum 2019 is proud to announce the preliminary program and introduce an early lineup of distinguished speakers:



Keynote:  
**Steve Collar**  
President & CEO  
SES



**Huang Baozhong**  
EVP  
APT Satellite



**Roger Tong**  
CEO  
AsiaSat



**Jean-François Fenech**  
CEO  
Eutelsat Asia,  
Chairman of  
AVIA Satellite  
Industry Committee



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Executive Officer &  
Group President,  
Global Business Group Space  
& Satellite Business Unit  
SKY Perfect JSAT



**Barry Matsumori**  
CEO  
BridgeSat



**M.N. Vyas**  
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VP, Commercial &  
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event days in June when the industry comes together to share, make deals and network. This new iteration of ConnectTechAsia is testament to our ever-growing commitment to support the TMT industry and facilitate its path towards successful growth in the region,” says Ivan Ferrari, Event Director for ConnectTechAsia, from organiser UBM Singapore.

In 5G, Artificial Intelligence (AI), cybersecurity, multi and hybrid-clouds, Internet of Things (IoT), smart cities and more, ConnectTechAsia, comprising three pillars catering to each sector of the TMT space, will bring together the diverse yet hyperconnected businesses that will form a big part of tomorrow's digital life.

CommunicAsia brings together next-gen technologies for the telecom and related industries. BroadcastAsia is where broadcasting media companies and equipment makers showcase their latest products and services, and NXTAsia will feature emerging technologies and enterprise solutions. There will also be power-packed activities, free workshops and seminars, speciality zones, partner programmes and networking receptions to keep attendees fully immersed and engaged.

Commenting on the event, Andrew Phua, Director, Exhibitions & Conferences, Singapore Tourism Board says, “STB is pleased to support the second edition of ConnectTechAsia. ConnectTechAsia is one of Singapore's flagship exhibitions and anchoring it here bolsters Singapore's reputation as a centre for knowledge, innovation and economic exchange in the Asia-Pacific region. We are glad to host leading international experts and thought leaders in the tech, digital, and media industries here, and to facilitate

the exchange of ideas, knowledge and connections, which will in turn deliver greater value to delegates.”

**ConnectTechAsia Exhibition Highlights**

Led by the chairman of the ASEAN Smart City Network (SCN), in cooperation with country partners such as China, South Korea, Japan and Singapore, and the ASEAN Smart Cities Communities (SCC), 2019 will see a new Smart Cities Arena at ConnectTechAsia. With connectivity and digital solutions for city planning, smart buildings and smart homes, this will be where government delegations, investors, technology suppliers, disruptors and infocomm operators gather to do business to develop the cities of the future.

Also making a debut at this year's event is the 5G Experience - a dedicated platform with multiple live demo zones on how 5G will translate to new opportunities and possibilities for enterprises, especially in healthcare, energy, manufacturing and transportation. Attendees can learn how 5G-connected drones, for example, will make a difference for businesses, how 5G improves mapping and transportation, as well as its impact on a digital-ready manufacturing company.

**ConnectTechAsia Summit**

The ConnectTechAsia Summit, themed Shaping Future Societies, will bring together thought leaders from infocomm, technology, media and enterprises to discuss what is driving digital transformation in the region and how the latest tech trends and innovations are changing the landscapes of Cities, Economies, Business and Media.

The keynote by Harriet Green, CEO and Chairman of IBM Asia-Pacific, will explore how the shift from digital experimentation to scale adoption of new technologies will fundamentally alter the value chains of entire industries and change the way we work and live.

Let's take a look at some of the companies exhibiting:

**ABS**

ABS delivers cutting-edge satellite services across the Americas, Africa, Asia-Pacific, Europe, the Middle East, Russia and CIS countries. Operating a fleet of six satellites, it serves 93 percent of the world.

ABS operates a fleet of satellites: ABS-2, ABS-2A, ABS-3A, ABS-4/Mobisat-1, ABS-6, and ABS-7.

Headquartered in Bermuda, ABS has offices in the United States, United Arab Emirates, South Africa and Asia. ABS is majority owned by funds managed by the European Private Equity firm Permira.

**ADVANTECH WIRELESS TECHNOLOGIES**

At Advantech Wireless Technologies, the company designs, manufactures and deploys networking for broadband connectivity, broadcast solutions, video contribution and distribution and mobile backhaul, using satellite and terrestrial wireless technologies. Its revolutionary technologies include world-leading GaN technology high power amplifiers, SSPAs, block-up converters (SSPB), frequency converters, deployable antennas and terrestrial microwave radios.

**ARIANESPACE**

Arianespace is the world's leading launch service & solutions company, delivering innovative services and solutions to its customers for almost 40 years from its ideally located launch site in French Guiana on the Northeast coast of South



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ATOS helps your satellites to perform at full capacity during their entire mission to ensure that your investment is always safe. No matter if you are a satellite manufacturer who needs to check all electrical systems to be sure they are fully functional before the satellite is launched, or if you are a satellite operator who has to avoid signal interferences at all costs – ATOS provides proven and reliable satellite testing and monitoring solutions that give you the peace of mind that you will be able to fulfill all your contractual obligations.

**AVL TECHNOLOGIES**

AvL Technologies, Inc. is a privately held US company specializing in the design, development and production of mobile satellite antennas and positioner systems. With corporate headquarters based in Asheville, North Carolina, and a regional office located in the UK, AvL is able to offer superior service and support to customers around the world. AvL provides systems integrators with positioner and complete antenna system products, product development and services that maximize the technical and commercial benefits for their customers with cost, performance, quality and reliability requirements.

AvL provides solutions and support for satellite ground terminals for SNG, mobile broadband Internet access, Disaster Relief, Oil & Gas Data Backhaul, and Defense & Homeland Security customers throughout the world. AvL offers the world's largest range of satellite antennas for vehicle-mount, flyaway and fixed Earth station applications with sizes ranging from 60cm to 5.0 metres. Thanks to state-of-the-art manufacturing capabilities, cutting edge designs and development, AvL antennas are extraordinarily sturdy, efficient, and reliable. In addition, AvL is well known for providing adept customization to meet specific needs and requirements.

**CARNEGIE TECHNOLOGIES**

Carnegie Technologies works across industries to seize the biggest opportunities in communications technology. Bridging divides between cellular, Wi-Fi and satellite networks. Strengthening the Internet of Things and helping entrepreneurs take advantage of the connected future. In short, the company is bringing the future to the present, identifying challenging problems and assembling the best team of people to solve them.

Photo courtesy of Shutterstock



**C-COM SATELLITE SYSTEMS**

C-COM Satellite Systems Inc. is a leader in the development, manufacture and deployment of commercial grade mobile satellite-based technology for the delivery of two-way high-speed Internet, VoIP and Video services into vehicles. C-COM has developed a number of proprietary Mobile auto-deploying (iNetVu®) antennas that deliver broadband over satellite into vehicles while stationary virtually anywhere where one can drive. The iNetVu® Mobile antennas have also been adapted to be airline checkable and easily transportable.

**COMTECH TELECOMMUNICATIONS**

Comtech Telecommunications designs, develops, produces and markets innovative products, systems and services for advanced communications solutions. The company sells products to a diverse customer base in the global commercial and government communications markets. The divisions of Comtech that are exhibiting this year include:

**Comtech EF Data Corp.** is a leading supplier of satellite bandwidth and link optimization. Its high-performance satellite communications infrastructure solutions feature groundbreaking efficiency, robust intelligence and unparalleled horsepower. Commercial and government users around the world utilize the company's solution suite to reduce OPEX/CAPEX and to increase throughput for the most demanding fixed and mobile networks.

**Comtech Xicom Technology**, founded as Xicom Technology in 1991, has grown to be a world leading satellite communications (satcom) amplifier supplier, offering the broadest product line in the industry. Its focus on customers, innovation, and quality has driven growth and created a company with a reputation for excellence. Regarded as an industry leader across the board, Xicom provides rugged, highly efficient and reliable Traveling Wave Tube Amplifiers (TWTAs), Klystron Power Amplifiers (KPAs), Solid State Power Amplifiers (SSPAs), and Block Upconverters (BUCs) for commercial and military broadcast and broadband applications around the world. These Xicom High Power Amplifiers (HPAs) are in use in critical communications links on the ground, in the air and on the sea; they support fixed traditional and direct-to-home broadcast, mobile news gathering, transportable and flyaway systems, secure high data rate communications, and broadband access over satcom.

**Comtech Command & Control Technologies**

Comtech Command & Control Technologies specializes in affordable, high-precision tracking antennas optimized for LEO and MEO satellite missions like Remote Sensing, Earth Observation, and Communications. C&CT is an industry-leading full service provider of integrated ground station equipment and services for satellite and launch vehicle telemetry, tracking and commanding, and we provide high reliability EEE parts management for spacecraft manufacturers. It offers the industry's largest family of durable and low-maintenance X/Y pedestal antennas that eliminate the keyhole at zenith, cable wrap, and backlash. It also makes its own low-loss radomes, as well as carbon fibre shaped reflectors, which enable lightweight, high performance, multi-band antennas. Comtech C&CT provides complete engineering services for all ground station related operations, specializing in launch support, range safety, satellite TT&C, and communication systems.

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**CPI SATCOM & MEDICAL PRODUCTS DIVISION**

The Satcom Products Group of CPI's Satcom & Medical Products Division (CPI SMP) is a worldwide leader in uplink amplifier products and systems for satellite communications. CPI has played a pivotal role in the satcom industry since its inception: the first satellite projects, including INTELSAT and CONUS, were supported by CPI, which was then part of Varian Associates, Inc. Today, CPI's scope and global reach is unmatched, having shipped over 50,000 high power amplifiers to uplink stations in over 150 countries. CPI satcom products for satellite uplink and troposcatter applications are available in all standard frequencies from S-band to V-band.

CPI SMP's Satcom Products Group is uniquely equipped to be your one-stop HPA sub-system supplier for standard and emerging satcom applications, whether for GaN-based solid state BUCs and SSPAs, traveling wave tube amplifiers (TWTAs) or klystron power amplifiers.

CPI's Satcom Products Group is also a global leader in the design and manufacture of uplink klystrons and advanced millimetre wave klystron technology, with frequency ranges up to 700GHz.

**GAZPROM SPACE SYSTEMS**

Gazprom Space Systems (GSS) is a Russian satellite operator providing high quality Yamal capacity all over the world. The Yamal satellite fleet consists of four satellites, namely Yamal-202 (49°E), Yamal-300K (183°E), Yamal-401 (90°E) and Yamal-402 (55°E). Due to high performance and wide coverage areas, Yamal satellite capacity is in high demand over Asia-Pacific, Middle East, Europe, Russia and CIS. It is perfect for backhaul, trunking, broadband, mobility and SNG services.

**GILAT SATELLITE NETWORKS**

Gilat Satellite Networks is a leading global provider of satellite-based broadband communications. With over 30 years of experience, it designs and manufactures cutting-edge ground segment equipment, and provides comprehensive solutions and end-to-end services, powered by its innovative technology.

Delivering high value competitive solutions, the company's portfolio comprises a cloud based VSAT network platform, high-speed modems, high performance on-the-move antennas and high efficiency, high power Solid State Amplifiers (SSPA) and Block Upconverters (BUC).

Gilat's comprehensive solutions support multiple applications with a full portfolio of products to address key applications including broadband access, cellular backhaul, enterprise, in-flight connectivity, maritime, trains, defence and public safety, all while meeting the most stringent service level requirements.

**HUGHES NETWORK SYSTEMS**

Hughes Network Systems, LLC (HUGHES) is the global leader in broadband satellite technology and services for home and office. Its flagship high-speed satellite Internet service is HughesNet®, the world's largest satellite network with over 1.3 million residential and business customers across the Americas. For large enterprises and governments, the company's HughesON® managed network services provide complete connectivity solutions employing an optimized mix of satellite and terrestrial technologies.

The JUPITER™ System is the world's most widely deployed High-Throughput Satellite (HTS) platform, operating

on more than 20 satellites by leading service providers, delivering a wide range of broadband enterprise, mobility and cellular backhaul applications. To date, Hughes has shipped more than seven million terminals of all types to customers in over 100 countries, representing approximately 50 percent market share, and its technology is powering broadband services to aircraft around the world.

Headquartered outside Washington, D.C., in Germantown, Maryland, USA, Hughes operates sales and support offices worldwide, and is a wholly owned subsidiary of EchoStar Corporation (NASDAQ: SATS), a premier global provider of satellite operations.

**INTEGRASYS**

Integrasys is a privately owned company specializing in engineering and manufacturing Satellite Spectrum Monitoring Systems in the telecommunication and broadcasting markets. Integrasys was founded in 1990 by a group of Hewlett-Packard engineers - experts on Automated RF & Microwaves Test Systems and Software. Since then Integrasys has evolved towards today's company, offering a wide range of signal monitoring products for different telecom services.

**INTELLIAN TECHNOLOGIES**

Intellian is one of the world's leading providers of satellite communications and smart systems for the maritime, industrial, and military sectors. Founded in 2004, Intellian is leading the way in driving innovation in the satellite communications market. Governments and global players choose Intellian's stabilized satellite antenna systems to deliver connectivity when it matters most. Intellian operates in 10 offices worldwide, including global logistics centres in Asia, the Americas, and Europe, and is supported by a network of more than 450 partners across the globe. Intellian Technologies Inc. is listed on the Korean Stock Exchange, KOSDAQ (189300:KS).

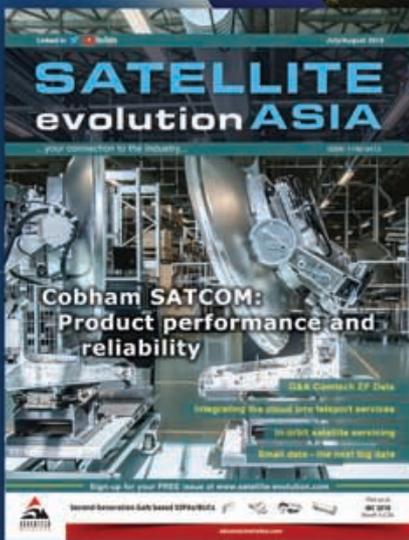
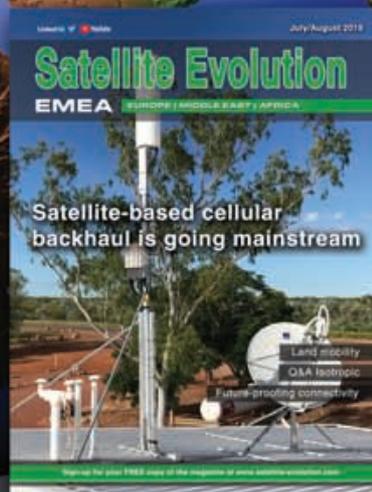


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**INTELSAT**

Intelsat operates the world's first Globalized Network, powered by its leading satellite backbone, delivering high-quality, cost-effective video and broadband services anywhere in the world. Intelsat's Globalized Network combines the world's largest satellite backbone with terrestrial infrastructure, managed services and an open, interoperable architecture to enable customers to drive revenue and reach through a new generation of network services. Thousands of organizations serving billions of people worldwide rely on Intelsat to provide ubiquitous broadband connectivity, multi-format video broadcasting, secure satellite communications and seamless mobility services.

**MEASAT**

Since 1996, MEASAT has been providing premium satellite solutions to customers across the Asia-Pacific region, and now has a reach that covers over 150 countries across Asia, Africa, Europe, Middle East and Australia, representing 80 percent of the world's population.

The MEASAT satellite fleet includes the state-of-the-art MEASAT-3, MEASAT-3a and MEASAT-3b satellites co-located at 91.5°E, supporting Asia's premium DTH and video distribution neighbourhood; MEASAT-5 at 119.5°E serving the broadband needs in Malaysia; and, AFRICASAT-1a at 46.0°E. The MEASAT fleet supports leading DTH platforms in Malaysia, Brunei, India and Indonesia, providing DTH multi-channel television services to over 20 million subscribers. The fleet is also used by many leading international channel operators to distribute television programming to pay television platforms, and by telecommunications operators

to support remote connectivity, cellular backhaul, IP trunking and corporate VSAT networks.

**ND SATCOM**

With over three decades of experience, ND SatCom is the premier supplier of and integrator for innovative satellite communication equipment systems and solutions to support customers with critical operations anywhere in the world. Customers in more than 130 countries have chosen ND SatCom as a trusted and reliable source of high-quality and secure turnkey and custom system-engineered communication solutions. The company's products and solutions are used in more than 200 transnational networks in government, military, telecom and broadcast environments.

ND SatCom's flagship product, the SKYWAN platform, enables international users to communicate securely, effectively and quickly over satellite.

**NEWTEC**

Newtec specializes in designing, developing and manufacturing equipment and technologies for satellite communications. As a pioneer in the industry, Newtec is dedicated to creating new possibilities for the broadcast, consumer and enterprise VSAT, government and defence, cellular backhaul and trunking and mobility, offshore and maritime markets. Its products and technologies can be applied in a wide range of single and multiservice applications from DTH broadcasting, video contribution and distribution and disaster recovery and backbones for cellular backhauling, to small and medium enterprises, SCADA and oil and gas networks, aircrafts and vessels.



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**RUSSIAN SATELLITE COMMUNICATIONS COMPANY (RSCC)**

Russian Satellite Communication Company (RSCC) is the Russian GEO satellite operator with global coverage. RSCC provides a full range of communications and broadcasting services via its own terrestrial telecom facilities and satellite constellation; e.g. video distribution and contribution, DTH, DSNG, broadband Internet access, IP trunking and cellular backhaul, maritime mobility, SCADA, enterprise networks connectivity and other. The company operates various regional satellite TV distribution networks and corporate VSAT networks for fixed and mobile customers.

**SATBRIDGE**

Founded in 2012, SatBridge is a Carnegie Technologies company headquartered in Austin, Texas, with a star-studded team of over 280 employees. With technical superiority, unique mobile industry experience and relentless engineering and development teams, SatBridge is emerging as the future leader for satellite ground terminals.

**SINGTEL**

Singtel Satellite is the leading provider of one stop satellite communications and ICT solutions to meet voice and digital challenges on land and at sea. Its established footprint covers more than 100 countries across Africa, Middle East and Asia Pacific regions.

This is supported by an extensive and robust terrestrial network of more than 428 direct points of presence in 362 cities. Enterprises can be assured of reliable and high-quality satellite connectivity anywhere, anytime.

**SPACEBRIDGE**

Founded in 1988, SpaceBridge Inc., is an established supplier and global market leader in broadband satellite communications systems technology. Previously known as Advantech Wireless Inc., the company is now doing business as SpaceBridge Inc.

Headquartered in Montreal, Canada, SpaceBridge Inc. is well positioned to meet the demands of today's global market, with two affiliate R&D offshore innovation centres. Sales, and support offices, as well as remote offices in: Brazil, Colombia, United Kingdom, the Middle East, Indonesia, China, and Russia. SpaceBridge is an ISO9001 registered vendor.



Photo courtesy of Shutterstock

The company develops and provides satellite network equipment and services, including VSAT HUBs and Terminals for Point-to-Point, Point-to-Multi-Point, and Mesh topologies, as well as SCPC and broadcast modems for GEO and NGSO satellite constellations

SpaceBridge Inc. also provides Cloud-Based autonomous managed services for its customers, helping them to eliminate initial large CapEx investments and save on network management OpEX, while speeding time-to-market.

**SPACEPATH**

Based in the UK, it manufactures and designs a wide range of high-power travelling wave tube amplifiers (TWTA), redundant system controllers and sub-systems.

It also offers a comprehensive range of solid state amplifiers (SSPA) providing small, lightweight, efficient power solutions covering all uplink frequencies. Backed by extensive industry experience, its satellite professionals provide in-depth engineering assistance, unparalleled customer service and world-wide technical support spanning North America, Europe and Asia-Pacific.

**TERRASAT COMMUNICATIONS**

Terrasat Communications designs and manufactures innovative RF solutions for satellite communications systems. Its ground-breaking IBUC – the Intelligent Block UpConverter – brings advanced features and performance to C-band, X-band, Ku-band, & Ka-band satellite earth terminals and VSATs. Its products offer exceptional value at a reasonable cost, thereby allowing customers to stay ahead of their competitors. Through conservative engineering, Terrasat products have gained a reputation for enduring over the long term in extreme operating conditions.

**UHP NETWORKS**

UHP Networks is a leading global manufacturer of advanced VSAT networks and systems. UHP has over 370 networks & 40,000 remotes installed in 50 countries. Among its customers are Fortune 500 corporations, major broadcast networks and top-tier mobile network operators.

The UHP platform has industry-best performance in processing capability, TDMA efficiency and DVB-S2X signalling. UHP won the 2018 VSAT Stellar Award for Best Ground Segment Technology.

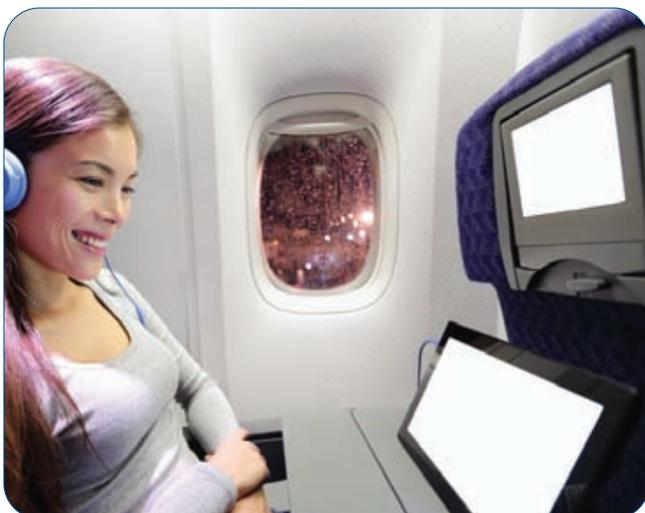
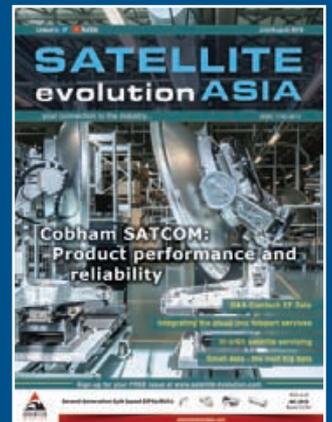
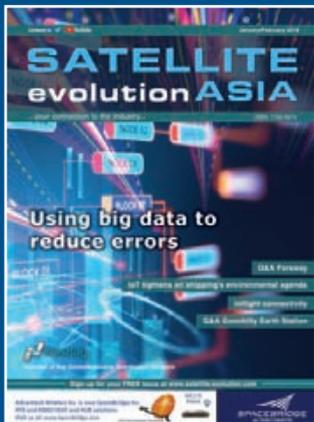


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## COMING SOON...

Enjoyed this issue of Satellite Evolution Asia? Well hold on to your hats, because there is much more to come!

Coming up in Satellite Evolution Asia - July/August :

- News
- Commercial spaceflight
- Oil and gas: Cobham SATCOM
- Q&A Orion Span
- Q&A Hughes
- Q&A Northrop Grumman
- Space traffic management: SDA

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