

Satellite Evolution

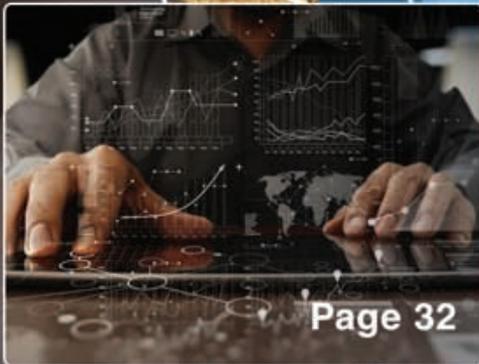
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May/June 2019

Inflight connectivity – A must have service for the 21st Century



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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.

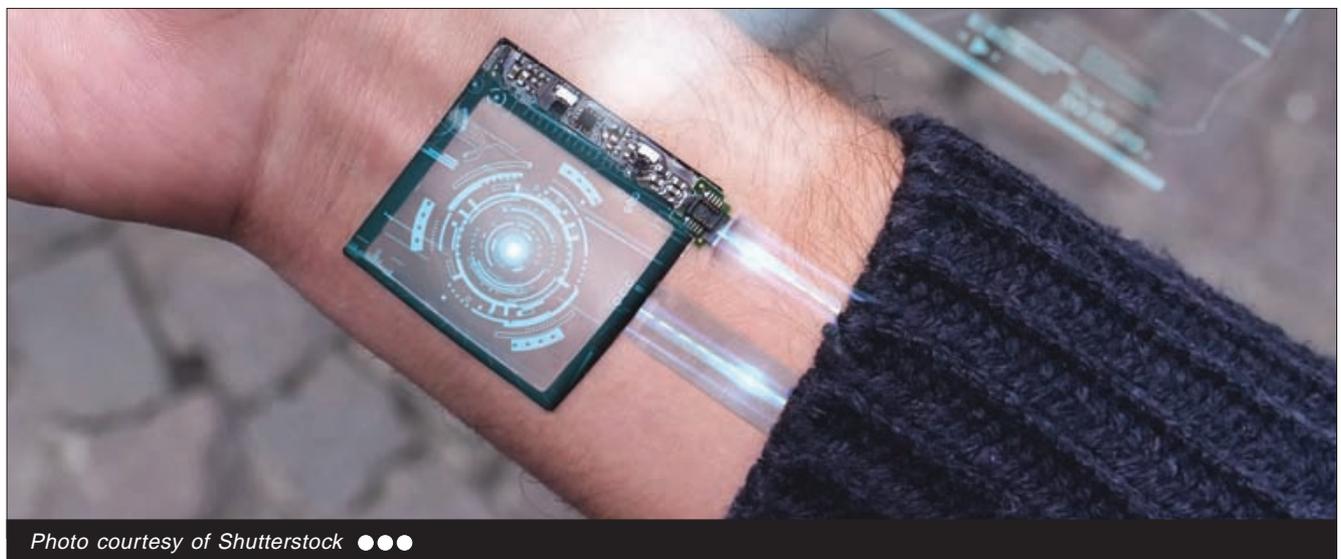


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1 Editorial
Body modifications 2.0!

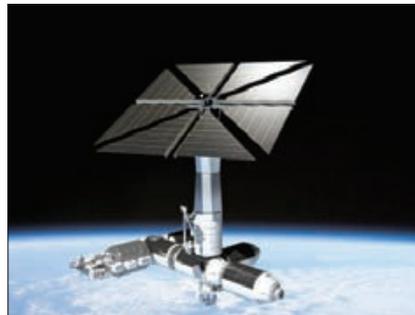


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Satellite Industry Forum 2019

17 June 2019, Four Seasons Hotel Singapore
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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:
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President & CEO
SES



Huang Baozhong
EVP
APT Satellite



Roger Tong
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Thales acquires Psibernetix for decisive technologies in artificial intelligence

Thales has acquired the artificial intelligence (AI) company Psibernetix to help create Certifiable AI. Originally made famous by its aerial combat application called ALPHA, which consistently defeated the world's top pilots in simulated air combat, Psibernetix is a pioneer in computationally efficient AI technologies.

For Thales, the acquisition will establish explainable AI processes for applications in safety-critical environments. With explainable AI-driven outcomes, AI applications can be certified and trusted. Together, this further enables the widespread adoption of AI capabilities across Thales' markets.

Through a machine-learning algorithmic process invented by Psibernetix, called Genetic Fuzzy Trees, AI decisions are able to be mathematically verified and validated through a unique constraint-breaking approach that applies fuzzy logic-based AI to large-scale problems. This process also creates AI applications that can be placed on edge processing devices and be extremely resilient to digital noise, environmental uncertainties, and randomness.

This acquisition of Psibernetix continues to help Thales bring truly unique and differentiating AI technologies to its customers for critical decisions – whatever it takes.

"Having certified, explainable AI is a game-changer for the future of critical decisions in safety driven markets. With this new capability, Thales will create truly unique and differentiated AI technologies that will empower customers to make better, more informed decisions, more quickly," said Gil Michielin, Thales Senior Vice President, Avionics. ■

Viasat CBM-400 modem certified as the only software-defined modem authorized to operate on wideband global satellite communications network

Viasat Inc., a global communications company, has announced that its Commercial Broadband Modem (CBM)-400 has become the first-ever software-defined modem to successfully complete the Army Forces Strategic Command (ARSTRAT) certification process. By successfully completing the certification process, the Viasat CBM-400 modem is now the only software-defined modem authorized to operate on the Wideband Global Satellite (WGS) communications network, which will significantly enhance air, land and sea performance capabilities while reducing overall satellite communications (SATCOM) costs for US Department of Defense (DoD) customers.

The Viasat CBM-400 combines the power of high-speed connectivity with the flexibility to switch over to new satellite networks in near real-time in order to meet the needs of nearly any mission and application. The CBM-400 delivers satellite broadband performance whether at-the-halt or on-the-move. With the CBM-400, ground vehicles, sea vessels and aircraft will have the ability to securely send and receive high-definition video, voice and cloud-based networking data from nearly anywhere across the battlespace.

"Successful completion of the ARSTRAT certification process validates the proactive business approach and forward leaning capabilities of the only US Government-validated software-defined modem," said Ken Peterman, President, Government Systems, Viasat. "With our CBM-400, DoD customers now have access to the significant advantages and flexibility of a software-defined architecture, which will allow customers to rapidly meet evolving

communications needs and emerging mission requirements by utilizing modems and terminals that readily and affordably adapt to embrace new waveforms and satellite networks."

The CBM-400 currently supports three waveforms heavily fielded throughout the DoD including the LinkWay waveform, the Enhanced Bandwidth Efficient Modem (EBEM) waveform and the ArcLight waveform. The software-defined nature of the CBM-400 also allows operators to easily switch between waveforms to meet the unique demands of each mission. The CBM-400 running the LinkWay, EBEM, or ArcLight waveform have all been certified by ARSTRAT for operation on the WGS constellation. The software-defined architecture enables the CBM-400 to readily embrace innovation due to its ability to keep pace with rapidly accelerating private sector SATCOM technology trajectories.

Importantly, the Viasat CBM-400 is purposefully designed to fit into Viasat's Hybrid Adaptive Network (HAN) architecture concept, which would allow users to seamlessly operate across both commercial and government purpose-built SATCOM networks, such as WGS. The HAN concept creates an end-to-end network that provides mitigation against congestion situations, intentional and unintentional interference sources and cyber threats through implementation of layered resiliency in highly contested environments. Terminal equipment like the CBM-400 supports the HAN architecture concept by readily and affordably adapting to operate over new, innovative SATCOM networks as they become available.

The Viasat CBM-400 is available for purchase and use across all branches of the US DoD. The modem's hardware platform comes in both a standard 19-inch 1RU rackmount version and a ruggedized, sealed enclosure, outdoor variant. Both CBM-400 variants are certified for operation on the WGS constellation. ■

MACOM extends high-performance SATCOM portfolio with the addition of a 4-watt ka-band power amplifier

MACOM Technology Solutions, a leading supplier of semiconductor solutions, has announced an addition to its



Photo courtesy of Business Wire ●●●



portfolio of high-linearity Ka-band power amplifiers with the introduction of the MAAP-011250. Ideally suited for next generation commercial VSAT outdoor units, the MAAP-011250 utilizes a balanced design, giving system designers' a consistent match regardless of their board impedance.

As the demand for high speed, broadband, data connectivity continues, MACOM is seeing changes in fixed wired networks, such as HFC and Fibre along with terrestrial wireless networks, and SATCOM, in order to meet this demand. As the requirements for increased data rates and bandwidth continue to drive higher power, higher frequency and higher linearity MMICs, MACOM is well positioned to provide both catalogue and custom SATCOM solutions.

With the addition of the 4W amplifier, MACOM now offers 2, 2.3, 3, 4 and 7W power output options spanning frequencies ranging from 27 to 31.5GHz. These new GaAs-based Ka-band PAs can provide strong linear gain, which is expected to enable customers to efficiently increase the power from the input to the output port with minimal trade-offs.

The MAAP-011250 is a balanced 4W, 4-stage power amplifier assembled in a lead-free 5mm 32-lead AQFN plastic package. This power amplifier operates from 27.5 to 30GHz and provides 24dB of linear gain, 4W saturated output power and output IP3 of 41dBm while biased at 6V. The MAAP-011250 can be used as a power amplifier stage or as a driver stage in higher power applications. The amplifier complements MACOM's portfolio of Ka-band gain block amplifiers, drivers, mixers and PAs to deliver a complete chipset for high-performance wireless broadband data links. ■

Satellite data analytics saving dairy farmers valuable time with new grass management service

Grass SAT, an innovative, new grass management service has been launched by Rezatec, the geospatial data analytics company, to provide dairy farmers with automated daily updates of grass cover per paddock, and other features, to optimise grazing management decisions throughout the year.

Increasingly, dairy farmers are looking for new ways to save time, cuts costs and improve grass management activities. Currently, many farmers rely on manual methods, for example visual assessment or using a plate meter, which can be time intensive and require frequent manual updates to

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provide current and accurate estimates of grass cover.

Grass SAT, is an online grass management service for dairy farmers to optimise rotational grazing across their farms. Using a comprehensive grass growth model fed with regular analytics derived from satellite imagery, farmers are presented with a daily update of grass cover per paddock. The metrics are visualised in a secure portal supported with



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a grazing wedge, sorting grass cover from highest to lowest, as well as valuable decision support information such as number of grazing days per paddock and a colour-coded map of the farm presenting volumes and distribution of grass available.

The service is very easy to use and allows farmers to initially draw their paddocks in a digital map and add herd information before they are presented with their wedge and daily grass cover measurements. Farmers then update the portal with paddock activities, such as grazing or a cutting, and these feed into the model and reevaluate the grass cover analytics.

John Brocklehurst, Dairy Farmer, Hilltop Farm, commented, "Utilising as much grazed grass as possible is a top priority KPI for our business and I hope by using Grass SAT it will provide me with more frequent grass measurements of the whole farm without having to walk it. The data is already informing my day-to-day grazing management and moving forward I hope to identify areas of the farm that are less productive and improve them as well as allocating grass to the cows more efficiently."

Farmers can also pull out paddocks for silage production as well as run multiple wedges if required and new features, including an App, will be available over the coming months.

Philip Briscoe, Chief Operating Officer, Rezatec explained, "We have been developing this product for a few years now and are confident it will make farmers lives much easier. With an initial discounted trial period of two months, farmers can also be confident of the time the service can save them simply by providing an automated daily update of grass cover."

Grass SAT will also soon be available for beef and sheep farmers as well as general forage producers. ■

Momentum builds for One Sea as Inmarsat, MTI and Royal Institution of Naval Architects join autonomous shipping alliance

Three of the leading influencers in the international maritime sector have joined One Sea, the industry alliance that brings together leading exponents of autonomous ship technology.

Global satellite group Inmarsat and NYK Group research subsidiary MTI (Monohakobi Technology Institute) have joined

One Sea as full members, while the Royal Institution of Naval Architects (RINA) has signed a Memorandum of Understanding to become a One Sea associate member.

"We are delighted to welcome the largest global provider of ship-to-shore connectivity, the R&D arm of one of the largest shipowners in the world and the industry's leading professional body for naval architects as members," said Päivi Haikkola, One Sea Lead.

One Sea members ABB, Kongsberg Maritime and Wärtsilä ran separate autonomous ship trials off the Finnish and Norwegian coasts at the end of 2018. Finnish regulators have authorized One Sea to oversee future trials in Jaakonmeri off western Finland - the first dedicated test zone worldwide.

"Members have complete freedom to innovate and develop their own cost-efficient autonomous ship solutions inside an alliance which is nonetheless committed to harmonizing technical standards," said Haikkola. "Our expectation is that, as member numbers grow, operating solutions will multiply but members will also work towards integration." The new members would bring different perspectives and insights to the One Sea ecosystem, she added.

NYK and its Group companies MTI Co., Ltd. and Japan Marine Science Inc. (JMS) have already been working with nautical instrument manufacturers to develop highly automated ship navigation technologies, with a tugboat test for NYK company Wing Maritime Service Corporation scheduled for H2 2019. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) envisages autonomous ships operating in Japan by 2025. One Sea has also set 2025 as its target for an autonomous shipping infrastructure, including a full set of safety rules and technology standards.

Inmarsat VP Business Development, Stefano Poli, commented: "Inmarsat is joining One Sea in recognition of the special value it sees in initiatives that adopt a targeted and goal-based approach to autonomous shipping and its beneficial technologies. One Sea is emerging as a strong voice on interoperability and standards that the wider industry is listening to. As Inmarsat continues to roll out the high-speed maritime broadband service that will enable and protect



Momentum builds for One Sea as Inmarsat, MTI and Royal Institution of Naval Architects join autonomous shipping alliance ●●●



shipping's digital future, it is critical we support the alliances enabling integration.”

Haikkola said that the full research program being developed by One Sea continued to expand, with its most recent initiative focusing on autonomous ship piloting arrangements between ports and ships. “As an area where public and private interests converge, One Sea can play a special role in the different strands of research, funding, test coordination and results dissemination,” she said.

She added that One Sea was “honoured” to sign the MoU with RINA covering associate member status. “We look forward to working with RINA and to the opportunity of drawing on the unique knowledgebase represented by its membership.” ■

IAI places US\$1.8 million order for orbit's airborne audio solution for its “Heron TP” UAV

Orbit Communications Systems Ltd., a leading global provider of airborne communications solutions, announced at the Israel Defense & HLS Expo (ISDEF 2019) that Israel Aerospace Industries (IAI) placed a US\$1.8 million order for Orbit's Orion™ airborne audio management systems for integration aboard its next-generation medium-altitude, long-endurance (MALE) Heron TP unmanned aerial vehicle (UAV). Delivery of the systems is expected in 2019 and 2020.

Orbit's Orion enables essential communications between the UAV and civil Air Traffic Control (ATC) and other ground stations.

“All large UAVs are required to communicate directly with civil airports via Air Traffic Control using their own on-board

systems,” explained Aharon Huberman, Senior Program Manager in the MALAT division of IAI. “Orbit's Orion is the most mature solution on the market, in terms of its capabilities, reliability and regulatory compliance.”

“We believe that our ability to adapt the system and deliver it under an extremely tight schedule were key considerations in MALAT's decision to select our audio management solution,” commented Ben Weinberger, CEO of Orbit. “We are proud to provide readily integrated radio gateway solutions to help simplify IAI's development and operation on a system level,” he added. ■

EVERYWHERE Communications and Global Telesat Communications Partner to deliver always connected solutions to enterprise and government customers globally

Orbital Tracking has announced a partnership between its Global Telesat Communications subsidiary and EVERYWHERE Communications to deliver fully integrated, always connected solutions to enterprise and government globally. The new partnership enables GTC to offer EVERYWHERE's suite of purpose-built solutions, including the EC-100 Satellite Communicator, companion smartphone app, and EVERYWHERE Hub, to its global customer base.

“We are excited to be partnering with EVERYWHERE, allowing us to bring its innovative range of communications, location and monitoring systems to our customers. EVERYWHERE's technology and proven industry experience makes them a leader in the market and the EC-100, app and Hub fits perfectly into our current product portfolio while



expanding our enterprise-level system offerings," said David Phipps, Chief Executive Officer of Orbital Tracking.

EVERYWHERE's solutions enable customers to globally connect through intelligent routing – whether on Wi-Fi, cellular or satellite networks. EVERYWHERE provides a vital communication lifeline to meet duty-of-care obligations and comply with lone-worker safety laws that are being adopted in many countries. ■

Marlink unifies its extensive IT services and solutions to provide fleet owners and ship operators with a new portfolio to fully manage the overall IT environment on board

Marlink has announced the launch of ILink, a complete portfolio of IT solutions for standardising, simplifying and automating IT operations at sea and delivering substantial time and cost savings related to on board network IT administration and management through advanced dashboard and intelligent applications.

The ILink suite is designed to service the maritime industry as a standalone service with fleet wide standardisation and digitalisation for ship owners. This is more important than ever to ensure all the advantages of remote IT intervention onboard, 24/7 monitoring of onboard IT environment and increase the level of compliance with reference to upcoming regulations such as IMO2021 and TSMA version 3.

ILink also provides deep transparency via an IT-specific

advanced online dashboard, which includes continuously updated PC and server status information.

ILink is available standalone or fully integrated with Marlink's global multi-band Sealink network and the XChange centralised communications management system. Crucially, it can also relieve Marlink customers of the time-consuming and stressful task of updating onboard networks and applications. Automated updates can reduce the time to secure, i.e., thousands of onboard PCs on a fleet with more than 100 vessels to a few days, while manual updates are known to be problematic and can take several months for a similar number of PCs. More than 1,000 ships are already saving time and money on IT updates using Marlink's IT automation services.

ILink is offered in three levels; Design, Deliver and Manage. In the initial Design phase, Marlink's expert team will identify elements to standardise and automate to ensure the highest levels of maritime IT compliance and work with them to organise a scalable, adaptable, automated and cost-effective vessel IT environment. The Deliver phase, meanwhile, will ensure that clients take benefit of Marlink's efficient large-scale delivery capabilities on both IT and connectivity. Finally, the Manage phase provides high-quality fleet management which simultaneously protects clients' IT environments with a range of maintenance services. Each phase is ring-fenced with Marlink's cyber security expertise, bolstered with a comprehensive suite of solutions from the company's Cyber Guard portfolio. ■

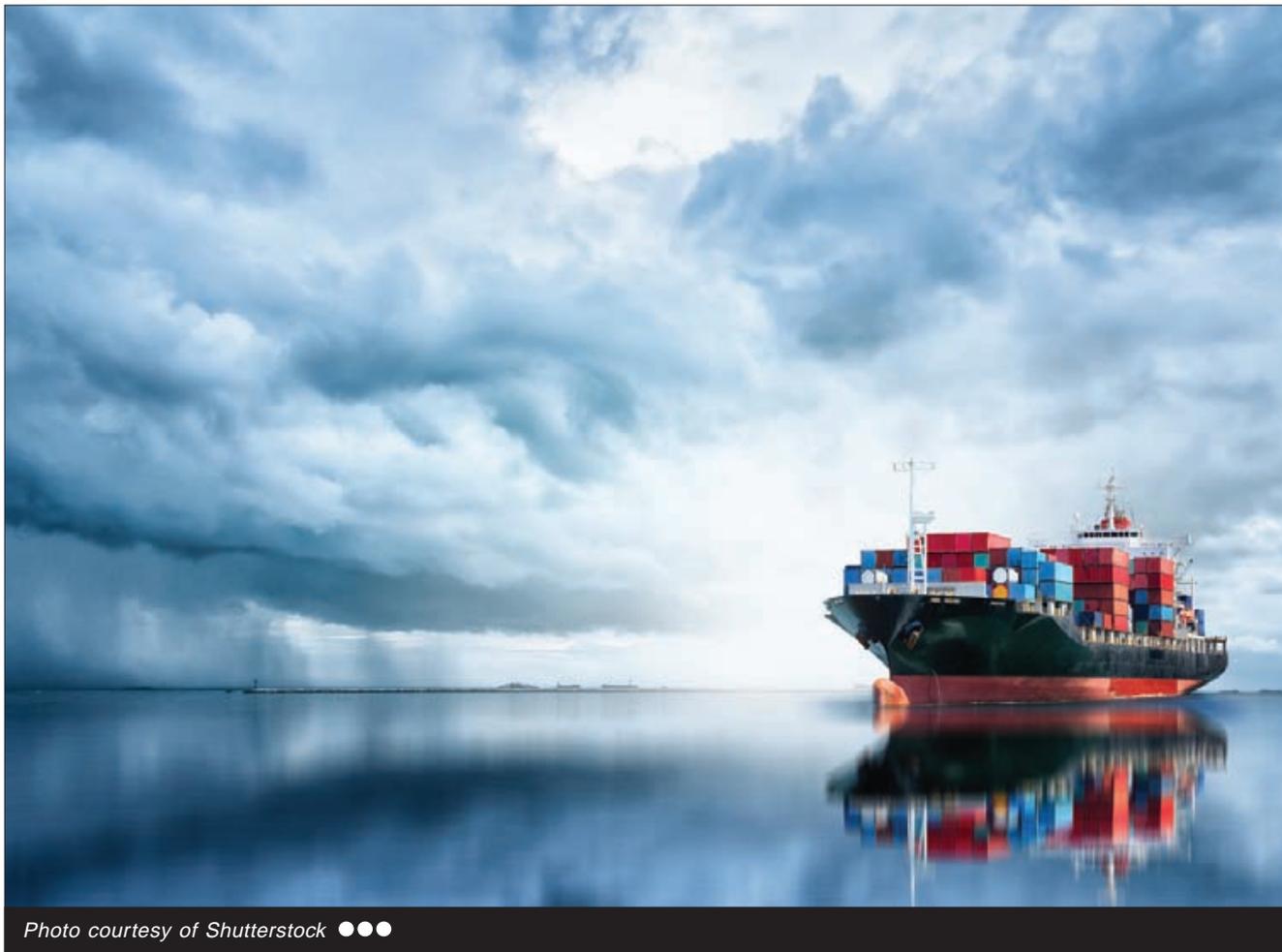


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Proven Performance Onboard

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Inflight connectivity – A must have service for the 21st Century

The mobility market, and the inflight connectivity market in particular, is one of the hottest areas to be in right now, with strong demand enabling huge opportunities for service providers, equipment manufacturers and satellite operators across the board. The market is booming, but suppliers are having to be smarter and make their money go further to deliver truly in-demand, cost-effective solutions; missing the mark, even by an inch, can be absolutely catastrophic.

Technologically-speaking, we've come a very long way in recent years. In the past two decades, we've gone from a place of dumb phones, slow dial-up Internet, coat-hanger TV aerials and remote controls that work less often than they do, to an era of Smart wireless devices, homes, vehicles and cities and always-on high-speed broadband, on land, at sea, or in the air.

The mobility sector, accordingly, has seen some of the biggest changes. Charging ports are becoming ubiquitous throughout trains, planes and automobiles, as is wireless, often free-to-use, Internet connectivity, and other on-board entertainment options. Even the local buses in my small town come equipped with complementary USB charging ports and high-speed broadband connectivity, and I can pay for my ticket with a simple tap of my credit card. We're seeing the first steps towards autonomous vehicles on land and in the air, and the Internet of Things (IoT) is enabling automatic fleet monitoring to ensure vehicles are kept in the best possible condition without costly breaks of services for routine checks and emergency maintenance.

When it comes to the aeronautical world, these changes

are being felt more keenly than ever before. This is important, because airlines hold a captive audience – you can't simply get off a plane if you find it's not suitable halfway through your journey. Passenger satisfaction is at an all-time premium, and, in a time of plummeting flight costs, even the smallest of differentiators between airlines is having a massive impact on business. Many of us take tens of flights each year for business and/or pleasure, and our expectations have changed accordingly. No longer are consumers satisfied with simply getting from A to B safely, now demands have boomed; food must be high-quality (with gluten-free, dairy-free, low sugar, vegetarian and vegan options, naturally), the latest movies must be available even ahead of DVD release, and broadband-level connectivity is a must for many.

Moving on up

Inflight connectivity (IFC) is nothing new, but strong global demand from business, government, military and leisure travellers alike means the sector is one of the fastest-growing in satellite applications today.

MarketsandMarkets' *'In-flight Entertainment &*

	Broadband access	E-commerce	Advertising	Premium content	Total
2018	\$822 million	\$36 million	\$26 million	\$39 million	\$1 billion
2028	\$9 billion	\$3 billion	\$2.9 billion	\$731 million	\$15 billion
2035	\$15.9 billion	\$6.8 billion	\$6 billion	\$1.4 billion	\$30 billion

Forecasted airline share of the US\$30 billion broadband enabled ancillary revenue opportunity. Credit: 'Sky High Economics: Quantifying the commercial opportunities of passenger connectivity for the global airline industry.'

Connectivity (IFEC) Market by End User (OEM, Aftermarket), Aircraft Type (NBA, WBA, VLA, Business Jets), Product (IFE Hardware, IFE Connectivity, IFE Content), and Region – Global Forecast to 2023,' report states that the inflight entertainment and connectivity market is expected to grow at a CAGR of 8.72 percent to US\$7.65 billion by 2023. The need to enhance the passenger experience, technological developments and an increase in aircraft deliveries are all expected to help drive the market during the 2018-2023 reporting period. Fleet upgrades to the newer narrow-body aircraft, including the A320neo and 737 Max are expected to lead IFEC installations during the reporting period.

Meanwhile, according to the 'Sky High Economics: Quantifying the commercial opportunities of passenger

connectivity for the global airline industry' report from the London School of Economics and Political Science (LSE) in association with Inmarsat, inflight broadband has the potential to create a US\$130 billion market within the next 20 years, resulting in US\$30 billion of additional revenue for airlines by 2035. The report predicts that broadband-enabled ancillary revenues for airlines will come from four main revenue streams:

- Broadband access charges: Providing connectivity to passengers inflight;
- E-commerce and destination shopping: Making purchases onboard aircraft with expanded product ranges and real-time offers;



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- Advertising: Pay per click, impressions, sponsorship deals with advertisers; and
- Premium content: Providing live content, on demand video and bundled W-IFEC access.

Despite strong demand and growth in recent years, the uptake of IFC systems is still quite low. According to the Sky-High Economics report, just 53 airlines of an estimated 5,000 offer IFC, although the service is expected to be pretty ubiquitous by 2035 thanks to passenger demand. Airlines which do currently offer IFC receive on average an additional US\$17 per passenger from traditional ancillary services such as duty-free purchases and inflight retail, food and drink sales; broadband-enabled connected ancillary revenues are expected to add an extra US\$4 by 2035.

Meanwhile, full service carriers are expected to generate US\$19 billion in revenues by 2035, or approximately 63 percent of expected airline revenues during the period. Capitalising on longer flight times, additional revenue will come from the ability to maximise e-commerce platforms and making deals with content providers to offer premium packages.

The report predicts that low cost carriers will generate US\$11 billion by 2035, the bulk of which will come from selling connectivity to passengers. The 'Sky High Economics' report also identified the greatest opportunity for broadband-enabled ancillary services lies in the Asia-Pacific.

Airlines in that region are expected to gain US\$10.3 billion of revenues through 2035, while airlines in Europe and North America can anticipate US\$8.2 billion and US\$7.6 billion respectively.

"The opportunity available to airlines is enormous. The Sky-High Economics study predicts the creation of a US\$130 billion market within the next two decades," wrote Dr Alexander Grous, Department of Media and Communications, LSE and Author of *Sky-High Economics*. "Globally, if airlines can provide a reliable broadband connection, it will be the catalyst for rolling out more creative advertising, content and e-commerce packages. We will see innovative deals struck, partnerships formed, and business models fundamentally changed for new players to lay claim to the US\$100 billion opportunity away from airlines. Broadband-enabled ancillary revenue has the potential to shape a whole new market and it's something airlines need to be planning for right now."

Forming alliances

The inflight connectivity market is certainly booming right now. Service providers such as Gogo, Global Eagle Entertainment, Honeywell, Echostar Corporation, Panasonic Avionics, Viasat and Thales Group are all getting in on the action, while new technology companies such as Kymeta and Phasor are focusing on technology developments to enable more efficient and cost-effective access to inflight connectivity. New partnerships and alliances are rife as companies compete to stay at the top.

The Seamless Air Alliance, for example, was formed in 2018 by Airbus, Delta, OneWeb, Sprint and Bharti Airtel to usher in 'a new era of innovation' for airlines on all routes. The alliance, which hopes to expand with the addition of new members, also claims it will reduce costs for everyone involved in the chain, eliminating the expenses and hurdles associated with acquisition, installation and operation of data

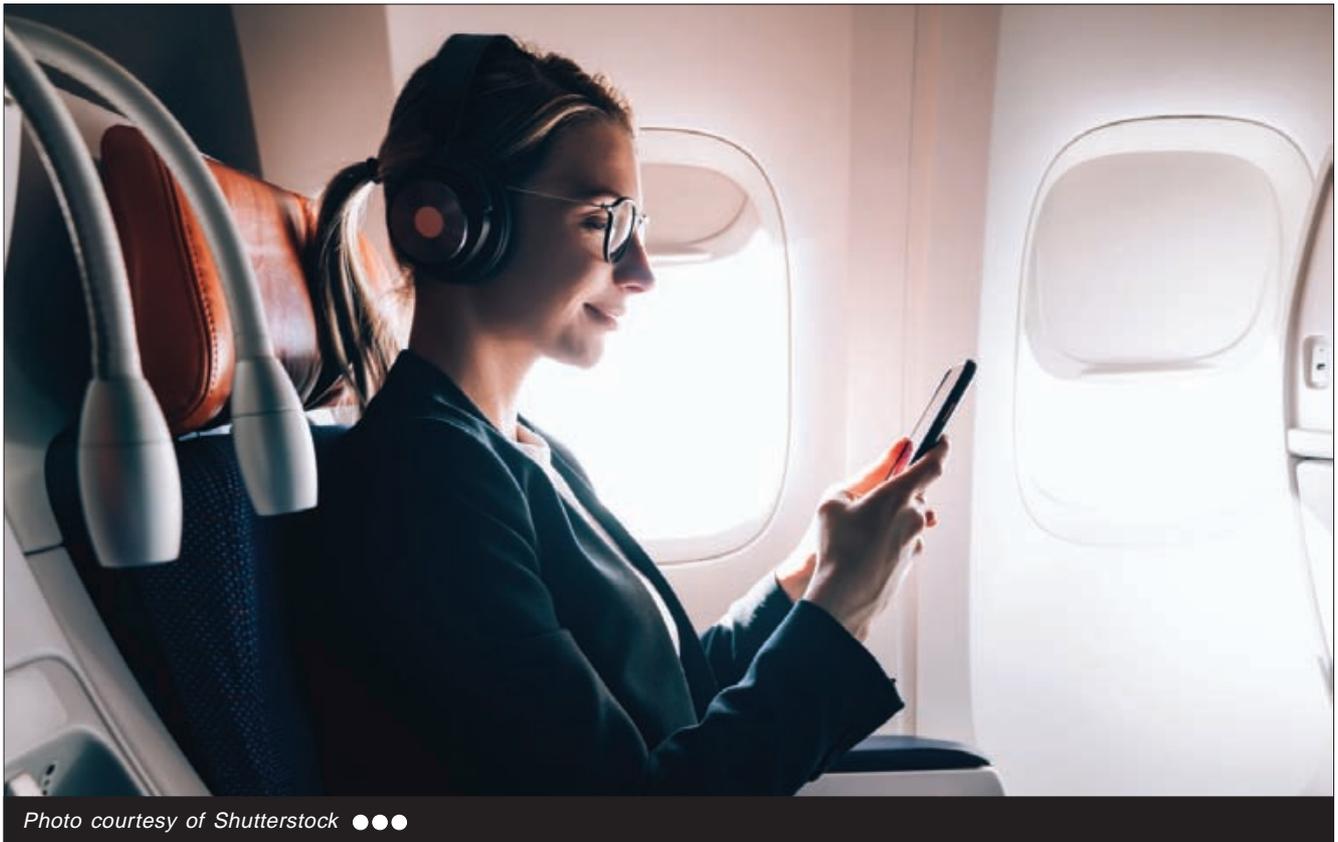


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access infrastructure by streamlining system integration and certification.

Estimations of future inflight connectivity market size vary depending on who you ask, but most agree that we can expect big things. According to The Insight Partners' *'In-Flight Wi-Fi Market to 2025 – Global Analysis and Forecasts,'* the IFC market is set to reach US\$7.30 billion by 2025, aided by higher expectations and an increased number of air travellers. Early adopter airlines that had installed inflight connectivity systems throughout their fleets in the 2000s are radically upgrading their equipment to be able to utilise the vastly-improved services on offer today, at great expense.

The cost challenges

Enabling inflight connectivity on even a single aircraft is an expensive business, and this cost is one of the reasons that IFC services are installed with less than half of airlines to date.

The equipment itself, while expensive, is not the biggest problem; typical installations of the plane-based equipment takes days rather than hours, and although efforts to reduce this are ongoing, there's still a long way to go. Taking just one plane out of operation for days costs tens-hundreds of thousands in lost revenues for the airline, which for some, is too steep a cost to bare. On top of the equipment costs and loss of operational revenues in an already-low profit sector are compounded by system maintenance costs, increased fuel costs due to the additional equipment weight, personnel costs, satellite capacity costs – falling, but still significant – and associated ground technology and support costs.

For all this to be worth it, the airline must have an extremely well-thought-out plan for monetizing inflight connectivity. Such on-board connectivity services are becoming less of a luxury and more of a standard, and research has shown that consumers are starting to resent paying for the service on top of their ticket price. As such, a variety of different models are in place; some airlines include the cost of inflight connectivity in the ticket, while others include a very basic package for free, often with a cap on

data use, with options to upgrade to a premium service offering. On the other hand, some airlines don't offer any connectivity for free, but allow passengers to log in via a dedicated system to purchase a package to suit their needs. No single model is leading the charge in delivering inflight connectivity - yet.

The next must-have

The inflight connectivity market marches on, and demand is expected to grow even further in the coming years, despite the associated costs.

It's hard to argue with the benefits on a consumer level. For business travellers, it's an opportunity to catch up on work during time that would otherwise be wasted. Responding to emails, reading reports and preparing documents is the type of activity many business travellers appreciate being able to get on with during a flight that they may not even want to be taking, since it allows them more time to catch up with family and loved ones once they arrive back home. Indeed, the ability to work pretty much as normal during a flight is an excellent opportunity, almost inventing time from nowhere. Meanwhile, for leisure travellers, IFC might be even more important. Many younger consumers have a desire to document their every move in real-time, so being able to share photos on social media from their seats is a great draw towards airlines that can deliver. For other consumers, the ability to stay in touch with loved ones, check on flight and hotel updates, do last-minute research on their destination, or maybe stream the latest episode of their favourite TV show, is priceless.

As inflight connectivity services become increasingly ubiquitous across airlines, with at least the opportunity to pay for on-board connectivity, airlines will face increasing pressure to install such systems just to keep up with their competitors. Across Europe and North America, competition is already heating up, with access to inflight connectivity services and noted market differentiator. In the years to come, we can expect to see IFC follow the path of Smart phones and 4G, moving on from a nice-to-have to a must-have. ✈️

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Jacob Keret, Senior Vice President
Sales & Marketing ●●●

Q&A

African expansion

Spacecom is a multi-regional satellite operator and service provider delivering end-to-end solutions to the media, telecom and data networks, and broadband sectors via its AMOS satellite fleet. With vast experience in designing, operating and marketing satellite services, Spacecom's team of experts, together with its wide network of partners, including teleports, consultants, content and hardware providers, and deployment experts, allows the company to provide specific or turnkey solutions as well as tailored packages. Jacob Keret, Senior Vice President Sales & Marketing at Spacecom, outlines the company's plans for the satellite sector.

Question: Spacecom provides satellite capabilities for a variety of geographic and end user markets. Could you walk us through which ones are key to Spacecom's business?

Jacob Keret: In terms of satellite capabilities, we are getting ready to launch a new satellite, AMOS-17. This satellite will have high throughput satellite (HTS) C-band spot beams. The new satellite will continue our expansion into African markets, specifically Sub-

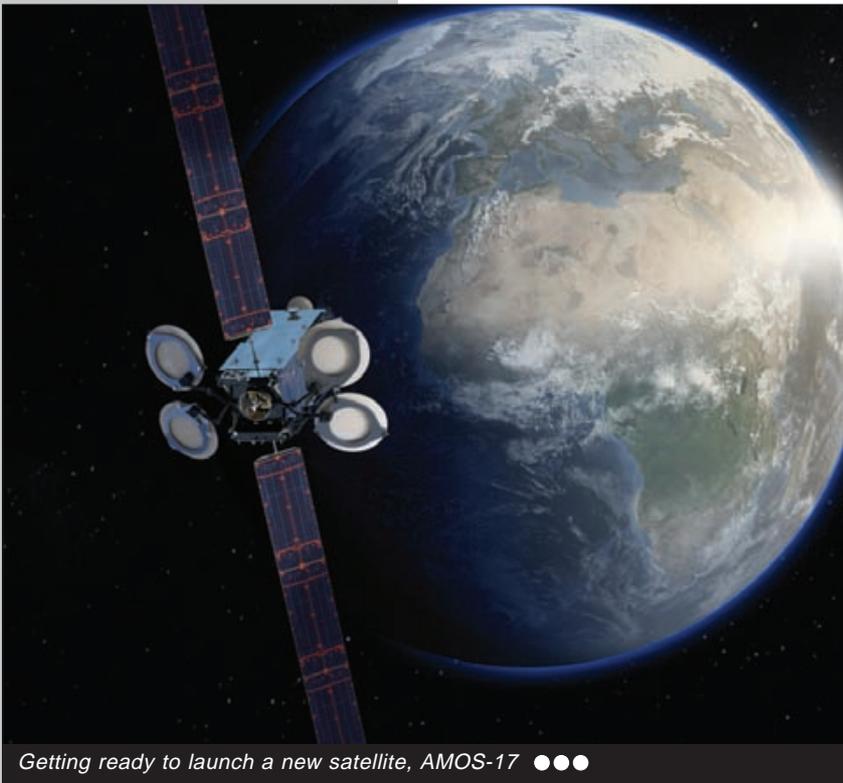
Saharan Africa, joining AMOS-4 and AMOS-7 in providing services in Africa. With regards to our other geographic markets, we're concentrating on Central and Eastern Europe, the Middle East, Eastern Africa, as well as parts of Asia.

We see more opportunities in the cellular backhaul sector for mobile network operators (MNOs) going forward. It's very much a growing segment, especially in Africa where Smartphones are the most popular communications platforms to consume Internet. We also see growth in the mobility market. Another sector that is heading upwards is that of regional African broadcasters and operators. These regional channels are seeking to deliver entertainment to larger areas and thus need the support and backbone that satellite provides.

On the other hand, the broadcast sector is pretty stable, with some growth in Asia. In Nepal, the nature of the country is such that they have to use satellite in order to broadcast to the entire population. We have a DTH operator partner there who is adding more channels, more HD channels – they're moving from 40 to 60 HD channels.

Question: The satellite sector is undergoing a great deal of change right now as high throughput satellites (HTS) move on to extreme throughput satellites (XTS), and small satellites and mega-constellations are major trends. What's your assessment of all this change?

Jacob Keret: I'd like to think we are part



Getting ready to launch a new satellite, AMOS-17 ●●●

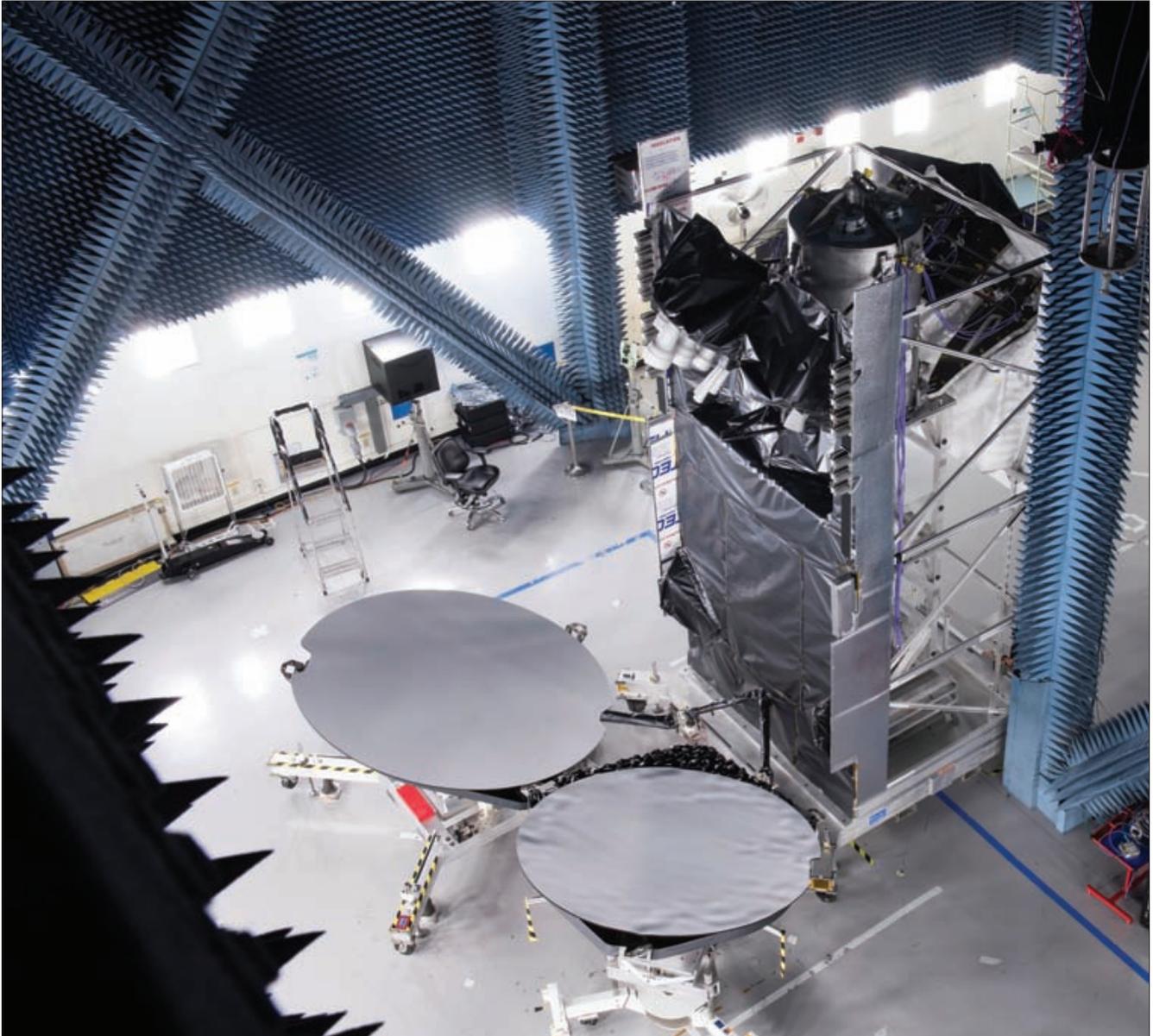


Photo courtesy of Spacecom ●●●

of these big changes. As I said, on AMOS-17 we'll have HTS C-band spot beams covering the entirety of Sub-Saharan Africa, so we're already in the HTS segment.

In terms of the mega constellations, there are more questions than clear ideas about how these are going to develop. We are looking for cooperation with partners. Spacecom is not a huge company, so we're not going to launch our own low Earth orbit (LEO) or medium Earth orbit (MEO) constellation, but we are looking to work with other satellite operators. We are working towards better understanding how these new satellite market places

will create new opportunities for our growth. This all is sorting itself out as we work towards creating new and various platforms for our future development.

Question: What are Spacecom's plans to continue to thrive in such a fast-paced market?

Jacob Keret: Our growth generator is Africa. There are so many opportunities there, particularly with MNOs, and we are taking part in this growth. The broadcast sector in some Sub-Saharan African countries is also growing, so this is something we're addressing via C-band and Ku-band.

More and more, we're seeing satellite being utilised as back-up services to fibre, which isn't so reliable in some regions of Africa. We have products that can be installed to provide this kind of back-up, particularly for banks, hospitals and large organisations that cannot rely on the local fibre, which cuts off some days. These services take into account that a few users share the same hub and space segment, and if one of them is experiencing such a breakdown, we provide them with satellite services instantly. With several customers sharing this service, prices can be reduced for everyone.

Question: The broadcast market in particular is changing rapidly, with OTT and other IP-based services providing major competition for traditional satellite TV. What's your assessment of this trend, and what it means for satellite operators?

Jacob Keret: This trend has been going on for some time now. Although some markets, North America in particular, have seen a decline in the number of regular subscribers to multi-channel distribution systems, most indicators point to the fact that OTT services are mainly perceived as augmented entertainment services and not as replacement to the traditional services that we have known for years. What we're also seeing now is some MNOs looking to provide OTT services, particularly in areas that aren't well-connected, over satellite. These companies are now providing IPTV via

satellite in places all around the world. This is good news for the satellite industry. Here at Spacecom, we're starting to see demand for that.

Question: AMOS-17 is due for launch in the second half of 2019 and is designed to meet the growing needs of the African continent. How is progress to date, and what market demands do you plan to meet?

Jacob Keret: AMOS-17 is in the final stages of construction. Boeing is the manufacturer, and it's set for launch in the second quarter of 2019. We're right on schedule for launch and three months later, we'll start commercial operations. AMOS-17 is a multi-band payload; C-band HTS, Ku-band, and some Ka-band capacity. The digital payload means it can connect Europe, the Middle East, India, China and Africa. We can uplink in Ku-band and downlink

in C-band, for example. We've worked a lot of flexibility into this satellite, which will enable us to provide value added services to customers.

Question: What are Spacecom's plans and expectations for 2019?

Jacob Keret: Our big plan for 2019 is the launch of AMOS-17 and to start providing services over the African continent. The company is very much focusing on this. We've already signed pre-launch agreements for AMOS-17, including one large agreement, and we're looking to sign more pre-launch contracts.

Spacecom is also actively exploring options for developing and building the AMOS-8 satellite. The program for this new satellite is not yet in place. Therefore it is premature to talk about specifics or a time-table for building and launching this satellite.



Photo courtesy of Spacecom ●●●

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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/>.

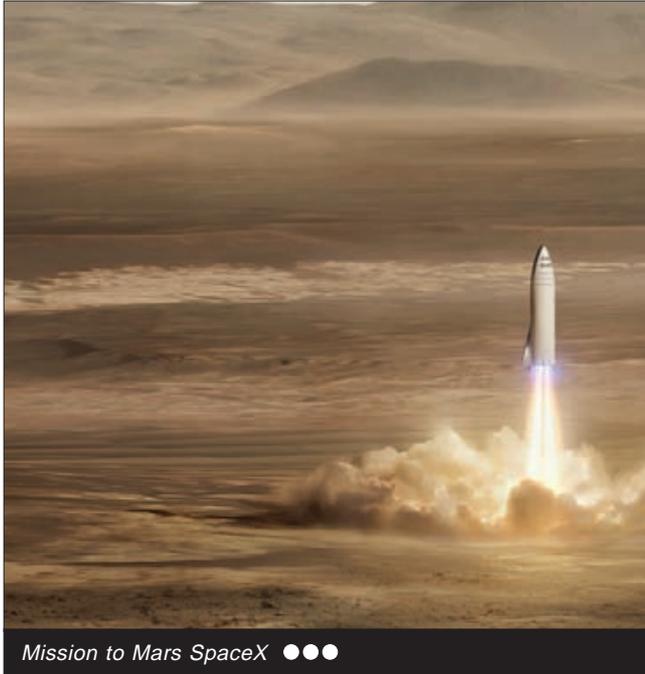
The NewSpace movement is incredibly varied and wide-reaching, encompassing a whole host of sub-sectors. Some of the more traditional satellite segments have been evolving in recent years to accommodate the increased focus on the commercial side of the industry and the myriad of new applications coming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



Mission to Mars SpaceX ●●●

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.

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 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

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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



Axiom Station forward view ●●●



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.

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.

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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 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.

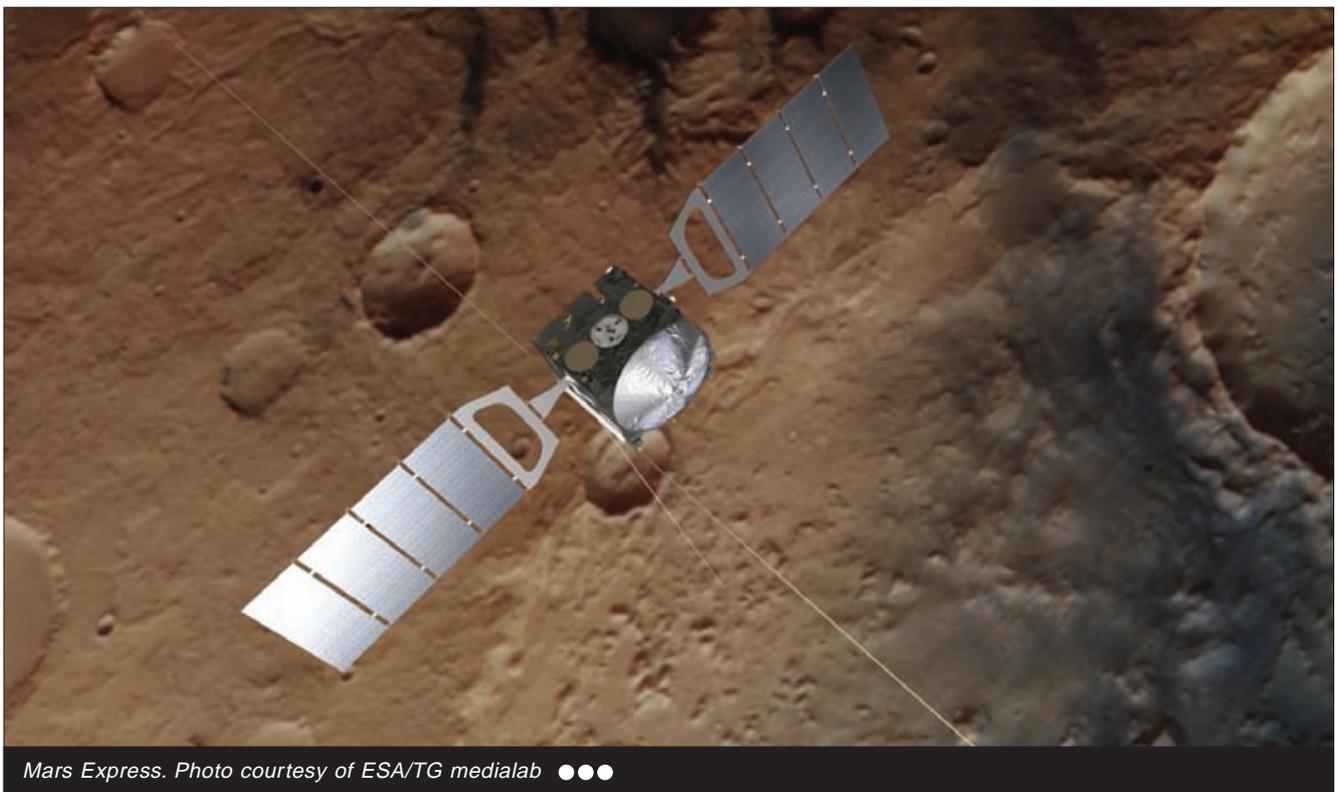
SpaceX's Elon Musk has stated that one of his longer-term goals is the colonisation of Mars, while the Mars One project, headed by Bas Lansdorp, is aiming for a permanent manned Mars landing in 2032. Lockheed Martin has outlined its Mars Base Camp concept, a crewed Mars laboratory orbiter, for NASA; 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 of ESA/TG medialab ●●●



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Jo De Loor, VP Market Development at Newtec ●●●

Q&A

Opening up new markets

Newtec has specialized in designing, developing and manufacturing equipment and technologies for satellite communications since 1985. The company 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. Jo De Loor, VP Market Development at Newtec, opines on current market trends and the growing government sector.

Question: Newtec is highly active in the satellite sector; what trends do you see emerging that could provide opportunities for Newtec?

Jo De Loor: There are a few elements around right now. On the technology side of things, there's a big evolution in high throughput satellites (HTS), which is emerging all over the world. That's good for us and our customers.

We address a wide spectrum of markets, and there's big traction in all of them. There's a lot of movement in the mobility market, both aeronautical and maritime, which are big growth areas for Newtec. The cellular backhaul market also holds a lot of opportunity for us. There's the evolution of the broadcast market as well, where we're evolving from traditional broadcast

towards IP satellite news gathering (SNG) and over the top (OTT) video delivery; both are becoming increasingly relevant in terms of growing markets for us. The government sector, too, is looking promising.

One of our biggest achievements was the penetration of the mobility market, particularly the aeronautical sector. Panasonic is a great customer with great capabilities, and if you take an international flight now and connect via Panasonic's In Flight Connectivity service, there's a good chance that will be enabled by Newtec technology.

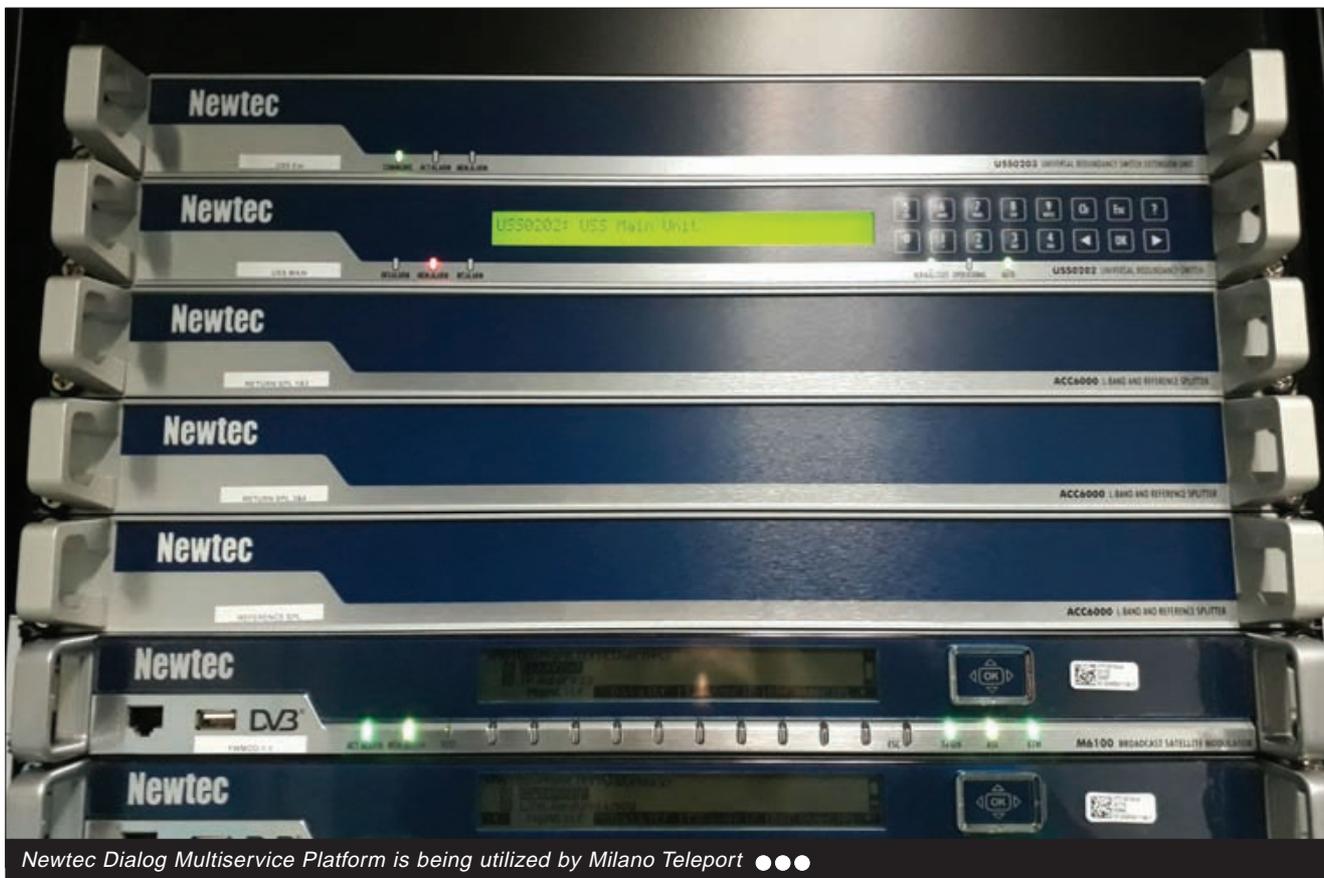
Question: Let's talk more about the development of the government markets; what's going on in this area?

Jo De Loor: We have various initiatives and projects in the government market right now. We have two European GovSatcom projects that we're working on, one with Airbus and one with SES. There are integrators integrating our products into their specific terminals for the government sector, and there's a lot of traction in this area.

There are a lot of new things going on in the humanitarian government markets, mainly in the disaster recovery and emergency communications areas. We've been supplying some major international organisations with equipment for these humanitarian projects, covering Europe, the Middle East, Asia and Africa. There's also a lot of interest from the USA. We're seeing more and more provisions in this field all over the world, as floods, earthquakes and other natural disasters



Newtec is enabling Communications & Commerce (Com & Com) to launch a mobile backhaul network for Mytel ●●●



Newtec Dialog Multiservice Platform is being utilized by Milano Teleport ●●●

are becoming increasingly common.

A lot of our technologies are used across all markets, commercial and government. It's more about how that technology is used, and it comes back to integration into specific terminals. When a disaster happens, the initial infrastructure to provide communications must be deployed quickly. That equipment must therefore be small, easy to install, flyaway or auto-pointing terminals. Integrating our products into those terminals is one of the things we have to stay on top of. Overall, there's a little adaptation required to make our commercial products suitable for government applications, and sometimes we have to add certain capabilities for these customers.

Question: The satellite sector is changing rapidly right now, with XTS, small satellites and constellations making significant headway. What are the main challenges for equipment suppliers like Newtec in such an environment?

Jo De Loor: The drive behind all these new constellations, HTS, and soon XTS

or VHTS, is to provide better services to the customer, which better fit their demands, and are more cost-effective. Of course, the constellations bring additional value from their low latency, because the round-trip time to low Earth orbit (LEO) is much lower; that's an important driver for some applications.

For us, it's a good opportunity to be part of something new. The industry is in a state of change, and we're an innovative company. We have a lot of projects in the HTS domain with customers in a variety of markets, including mobility, backhaul and consumer broadband.

We've taken a good look at NewSpace, because there are a lot of things happening. Beyond the LEO constellations, there's new trends in CubeSats, high altitude platforms (HAPs), and a lot of new players coming to the market.

There's an evolution to smaller and more flexible satellites which fits very well to our capabilities. We're taking a good look at our potential role in this area, we need to ensure any new areas fit our DNA as a company and meet our customers' needs.

Question: In June 2018, it emerged that Newtec is enabling Communications & Commerce (Com & Com) to launch a mobile backhaul network for Mytel, Myanmar's newest mobile operator. What can you tell us about the deal, and the opportunities available in Myanmar today?

Jo De Loor: We delivered this solution together with Com & Com – our long-term partner and a joint venture company established between Terabit Wave (Myanmar) and OSB JSC (Vietnam). Com & Com was awarded the tender for this project due to its high performance, low operational expenditure (OpEx) and its support of our dynamic bandwidth allocation technology, Mx-DMA®. A number of Newtec MDM3100 Satellite Modems have already been installed, empowering Mytel to deliver 2G, 3G and 4G services across Myanmar and increasing its coverage as it prepares for the expected growth in mobile traffic. Com & Com is responsible for fully managing the Newtec Dialog®-based network, supported by the platform's network management system. This is Myanmar's first all-4G network and the

project really emphasises the role satellite has to play in delivering fast mobile Internet access at affordable rates.

Myanmar is an interesting market because it really opened up for VSAT a few years ago. There's a lot of potential there, and that potential is starting to emerge now as the first projects are being realised.

There's a big drive to roll out mobile networks throughout the country, and there's the opening of the VSAT market; these are nicely linked together to deliver 3G and 4G services to the end users, who cannot be served otherwise. We see more opportunity in the VSAT market out of Myanmar moving forwards.

Question: In August 2018, it was announced that the Newtec Dialog Multiservice Platform is being utilized by Milano Teleport to enrich its maritime services. Can you outline what benefits Newtec's technology will deliver in this maritime environment?

Jo De Loor: Milano Teleport had a

challenge to serve the most demanding customers. It has customers with superyachts and cruise ships, and with the technology that it had in place, it wasn't capable of delivering the required services, and it wasn't capable of delivering in an affordable way. The reason Milano introduced our Newtec Dialog technology for those two mobility markets, and other additional markets in the future, was because we were able to solve this challenge.

We were able to deliver the capability to serve Milano Teleport's most demanding customers, and at the same time, do it very efficiently so that it becomes an affordable service. On top of that, the technology allows Milano Teleport to extend into other markets, including other maritime and fixed satellite services.

Question: In September 2018, Newtec and Arabsat signed a new multi-million Euro contract to enable the launch of new HTS services in the Middle East and Africa. Can you outline the applications that will be enabled, and how Newtec's

technology will deliver market-leading results?

Jo De Loor: Our latest contract with Arabsat is an extension of our long-term partnership and will provide the base for Arabsat's new HTS services in the Middle East and Africa. These include Enterprise and VNO services, IP Trunking and mobile backhaul for 3G and 4G services. Under the partnership, Arabsat will deploy a Newtec Dialog platform with a variety of Newtec's DVB-S2X Wideband modems. The specific modem used for each customer will depend on the market being served, with Newtec's portfolio providing vertical-specific solutions to deliver the best connectivity experience for any satellite application.

For Arabsat, the deployment will help it meet rising market demand for high-throughput and high-performance services, pushing the boundaries of what is available today. It chose to partner with Newtec again due to our proven expertise in enlarging addressable markets and maximising the benefits of HTS systems to achieve the highest efficiency and throughput.



In September 2018, Newtec and Arabsat signed a new multi-million Euro contract to enable the launch of new HTS services in the Middle East and Africa.

GVF

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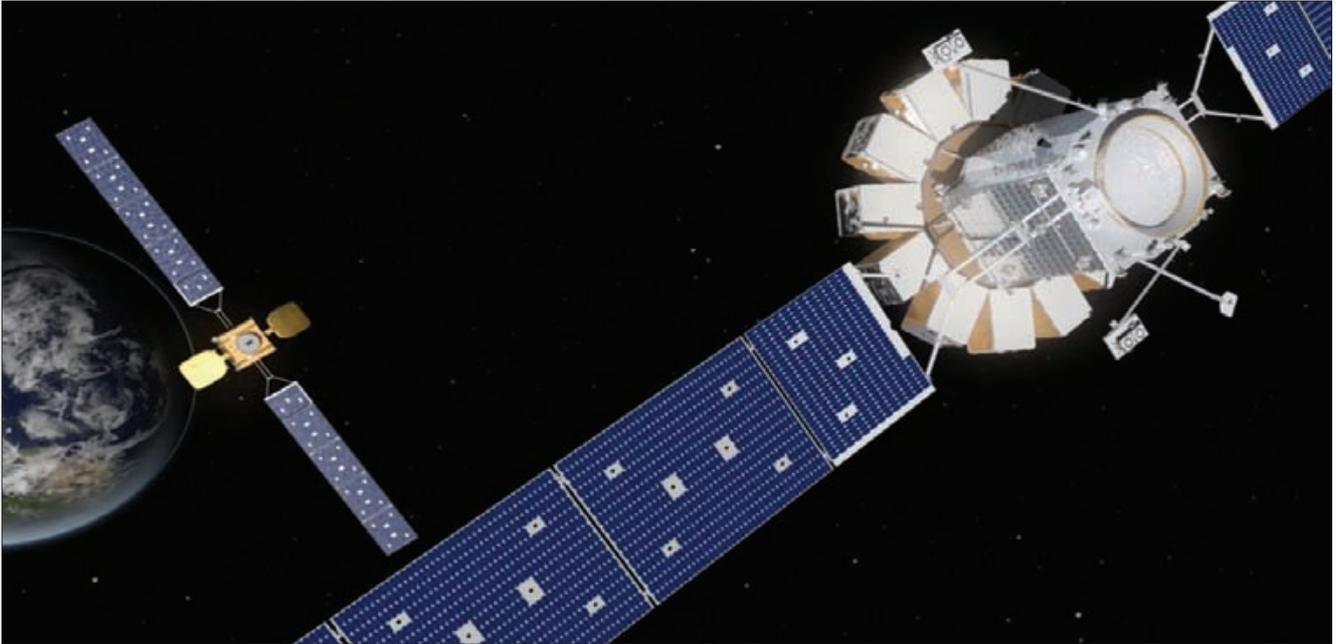


Photo courtesy of Northrop Grumman ●●●

Extending operations with space robots

On-orbit satellite servicing became major news in 2018 with ground-breaking announcements from Orbital ATK (now Northrop Grumman), Effective Space, DARPA and NASA. The idea makes sense – satellites are one of the few technologies that are rendered obsolete by lack of simple maintenance and fuel – but until now, we haven't had the capabilities to bring it to fruition. All that is about to change as these next-generation technologies bring satellite servicing front and centre.

The lifespan of a typical satellite is currently largely dependent upon the amount of fuel on board. Of course, small errors can also occur during the lifetime of the satellite that halt a satellite's operations. In both situations, the ability to refuel or carry out minor repairs, perhaps replacing parts here or there, could drastically change the economics of today's satellite sector.

The satellite industry is a very expensive game to be in, especially for operators. Every stage of a satellite's lifetime has a multitude of associated costs; design, manufacturing, insurance, launch, operations, etc. It all costs a great deal of money. For traditional geostationary satellites, the expected 15-year lifetime is imposed purely because of fuel supplies, and once that fuel is depleted, that US\$100 million asset is

rendered useless. Much of the technology on board these satellites can outlast the satellite's lifetime two or three times over, so good are manufacturing techniques today. Indeed, all it would take to add an extra five, ten, maybe even 15 years of life onto a satellite is a fresh supply of fuel, which is where today's ambitious on-orbit satellite servicing plans come in.

Developing the technology

The difficulties in on-orbit satellite servicing are not by any means insurmountable; the costs for developing technology that can be remotely operated from here on Earth; designing an interface that will be compatible with the majority of fuel valves used on satellites already in orbit; the costs to launch and deploy on-orbit satellite robots; and training personnel to safely operate the equipment without causing a catastrophic chain reaction of satellite destruction with one miniscule bump. All these issues can, and are being, solved. The costs of developing these services pale in comparison to the amounts invested in existing operational satellites.

There are also the implications for space debris to consider; the European Space Agency (ESA) estimates that there are around 30,000 debris objects larger than 10cm, 60,000 objects larger than 5cm, and around 750,000 objects larger than 1cm, currently floating around in orbit above the Earth. The time to act on this debris is now, and with on-orbit satellite servicing coming to fruition, fewer satellites will be launched, and the exponential growth of debris could be slowed. In addition, currently-proposed debris-removal technologies tie in nicely with on-orbit servicing vehicles; both vehicles must be remotely operated with absolute precision to achieve their goal. In a remarkable leap forwards,

September 2018 saw the first example of space debris capture by the RemoveDEBRIS technology demonstrator, which captured a piece of debris with a net.

Truly, we stand on the edge of a whole new era of space-based capabilities for the satellite sector. Indeed, according to research from MarketsandMarkets, the space robotics segment is expected to grow at a CAGR of 8.64 percent from US\$2.88 billion in 2018 to US\$4.36 billion in 2023. Increasing investments in space exploration, demand for on-orbit satellite servicing, manufacturing and assembly, debris removal, and advancements in autonomous systems are all fuelling the growth of the space robotics sector. While growth is strong among the commercial and government markets, organisations, space agencies, defence forces and satellite operators, the commercial markets are expected to dominate, particularly in North America.

So, what can we expect to see in the next few years? A form of 'space tug' is the most popular idea floating around right now. These tugs would be able to dock with existing satellites and overtake station-keeping duties and attitude control once the satellite's fuel is depleted. No fuel would be transferred, making in-space operations more facile, although it would be less energy-efficient than re-fuelling, because the tug would have to keep both the satellite and its own mass in position. Industry experts have pointed out that utilising electric thrusters on the space tug would improve efficiency. While most entities involved in the satellite life extension area are focusing on these space tugs, refuelling missions are also on the agenda.

Effective Space moves forwards with SPACE DRONE

Founded in 2013, UK-based Effective Space Solutions Ltd is currently developing the SPACE DRONE. The satellite servicing spacecraft docks to a host satellite with a patent-pending universal non-intrusive docking system in order to provide station-keeping and attitude control capabilities to extend the lifetime of a satellite by several years.



RSGS GEO Robotic Servicing Vehicle (RSV) ●●●

The sub-400kg SPACE DRONE design features electric thrusters and can dock with almost all of the 400+ satellites currently in GEO. The spacecraft, which can be launched on rideshare vehicles, can complete multiple satellite servicing missions during its 15-year lifetimes. Effective Space's initial focus for the SPACE DRONE is on station-keeping and attitude control, relocation, deorbiting, orbit and inclination correction and 'bringing into use' (BIU), however, the spacecraft could be deployed in the future for active debris removal, the support of low or medium Earth orbit constellations and in-space explorations, mining and manufacturing logistics.

Effective Space has signed several Memorandum of

Advertisement for Azure Shine International Inc. featuring a large satellite dish antenna in the foreground and a satellite in orbit in the background. The text reads: "leading in VSAT antenna innovation". Below the text is the company name "Azure Shine International Inc." and the website "http://www.azureshine.com.tw". There are also logos for "eutelsat" (type approved for Broadband Services) and "INTELSAT".



Understanding (MoU) deals with satellite operators in the last few years, including a January 2018, US\$100 million multi-year contract with an unnamed major regional satellite operator which will see two SPACE DRONE spacecraft launched by ILS in 2020 to provide station-keeping and attitude-control capabilities to significantly extend the life of two communication satellites.

The technology took a step forwards in April 2018, when Effective Space announced a partnership with ArianeGroup for the provision of electric propulsion systems. ArianeGroup's Arclight Radio Frequency Ion Thruster technology will propel the SPACE DRONE to geostationary orbit and provide complete station-keeping and attitude control services. Four Arclight electric propulsion thrusters per SPACE DRONE will deliver the highest efficiency propulsion in its size class, in a compact, lightweight package, as well as providing several on-orbit service modes which can be tailored in accordance with the SPACE DRONE service mission phases.

Later in July 2018, Maxar Technologies' Neptec UK Ltd subsidiary signed a contract to supply a spaceflight LIDAR and infrared camera for the SPACE DRONE. The equipment will enable the SPACE DRONE to safely approach and dock with satellites in orbit, generating a 3D picture of the target spacecraft and critical information on distances and dimensions.

Meanwhile, September 2018 saw the announcement that Effective Space had partnered with Israel Aerospace Industries (IAI) technologically and financially, with IAI named

as the prime contractor for the SPACE DRONE project.

Northrop Grumman strides ahead with MEVs, MEPs and MRVs

Orbital ATK and its subsidiary company, Space Logistics LLC, made some of the biggest news in 2018 with its on-orbit satellite servicing plans. The company has since been acquired by Northrop Grumman and now goes by Northrop Grumman Innovation Systems.

The initial announcement featured the Mission Extension Vehicle (MEV), a cooperative on-orbit satellite life extension and manoeuvring services vehicle for geostationary satellites that will deliver flexible, scalable, capital-efficient and low-risk solutions. Northrop Grumman's MEV docks with up to 80 percent of existing satellites, providing the propulsion and attitude control needed to extend their lifetimes. A suite of integrated proximity sensors is used to safely rendezvous with the satellite, and a mechanical docking system creates a firm connection between the MEV and the satellite. Once the customer no longer requires the life extension service, the MEV, which has an expected 15-year lifetime, can undock and move away to serve its next customer.

Intelsat placed the first order for an MEV, currently dubbed MEV-1, in 2016, to add an additional five years of life onto an existing satellite asset. This was followed by a second order, for a second MEV (MEV-2), in January 2018, which is due for launch in the middle of 2020.

In March 2018, the next step in Northrop Grumman's on-



Artist's concept of Restore-L ●●●





orbit satellite servicing plans was announced: A new robotic servicing system that provides additional options for customers to enhance the value of their satellites. The new system consists of two products, Mission Robotic Vehicles (MRVs) and Mission Extension Pods (MEPs), which will provide customers with more flexibility to extend the life and effect repairs to satellites in-orbit. The MEP is an external propulsion module that attaches to and provides up to five years of orbital life extension for satellites which are running low on fuel. While the primary application of the MRV is to transport and install 10-12 identical MEPs or other payloads on customer satellites, it will also offer on-orbit robotic capabilities for in-orbit repairs and similar functions. One of the new features of the MRV is the ability it brings to capture those remaining 20 percent of satellites for servicing that can't be targeted by the MEV, utilizing robotic arms. Northrop Grumman expects to launch the first MRV and MEPs in 2021.

DARPA meets major milestone review for RSGS programme

Never one to be left behind, the US Government's Defense Advanced Research Projects Agency (DARPA) has also launched a Robotic Servicing of Geosynchronous Satellites (RSGS) programme to develop technologies that would enable cooperative inspection and servicing in geostationary orbit.

Early in 2017, DARPA selected Space Systems Loral (SSL) as its commercial partner for the RSGS programme. DARPA will develop a robotic module, including hardware and software, and provide technical expertise and a government-funded launch, while SSL will provide a spacecraft, integrate the robotic module onto the spacecraft to create a robotic servicing vehicle (RSV), install the RSV onto the launch vehicle, and provide a mission operation centre and staff. After a successful on-orbit demonstration of the RSV, SSL will operate the vehicle and make cooperative servicing available to both military and commercial satellite operators on a fee-for-service basis. In exchange for providing property to SSL, the US Government will obtain reduced-priced servicing of its satellites and access to commercial satellite servicing data throughout the operational life of the RSV.

The RSGS project aims to enable high resolution inspection; correction of mechanical anomalies such as antenna and solar array deployment malfunctions; refuelling; assistance with relocation and orbital manoeuvres; and the installation of attachable payloads for upgrading existing assets. DARPA intends to provide the space robotics technology to other interested US space corporations - qualified companies will be able to obtain and license the technology through cooperative research and development agreements. SES will reportedly be the first commercial customer to benefit from the DARPA/SSL satellite refuelling service and will be able to activate the service whenever required. The satellite servicing spacecraft vehicle is planned for launch in 2021.

In August 2018, DARPA completed a major review milestone for the RSGS programme, which showed that the robotic payload design – assigned to the US Naval Research Laboratory (NRL) by DARPA – and the SSL-built spacecraft bus are on track to fulfil a multi-year mission to service at

least 20 commercial and government spacecraft. According to DARPA, several elements have advanced beyond the preliminary design review stage, and flight versions of two dexterous robotic manipulator arms, which will allow up-close inspection, repair, and installation of technical packages on the exterior of satellites, are in production and are expected to deliver in 2019.

NASA targets LEO for on-orbit satellite servicing

NASA is another major organisation working on its own robotic satellite servicing plan, but unlike the other projects going on right now, NASA is focusing on low Earth orbit (LEO). The Restore-L mission will feature a carefully-curated suite of satellite-servicing technologies for on-orbit rendezvous and grasping, refuelling and repositioning. The technology includes an autonomous navigation system with supporting avionics, dextrous robotic arms and software. Restore-L is due for launch in 2022.

According to NASA, future candidate applications for individual Restore-L technologies include on-orbit manufacturing and assembly, propellant depots, observatory servicing, and orbital debris management. NASA is also directly applying several Restore-L technologies to the Asteroid Redirect Mission. The robotic vehicle of NASA's Asteroid Redirect Mission directly leverages Restore-L's autonomous rendezvous system, avionics, dextrous robotics and software, and tool drive and other systems. This mission is being designed to be refuellable.

In October 2018, NASA selected Orbit Logic's STK Scheduler software for the Restore-L technology demonstrator. The software, which includes timing and event constraint checking and auto-sequencing features, will provide NASA with an adaptable, invaluable tool to perform Restore-L's highly complex mission timeline and sequencing. Since Restore-L is being executed in LEO, schedule visibility for radio frequency (RF) communications is critical to mission success.

Strict rulesets and mission constraints, coupled with RF communications, must be cross-referenced for specific servicing tasks and approach sequences. STK Scheduler supports the configuration and implementation of all Restore-L scheduling constraints out-of-the-box, allowing for quick initial deployment, testing, and use in prelaunch planning, simulations, and on-orbit mission execution at a fraction of the cost of custom software development.

During the same month, NASA selected SSL to develop a vital 'Tipping Point' technology related to its on-orbit satellite servicing plans. NASA's Tipping Point awards are designed to foster the development of commercial space capabilities and benefit future NASA missions; a technology is considered to be at a tipping point by NASA if an investment in a demonstration is likely to be infused into a commercial space application and deliver significant improvement in the ability to successfully bring the technology to market. SSL's In-Space Xenon Transfer for Satellite, Servicing and Exploration Vehicle Replenishment and Life Extension project will unlock new possibilities for on-orbit servicing and refuelling by demonstrating that fuel transfer can be performed reliably in space. According to NASA, the incremental and reliable addition of xenon transfer to existing robotic refuelling payload opens new refuelling opportunities.





Photo courtesy of LeoSat ●●●

Living up to expectations in NGSO

The satellite sector has come on in leaps and bounds in recent years, and nowhere is this truer than when we look at the satellites themselves. Shrinking in size, weight and cost, and with more power and flexibility than ever before, this new era of satellites is set to enable a whole new world of applications from the lesser-used medium and low Earth orbits (LEO and MEO).

Satellite technology has been enabling global communications capabilities since back in the 1960s. The geostationary orbit (GEO) has become the gold standard in satellite technology, enabling applications as diverse as communications, consumer Internet, environmental monitoring, banking, e-health, distance learning, broadcasting, etc. While that gold standard remains in place today, a noticeable shift towards non-geostationary orbits (NGSO) is underway.

Why move beyond GEO?

The majority of satellites throughout history have been launched into geostationary orbit, with NGSO selected for only a small number of very niche applications until now.

The new NGSO satellite networks are expected to offer a unique set of attributes. Latency is one of the key selling points; for GEO satellites, latencies are usually in the region of 270ms, compared with less than 200ms for MEO, and around 25ms (in theory) for LEO. While NGSO advocates

argue that this low latency will be absolutely vital for certain services going forwards, including military applications, consumer gaming and banking, others claim that latency is relatively unimportant for the majority of applications.

The distances involved also raise some interesting points. Three GEO satellites orbiting some 35,786km above the Earth can cover the entire globe, while for MEO, some 20,200km above the Earth, and LEO at around 2,000km, many more satellites are required to deliver global coverage. With more satellites involved, mobile satellite users are required to make many more handovers between satellite beams, requiring highly-advanced antennas and tracking capabilities, and much more costly ground architecture.

Launch capabilities are also more complex. While cost-effective launch opportunities are available, either with dedicated launches or on rideshares, it seems unlikely that there is adequate launch capacity for the more than 5,000 satellites due for launch to MEO and LEO in the next few years.

While this opens up the launch markets to new entrants, and indeed we're seeing a lot of start-ups dedicated to developing unique small satellite launch systems, demand remains unmet. These upcoming NGSO satellites also have much higher refresh rates than the standard 15-year GEO satellite lifespan, requiring replacement in anywhere from 1-5 years.

We're also only recently starting to discuss the 'shielding effect' as an industry. The impact of an additional 5,000 satellites being launched into NGSO is currently unknown: Will these new satellites shield signals being transmitted between GEO and Earth? We just don't know, and we're still waiting for accurate modelling to determine the answers.

Big money in NGSO

All the benefits that come with NGSO satellites, and the huge potential market applications, have provided plenty of reason for governments, commercial organisations, venture capital funds and billionaires to get in on the ground floor.

According to NSR's 'Global Satellite Capacity Supply & Demand, 15th Edition' report, NGSO annual capacity revenues are expected to boom to US\$4 billion by 2027. The new NGSO constellations are expected to open up entirely new greenfield markets, however, the report highlights that CAPEX exposure will be massive and that 'new revenue drivers may not be enough to pay back initial investments.' The risk of price disruption for the entire satellite industry is considerable should these new constellations find the need to offload capacity at rock-bottom prices.

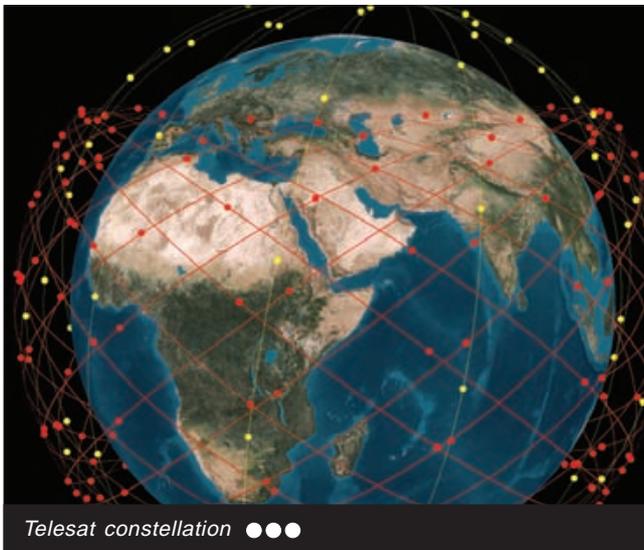
"According to their schedule, LEOs need to start offering concrete examples of progress, but results are still mixed," said Lluc Palerm, NSR Senior Analyst and report author. "Funding is still far from resolved and even the ones that have already attracted billions in investment still do not have a clear path to service. Delays and cost overruns plague many programs. Regulatory challenges are coming to light with first denials of access to key markets. Technology wise, there are still many questions to answer, beginning with user terminals. On the other side, progress continues in the form of testing satellites, new rounds of funding and establishment of baseband networks."

The report states that, to date, technology development has consumed most of the attention as far as NGSO constellations are concerned; however, as the constellations near service entry, more attention must be paid to commercialisation options. According, many upcoming operators are trying to strike out a niche vertical market for themselves, and others are linking up with well-established GEO satellite operators.

The state of play

The NGSO market is absolutely booming right now.

In the MEO segment, the market is still limited to a small number of players. To date, most satellite constellations in this orbit have been the reserve of government organisations,



including the Global Positioning System (GPS), Global Navigation Satellite System (GLONASS), Compass and Galileo (completion expected by 2020).

O3b Networks, part of SES Networks since 2016, is one of the biggest players in the private NGSO sector, and the only NGSO constellation to date to merge MEO capabilities with a GEO fleet. The O3b ('the Other 3 Billion') constellation delivers voice and data communications to mobile operators and Internet service providers and is currently being refreshed with new satellites; four were launched in March 2018, and an additional four in the first half of 2019. SES Networks is also developing O3b mPOWER, a next-generation constellation of seven 'super-powered' MEO satellites which will feature more than 30,000 dynamic electronically-generated, fully-shapeable and steerable beams that can be shifted and switched in real-time. Due for launch in 2021 and scalable to multiple terabits of throughput globally, O3b mPOWER will deliver coverage to more than 400 million square kilometres.

Viasat, too, is getting in on the action, with a planned constellation of 20 satellites, namely five satellites in four different MEO orbital pathways. The company plans for Ka and V-band frequency satellites which will, like SES Networks,

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operate in combination with its GEO satellites to provide more holistic capabilities.

In the LEO segment, meanwhile, there are significantly more companies getting in on the action. Existing constellations in this orbit are typically private sector, including the Iridium and Iridium NEXT constellations, Globalstar and ORBCOMM.

OneWeb Satellites, a joint venture between OneWeb and Airbus Defence and Space, is a planned LEO constellation of 882 Ku-band satellites that will provide a global broadband Internet service to consumers. The first satellites were launched in February 2019, with services expected to commence later this year. OneWeb has made history with the establishment of three satellite assembly lines, in France and the USA, which will validate, test, and integrate the company's satellites.

Telesat, too, is developing a global LEO constellation of 120 satellites which will accelerate 5G expansion and bridge the digital divide by delivering fibre-like high speed services into rural and remote communities by 2021. The company launched its Telesat Phase 1 LEO satellite in January 2018 to demonstrate the constellation's system design, specifically the capability of the satellite and customer terminals to deliver a low-latency broadband experience.

LeoSat Enterprises is another start-up with a planned LEO constellation; LeoSat's satellites will feature a unique architecture utilizing inter-satellite laser links to connect the satellites, creating fibre-like symmetry at Gigabit speeds, while providing total security as the data is encrypted and secured from end-to-end across the network, with no terrestrial touch points. The 78 satellites will be divided into six polar orbits, 20 degrees apart, each with 12 active and one on-orbit spare.

Each satellite will have almost 30Gbps of full duplex data, providing a 2Tbps capacity constellation upon completion. Launches are expected to begin in 2021 and be completed

in 2022. Japan's SKY Perfect JSAT and Spain's Hispasat have both invested in the constellation.

Probably the world's most famous space sector company, SpaceX has also outlined plans for a LEO constellation. The company plans to launch almost 12,000 satellites by the mid-2020s, including 4,425 for the Starlink constellation, as well as an additional 7,500 V-band satellites to orbit 340km above the Earth. Like LeoSat, the Starlink constellation will utilise inter-satellite links between its Ka and Ku-band satellites and will provide a low-cost global broadband network with latencies of 25-35ms. Tintin A and B, two demonstration satellites for the Starlink constellation, were launched in February 2018 to example the constellation's capabilities.

Facebook is another house name with plans to launch its own constellation of LEO satellites. The Athena constellation will reportedly provide efficient broadband access to unserved and underserved areas parts of the world. We look forward to hearing more about this project in due course.

The bottom line

NGSO is big money, both now and in the future. There are billions of dollars being invested into these systems today, yet we won't begin to see the fruits of these labours for some time yet. Unlike MEO, which in the case of O3b Networks is a successfully-proven concept, it remains to be seen whether LEO will yield the expected results, or whether it will be a disaster with major knock-on effects for the entire satellite sector. Indeed, industry experts have been pointedly vocal in their disbelief that all currently-planned LEO constellations will be brought into reality.

The bottom line is that some of these constellations will no doubt be built out and launched, and we'll be able to establish whether they live up to all that has been promised in the next two to three years. With so many fantastical expectations, from bridging the digital divide to providing cheap, global, high-speed Internet, NGSO has a lot to deliver.



Photo courtesy of LeoSat ●●●



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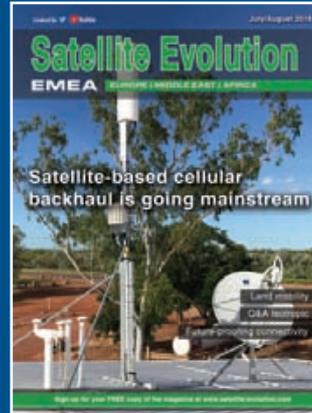
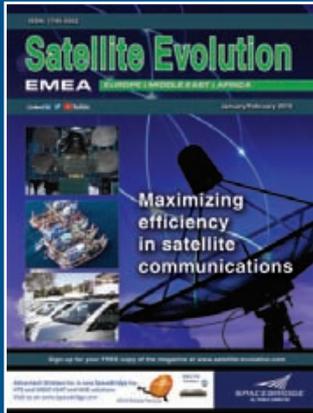


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