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Going green

So here we are, winding up yet another year! It seems to rush by faster each year somehow, almost as if time speeds up as we near the finishing line. Rounding out two years - and counting - of the COVID-19 pandemic, growing international tensions with Russia and China, and fears of global unrest buoyed by extremely unstable markets and economies, it's hard to view the last twelve months as a particularly successful period for anyone in particular.

At the time of writing, the COP26 is well underway in Glasgow, with world leaders meeting to address the growing alarm over the Earth's climate. With greenhouse gas emissions and global temperatures continuing to rise, we wait anxiously to discover whether negotiators can make progress on climate finance, coal use, and methane emissions, among other topics.

Thus, it is timely indeed that we're now hearing some good news about the new Orbex Prime space rocket, which will reportedly have a carbon footprint up to 96 percent lower than comparable space launch programmes. Indeed, Prime is poised to become one of the most environmentally friendly orbital launch vehicles ever built, benefiting from the use of renewable, ultra-low-carbon biofuel. It is also designed to be reusable and will not leave any debris on Earth, in the Earth's oceans, or in the Earth's atmosphere. Orbex is also committing to offsetting all emissions from the rocket and its launch operations, ensuring every launch is carbon neutral. The company plans to launch from Space Hub Sutherland, the carbon-neutral Spaceport in the North of Scotland.

The new University of Exeter study reveals that a single Prime launch would produce up to 86 percent less emissions than a similar-sized vertical launch vehicle powered by fossil fuels. A key factor in the emissions saving is the use of BioLPG fuel sourced from Calor; the fuel is produced as a by-product from the waste and residual material from renewable diesel production, meaning its greenhouse gas (GHG) factor is 90 percent lower than fossil fuels such as RP-1, a highly refined form of Kerosene typically used as rocket fuel. Reducing emissions from orbital launches is more critical than many are aware, with the amount of black carbon in the upper atmosphere created by 120 launches, roughly equivalent to the emissions from the entire global aviation industry. Shocking stuff.



Meanwhile, it's time to say goodbye to Satellite Evolution Asia. This November/December issue will be the last ever, as in 2022 we move forwards to a new, monthly, Satellite Evolution Global publication which will better reflect the changing and increasingly global world we live in. In this last-ever issue, we've interviewed Andrew Bacon from Space Forge to learn more about how a world-first startup based in Wales is hoping to bring microgravity-as-a-service to the global space economy. We've also discussed changing trends, goals and industry collaboration with Satcoms Innovation Group's Helen Weedon, and the demands of the pandemic and changing industry landscape with Intelsat's Steve Spengler. Hans Massart from ST Engineering iDirect opines on the paradigmchanging impact of cloud technologies on remote production. We've reviewed the past twelve months, looking at the biggest achievements in aerospace, and spoken with our friends in industry to gain different operational perspectives in the COVID-19 era. Another area of interest, we've explored the fantastic progress made in Australia's space economy in recent years, with input from LatConnect 60's Venkat Pillay.

We hope you enjoy this final issue, and we wish all our readers Happy Holidays!

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SES, MDDIAI RK, RCSC, and AsiaNetCom test high-speed remote connectivity via O3b constellation

Residents of two remote Kazakhstan villages can now benefit from unprecedented Internet speeds via satellite-enabled Wi-Fi, through a network set up for 30 days by the leading global content connectivity solutions provider SES. The demo is implemented in cooperation with the Republican Center for Space Communications (RCSC), a subsidiary of the Ministry of Digital Development, Innovations and Aerospace Industry and AsiaNetCom, a Kazakhstan-based connectivity provider. During the demonstration, the companies achieved 380Mbps downlink and 120Mbps uplink via SES's O3b satellite constellation, the highest speed ever recorded in Kazakhstan via satellite.

The demo is done in the framework of the country's national project called 'Technological breakthrough via digitalization, science and innovation', that aims to bridge the digital divide and bring the benefits of high-performance communication networks for healthcare, businesses, local administrations, education and more.

As part of the collaboration agreement between SES and RCSC signed earlier this year, the test demonstrates the benefits of SES's Medium Earth Orbit (MEO) networks and its upcoming second-generation O3b mPOWER communications system.

The current demo network is leveraging SES's firstgeneration O3b satellites to connect an RCSC teleport located in Kokterek with the villages of Akterek and Beriktas for high-speed Internet access.

"Kazakhstan has already made progress in providing Internet connectivity to the population. However, there are still remote villages where it is impossible to deliver a network using radio relay communications or through cable connection. In those circumstances, we decided to use satellite constellations. This will allow us to expand our coverage and provide broadband Internet connection to the population of Kazakhstan," said Bagdat Mussin, Minister of Digital Development, Innovations and Aerospace Industry (MDDIAI RK).

"The premise of national project 'Technological breakthrough via digitalization, science and innovation' is to bring the same quality of life and opportunities afforded by Internet access to every citizen of the country, wherever they live - in Nur-Sultan or in a remote mountain village. In some cases, the use of terrestrial networks is economically impractical, and we are considering the opportunities to implement innovative satellite technology to provide high-speed connectivity in those remote villages. The demo gives us an opportunity to explore the possibilities of further scaling," said Malik Zhuiriktayev, Chairman of the Board of JSC RCSC.

"We are very excited to participate in this project, which aims to digitalize and to improve all spheres of life and economy in the country. Today in collaboration with our partners RCSC and AsiaNetCom, we have demonstrated the



unrivalled performance of our innovative and proven MEO network by connecting rural Kazakhstan," said Sandeep Jalan, Chief Financial Officer of SES. "When operational next year, our second-generation MEO system, O3b mPOWER, will further multiply the capacity delivered and bandwidth. In addition, it will deliver significantly higher speeds flexibly, catering to the increasing needs from governments, enterprises and mobile operators."

Northrop Grumman donates US\$12.5 million for quantum research and education

Northrop Grumman Corporation is the first anchor-level partner of Virginia Tech's Innovation Campus with a US\$12.5 million donation to advance talent development, teaching and research supporting quantum science and engineering. The company's donation will help establish a Center of Quantum Architecture and Software Development at Virginia Tech's Innovation Campus.

"Our partnership with Virginia Tech will help support their

vision to solve the world's most pressing problems with ground-breaking technologies," said Kathy Warden, Northrop Grumman Chairman, Chief Executive Officer and President, who is also a member of the Innovation Campus Advisory Board. "Through partnerships like this, we can build on a 'better together' approach to prepare future talent – to help build the next generation of engineers, scientists and technologists – while driving innovative critical research."

Northrop Grumman's support will be used to:

- Establish an endowed faculty position and recruit an internationally recognized researcher to head the new Center of Quantum Architecture and Software Development, which will be based at the Innovation Campus.
- Endow five to ten graduate fellowship positions to recruit nationally competitive doctoral and master's candidates, with a focus on diversity.
- Build programs to connect Northrop Grumman experts with Virginia Tech quantum science and engineering faculty based at the university's Innovation Campus and Blacksburg campus.
- Create or enhance pathway programs that engage K-12 students and students from under represented groups to open new talent pipelines and help shape a more inclusive culture in the high-tech sector.
- Support master's degree students through capstone courses or other experiential learning programs in computer science and computer engineering.

Virginia Tech's Innovation Campus plans to invest an additional US\$15.8 million to build the leading Center of Quantum Architecture and Software Development for the nation, bringing total support for the initiative to US\$28.3 million.

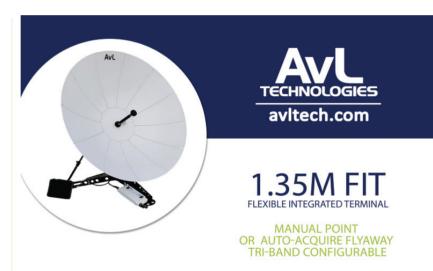
Northrop Grumman has a long-standing relationship with Virginia Tech. This fall, the

company launched a graduate degree cohort in computer and electrical engineering with a growing number of employees involved, and the company hired numerous Virginia Tech students as interns this past summer. In 2021, Northrop Grumman sponsored more than US\$600,000 in Virginia Tech research. The company employs over 700 Hokie alumni.

Arianespace to launch Australian satellite Optus-11 with Ariane 6

Arianespace and Australian operator SingTel Optus signed the launch contract for the Optus-11 communications satellite. The launch, scheduled for the second half of 2023, will use the Ariane 64 version of the Ariane 6 launcher, with four solid boosters.

Optus-11 is a Ku-band communications satellite with a coverage zone encompassing Australia and New Zealand. Optus-11 incorporates a number of advanced technologies, especially the latest developments in digital processing, plus



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active antennas enabling the creation of several thousand beams. Fully configurable in orbit, this satellite will expand the capacity of the operator's current geostationary orbit constellation – making it the largest constellation ever deployed by an Australian company.

"We are delighted and honored by this renewed mark of confidence from the operator SingTel Optus," noted Stéphane Israël, Chief Executive Officer of Arianespace. "Over the last 21 years, we have carried out all launches for Optus, and Ariane 6 will now continue this long and successful track record."

"A vital element to the successful deployment of a new satellite are the partners that we work with. We are delighted to be partnering again with Arianespace, who's demonstrated over many years the ability to consistently deliver a precise deployment and speed to orbit," said Ben White, Managing Director, Wholesale, Satellite and Strategy at Optus.

The Ariane 64 configuration for this mission provides enhanced performance to inject the Optus-11 satellite into a high-energy geostationary transfer orbit, enabling it to start operation more quickly.

Inmarsat secures installation agreement with Maersk supply service for Fleet Xpress portfolio

Inmarsat, the world leader in global, mobile satellite communications, has extended its Fleet Xpress service agreement with Maersk Supply Service to include fleet wide IoT-based ship management connectivity on separate, dedicated bandwidths. The extension has also enabled Maersk Supply Service to evaluate new vessel performance tools for selection, available through Inmarsat's Certified Application Provider (CAP) programme.

Operating off Europe, the Americas, West Africa, Southeast Asia and Australia, the 30-vessel Maersk offshore fleet includes some of the most modern anchor handlers and subsea support vessels in the industry. Under a long-term Fleet Xpress agreement, connectivity will now include

dedicated Inmarsat Fleet Connect for key digital applications and a commitment to the Fleet Data IoT platform for data acquisition and uploading.

"Maersk Supply Service is pursuing digitalization to support optimized fleet management and to improve vessel energy efficiency. Software-based digital solutions have a significant advantage over hardware-based counterparts as they can be deployed fleet-wide at the push of a button," said Kasper Thiesen, Head of IT, Maersk Supply Service (MSS). "By having the underlying Fleet Data, Fleet Connect infrastructure and sensor data collectors installed on our vessels, we have unlocked a portfolio of digital services which we can deploy to our fleet and bring to market in little-to-no time. As the digital eco-system develops, more solutions will become available, increasing our ability to remain agile and support our journey to decarbonize, and entry into renewable industries."

Fleet Data enables digitalization across the full scope of vessel operations, using cloud-based analytics, which is agnostic of OEM-specific applications or sensor technologies. Owner-operators are free to choose which areas will benefit most from predictive analytics and decision-making.

The new agreement will accommodate rapid scaling up of new IoT-based vessel performance applications fleet wide. Fleet Data and Fleet Connect offer a single IoT-based



architecture capable of working with every OEM-supplied or standalone analytics and management software in the market

Maersk Supply Service used Fleet Xpress in combination with Fleet Data to evaluate a number of fuel emissions and ship performance solutions provided through the Inmarsat CAP programme. The trials have resulted in a commercial commitment to SKF One Global Cloud platform that provides condition monitoring and remote diagnostics from SKF Marine and a proof of concept agreement with Yxney Maritime covering the Maress data analytics software for reducing fuel consumption and emissions.

"Maersk Supply Service has been quick to realize that dedicated Fleet Data and Fleet Connect bandwidths satisfy their digital offshore support vessel needs," said Marco Cristoforo Camporeale, Head of Maritime Digital, Inmarsat Maritime. "Hundreds of data points are monitored on each ship, with Fleet Data covering data acquisition and uploading to the cloud, and Fleet Connect bringing the bi-directional communication to stream data to and from the ship."

Fleet Connect offers digital solutions providers – including OEMs – the opportunity to take advantage of always-available, dedicated bandwidth for specific vessel management applications.

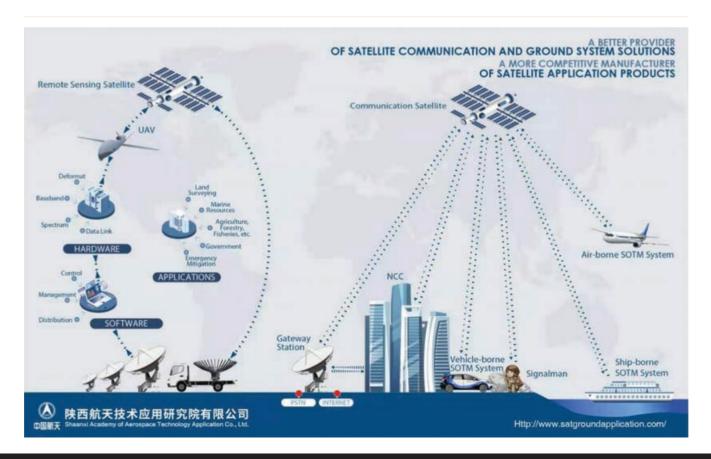
"We believe that everyone should have access to crucial asset data at any time," said Frank Hasselbalch - Manager Condition Monitoring, SKF Marine. "SKF's monitoring solutions provide the foundation for fleet condition-based maintenance strategies to meet and exceed class society recommendations".

"Maress is a system that unlocks a complete birds-eye

view and strategic perspective on fleet and vessel decarbonization efforts and results," said Sindre Bornstein, CCO, Yxney Maritime. "Building on a successful Maress trial, Maersk Supply Service will be able to use its data in a smart way to maintain a leading role in the ongoing industry transition; in short, providing transparency, accountability and strategic decision support around emissions."

"Introducing owners to solutions providers and trialling IoT-based management tools on board without commitment strongly benefited digital strategy development. Inmarsat's CAP digital ecosystem includes over 50 partners, with new applications added regularly," Camporeale said. "Together, Fleet Data and Fleet Connect create a flexible solution which takes care of data acquisition and transmission across multiple applications, leaving customers to manage their data as they see fit to enhance ship performance," he said. "This removes any integration burden and means owners and managers do not need to expend the time, energy and cost committing to single applications only to find out they are suboptimal; instead, they can assess solutions within an existing set-up."

Inmarsat recently unveiled ORCHESTRA - the first of its kind multi-dimensional, dynamic mesh network that will redefine connectivity at scale with the highest capacity for mobility worldwide. ORCHESTRA will integrate Inmarsat's ELERA (L-band) and Global Xpress (Ka-band) networks with terrestrial 5G, targeted low earth orbit (LEO) capacity. Dynamic mesh technologies will meet accelerating bandwidth requirements, deliver high performance connectivity everywhere and eliminate congestion challenges at high demand hot spots, including busy ports and sea canals.





Dr. Megan Clark, with Minister Andrews, Prime Minister Morrison and SA Premier Marshall officially opening the space agency. Photo courtesy Australian Space Agency ●●●

The exemplary progress of the Australian space economy

The Australian space economy has come on leaps and bounds since the nation resumed its reputation as a space power with the establishment of its space agency in 2018 as part of the global NewSpace era of space economics. Now with a multitude of space businesses growing in step with the demand for orbital services, the nation's space sector is becoming increasingly competitive.

Laurence Russell, Assistant Editor, Satellite Evolution Group

On the 25th March 2021, Karen Andrews, Australia's Minister for Industry, Science and Technology, announced that South Australian company Southern Launch will be federally licensed to launch suborbital satellites from its Koonibba test range site. "This is a major milestone for the Australian space sector," she explained. "And will unlock opportunities for our local space businesses to help them grow and create local jobs."

"Southern Launch is so excited by this development," added Lloyd Damp, CEO of Southern Launch. "With the Koonibba Test Range licensed to launch rockets into space and recover payloads in the uninhabited desert to the north, we are ready to provide a unique service to both domestic and international customers."

The history of Australia in space

Since 2018, when the Australian Space Agency (ASA) was formed, the Australian Government has invested more than AUS\$700 million into the civil space sector as part of its plan to grow the market to AUS\$12 billion and add another 20,000

jobs to the economy by 2030. Enrico Palermo, Head of ASA, said of the news: "We are committed to providing a supportive environment ... including for the innovative space start-up community, while ensuring the safety of space activities." Indeed, the Australian space economy has been quite a success story of rapid growth, embracing the NewSpace era to establish orbital business cases in the country.

As Karen Andrews continued, "Australia's geographical location and wide-open spaces makes it optimal for various launch activities and suborbital rocket launches provide an important capability to space-qualify Australian hardware and technology."

The history of the UK Space Industry has been very similar to Australia's, with both countries having been respectable players in the Space Race of the cold war, before cutting funding at the close of the conflict. As the 21st century brought with it the tools to create a sustainably profitable space economy, both nations changed their priorities.

In 2008, a Senate inquiry into Australia's space sector found that "Australia's involvement in space science and industry has drifted and the sense of purpose has been lost ... The committee believes it is not good enough for Australia

to be lost in space." A decade after the enquiry, ASA was launched with a focus on the civil space sector, making great strides toward building market competition in the global space economy.

"For decades it was received wisdom in the Australian space community that we would never launch again," remarked Alice Gorman, popular Space Archaeologist at Flinders University at the Southern Launch news. "It's amazing that we're back in the launch business."

LatConnect 60's success story

We approached Venkat Pillay, Co-Founder and CEO of LatConnect 60, a successful Australian satellite data and insights provider, for his perspective on Australia's burgeoning space economy.

The company recently announced that they would be extending their subscription to Spire Global's Automatic Identification System (AIS) vessel tracking service after being awarded an Australian Research Council (ARC) Federal Grant in partnership with Curtin University, for the Intelligent Sensing & Perception Laboratory that they co-developed, which endeavours to improve collision and contact avoidance strategies and contribute to more accurate predictions of traffic patterns for ship owners and insurers.

LatConnect 60 was founded around the same time as the Australian Space agency, and grew in tandem with the government body, in line with the key roadmaps of Australia's plans to support sovereign satellite Earth observation and connectivity with the use of small satellites.

"The Australian space sector has the advantage of a



significant end user base that consists of the largest mining companies in the world," Pillay explained. That customer base funds work that has "seen leading edge research and technologies being developed in the areas of satellite launch,



nanosatellite builds, hyperspectral sensors, IoT communications payloads, space edge computers, etc just to name a few."

The future of the Australian space economy

Pillay foresees these technologies and services going to export, "particularly in the areas of specialized satellite payloads, launch capabilities and downstream data analytics and processing for Earth observation capabilities."

He highlights a recent contract signed with the British company Surrey Satellite Technology Limited (SSTL) tasking LatConnect 60 with processing raw satellite data from SSTL's S1-4 high resolution imaging satellite into actionable analytics for clients, which represents the "first key commercial deal signed as part of the UK-Australia Space Bridge."

Australia counts another valuable customer in the United Arab Emirates (UAE), as ASA has possessed a Memorandum of Understanding (MoU) with the United Arab Emirates Space Agency (UAESA) since 2019, which promises a close working relationship between the two ambitious space economies.

At the 2021 International Astronautical Congress in Dubai, Stuart Ayres, Australian Minister for Investment, Trade, and Industry, explained that "with continued investment into domestic research and development, including Mars exploration, the UAE is poised to become a powerhouse within the space sector, and we know there's a real opportunity for our Sydney-based companies to be part of this growth."

LatConnect 60 plans to develop their own constellation of between 8-16 satellites for launch in the first quarter of 2023, which will use "proprietary software defined radio (SDR) and on-board AI capabilities to fuse IoT and other sources of data in orbit to deliver fast insights to end user terminals across a wide range of industries."

The company is one of many in Australia enjoying the fruits of government economic investment in pursuit of arranging a respectable piece of the global space market, and a valuable foothold in the Eastern world, from which Western businesses and government organisations will no doubt come to rely upon.

A proud history

LatConnect 60 is just one of many in Australia enjoying the fruits of government economic investment in pursuit of arranging a respectable piece of the global space market, and a valuable foothold in the Eastern world, from which Western businesses and government organisations will no doubt come to rely upon.

Looking back, it's startling to recognise what Australia has achieved. Being a venerable proponent of both space races and standing in a handsome position in the contemporary market, the nation's space economy is a picture of success.

It now remains to be seen if their explosive start will come to set a leading standard in the APAC region against their fierce competitors.



Aerial view of the Canberra Deep Space Communication Complex (CDSCC) in Southern Australia. Photo courtesy CSIRO •••

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Fueling the future of connectivity

Having recently entered a phase of voluntary financial restructuring, Intelsat has been a whir of activity as they've responded to the demands of the pandemic and gone on to fuel the future of connectivity via satellite. Steve Spengler, Intelsat CEO, recaps the company's recent activities and his contemporary views on key industry debates.

Laurence Russell, Assistant Editor, Satellite Evolution Group

Question: The pandemic's digitization boom has relied unprecedentedly on the satellite industry. How have satcoms, and Intelsat specifically, been able to keep up? Steve Spengler: The pandemic has made us all aware of the importance of

connectivity for people and communities around the world. We have seen this across our global network as our telecom operator partners have increased their data rates to meet the demand for e-education, e-government, e-health, and business applications, to name a few.

Despite the expansion of these services, there is still a long way to go





to achieve universal broadband connectivity across the globe. Satellite is an essential technology to complement terrestrial solutions to expand the reach of networks and to connect the unconnected. This is one of the drivers of our next generation network investment strategy.

Question: Intelsat has recently announced the expansion of its partnership with MaxIQ to fuel the Xinabox Space STEM program aiming to bring STEM education to teens in Africa. Would you care to discuss the program and its results? Steve Spengler: This will be our second year partnering with MaxIQ and its Xinabox Space program.

XinaBox removes barriers to participation in the growing STEM academic field and economy. MaxIQ provides hardware kits and virtual workshops where students can participate in these STEM projects.

It is remarkable to see how much the students learn throughout the sessions. After last year's iteration, students were able to mentor with Intelsat engineers to learn the industry and ask questions on how to pursue a career in the telecom and space industries. It's a wonderful program.

Question: Since we last spoke, Intelsat has had a whirlwind of change from financial restructuring to acquiring Gogo. Could you recap



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what has happened within the company?

Steve Spengler: Intelsat voluntarily entered financial restructuring in mid-2020. Since then, the company really hasn't missed a beat. We have managed though the challenges of the pandemic, and at the same time continued to deliver consistent high-quality services to our customers. Many of these services have expanded during the pandemic as we just discussed.

We have executed well on our C-band spectrum clearing project in the US as mandated by the Federal Communications Commission (FCC). This project will enable the expansion of 5G services in the US, while ensuring that our media customers can continue to distribute high quality HD and UHD content across North America for years to come.

In the midst of our restructuring, we acquired the commercial aviation inflight connectivity (IFC) business of Gogo. We rebranded that business and integrated the commercial aviation team into Intelsat. Intelsat is now the largest vertically integrated provider of IFC. As the commercial aviation market begins to recover from the effects of the pandemic, we are well positioned for growth in this high demand and evolving sector.

Finally, we have embarked on the first phase of investment in our next generation software defined network. The initial US\$2 billion plus investment will enable the world's first software defined 5G unified network. Our plan is to establish a multi-band, multi-orbit, and multi-level network unified though 5G orchestration.

Our customers will experience seamless services with superior economics to allow them to extend the reach of terrestrial solutions to their customers in the air, on the seas and in remote locations on the ground. We are very excited about these future capabilities and services.

Question: LEO satellites and smallsats are holding much of the limelight in the industry at the moment, but GEOs have remained a reliable service. Is Intelsat interested in exploring other orbits?

Steve Spengler: Our plan is to establish a unified network across various communications platforms. It

will be a multi-layer, multi-orbit, and multi-band 5G network of networks. We will leverage our 52 satellites, virtualized ground network, fleet of software defined satellites under construction, and ample orbital rights to meet tomorrow's demand.

Question: What delivers the best results in the satellite business? Cheap, quantitative platforms, or high-end, long-lived qualitative installations?

Steve Spengler: The industry needs to move away from declaring that the next technology and bespoke solution is the answer for all the world's communications requirements. We believe in open networks that leverage standards. This will facilitate the integration and interoperability of multiple telecommunications technologies for the benefit of telecoms network operators and end-users. End users really don't care what technology is used for their services so long as it is high quality, easy to use and economical. A unified network is at the center of our vision to leverage the 5G standard, software, and partnerships across the broader industry to best serve end user customers.

Question: You will be the keynote speaker at the upcoming AVIA Satellite Industry Forum - What video industry trends are you seeing globally, particularly in Asia?

Steve Spengler: Monetization of content is a big driver for programmers right now. One of the biggest opportunities in addition to subscriptions is advertising.

Total Asia Pacific Pay TV advertising spends is expected to grow at a CAGR of seven percent from 2020-2025 to reach US\$44.8 billion by 2025. Online video advertising (local and regional AVoD and freemium platforms plus broadcaster-led platforms) is expected to grow to US\$33.3 billion by 2025. The takeaway from this is that there are growth opportunities in all segments – not just streaming, and satellite remains a critical enabler in capturing that growth.

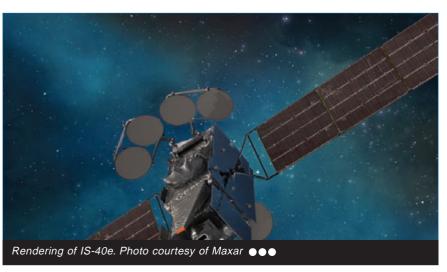
Even in the face of new technology, the data shows that more consumers are looking to add to their existing services, rather than cut the cord completely.

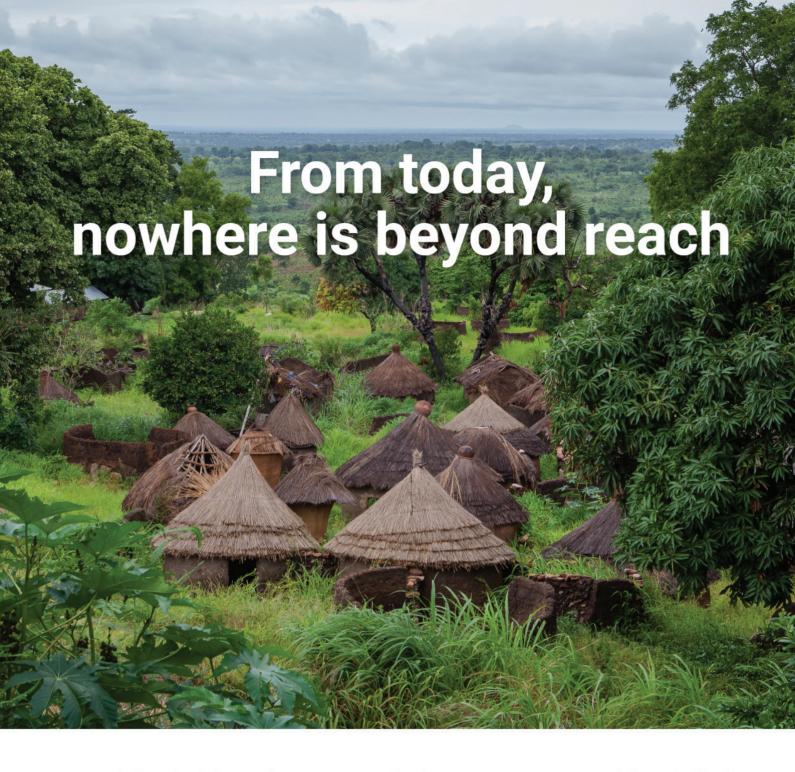
Cable services alone still make up over half of the market, reaching 57 percent of households and making up 56 percent of the revenue.

Though competition for audiences across distributors is fierce, linear distribution is the preferred delivery method of video in Asia Pacific.

Question: What will Intelsat's work bring the world in the next decade? Steve Spengler: Innovation, standards, and integration with the broader telecoms sector will enable a range of new services for customers, especially in mobility, and enable the expansion of networks to places where next generation satellite services are uniquely positioned to support the goal of universal broadband connectivity.

A lot of exciting things will happen in the next decade to enable future applications and address some of telecoms most vexing challenges once and for all.





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2021: An aerospace odyssey

It's been an interesting year for the aerospace sector, marked out by massive highlights in human ingenuity in the form of space tourism, immense paradigm-changing new space station plans, and of course, the ongoing effect of the novel coronavirus pandemic on our satellite industry colleagues.

Amy Saunders, Editor, Satellite Evolution Group

We're at that point again, the end of yet another year, and another spent under the cloud of COVID-19. After two years of widespread coronavirus infections and with no end in sight, I feel fully justified now in my assertion that this is indeed 'an era' – a significant period of time – for many of us, in which life is forever changed.

This year, there have been three key stories running through the aerospace sector, overshadowing all else. The huge achievements in private commercial spaceflight cannot be overstated, with three companies reporting successful world-first all-tourist flights into sub-orbital space. Massive new plans have been announced on the future of space station technologies, with existing projects coming to fruition and new plans being announced. Finally, the seemingly endless COVID-19 pandemic continues to impact on the satellite industry, although to a much-diminished extent than this time last year.

Space tourism

The biggest single area of development this year is undeniably space tourism – and what a year it's been. July was a truly historic month for the commercial spaceflight sector, with the two leading rivals both reaching suborbital flight with a full cohort of paying passengers for the very first time.

On 11th July, Virgin Galactic achieved its first fully manned test flight to the edge of space, with owner Richard Branson himself on board. The VSS Unity rocket was launched to an altitude of some 50,000 feet from a Virgin Galactic carrier plane, from where it used its own rocket power to reach the boundary of space.

Crew experienced around four minutes of weightlessness before descending back to Earth.

Branson beat rival Jeff Bezos by a matter of days, with Bezos having successfully launched himself to space on 20th July on board his Blue Origin New Shepard spacecraft, which also carried his brother and 82-year-old Wally Funk, the oldest woman (and person, at the time) to ever fly in space, to an altitude of around 328,000 feet, where the crew members experienced around four minutes of weightlessness. The rocket then detached from the crew capsule for self-landing, while the capsule descended back to Earth.

Both companies have gone on to achieve several more crewed launches for the rest of the year, the most notable in October with Blue Origin's second launch, carrying none other than Star Trek's Captain James T Kirk, infamous ladies' man and intrepid intergalactic voyager, played by William Shatner.

The launch made 90-year-old Shatner the oldest person to travel to space to date.

Following the successful launch and re-landing, Shatner is quoted as saying: "I hope I never recover from this." A rather touching sentiment from the now world's oldest astronaut. "I'm so filled with emotion about what just happened. It's extraordinary, extraordinary. It's so much larger than me and life. It hasn't got anything to do with the little green men and the blue orb. It has to do with the enormity and the quickness and the suddenness of life and death... To see the blue colour whip by you, and now you're staring into blackness ... everybody in the world needs to do this. Everybody in the world needs to see this."

While SpaceX has far surpassed both Blue Origin and Virgin Galactic in its launch and re-landing capabilities and has been employed by NASA to operate commercial runs back and forth to the International Space Station, it did not complete its first all-tourist space trip until September of this year. SpaceX's Crew Dragon capsule carried billionaire businessman Jared Isaacman, geoscientist and science communicator Sian Proctor, physician-assistant Hayley Arceneaux, and engineer Chris Sembroski, Isaacman chartered the flight dubbed Inspiration4 from SpaceX and gave away three seats through a raffle and fund-raising partnership with St Jude Children's Research Hospital. The crew spent three days orbiting Earth aboard the Dragon capsule, flying as high as 590km above the Earth. After the third day, the Crew Dragon manoeuvred itself into descent back to Earth; balloons and parachutes were used to slow the descent and the capsule was safely re-landed on 18th September. SpaceX's next tourist flight is scheduled for January – the AX-1 mission will see Axiom Space (more on these guys later) customers hosted on board the ISS for eight days.

With more flights planned for 2022 from Blue Origin, Virgin Galactic and SpaceX, the market is expected to grow out of this world at a CAGR of 16.3 percent from 2021-2027 to reach US\$2.55 billion by 2027, according to Industry Research. The future looks bright indeed for the space tourism sector, although questions remain about its long-term viability, both in terms of financing and environmental concerns.

Commercial space stations

The International Space Station (ISS) was launched in 1998; since then, it has travelled around the Earth in LEO and been home to thousands of off-world experiments. With more than a handful of other space stations planned and abandoned over the years, the ISS remains the only successful space station to date.

Now some 24 years old, the ISS is currently in use beyond its initially planned years. NASA is thus now preparing to award up to US\$400 million to companies to build commercial space stations rather than building its own replacement. The 'Commercial Low-Earth Orbit Destinations' contract has already received around 12 proposals, and NASA will select two to four by year end. With ISS operational costs of around US\$4 billion per year, NASA expects to save more than US\$1 billion annually by opting for an external deal.

Alternative space stations are already well underway. In an interesting move, NASA has awarded Axiom Space US\$140 million to fly modules to the ISS that will eventually

detach to form their own separate space station. The first module is due to attach to the ISS in 2024 and be detached later in the decade when the ISS is retired.

Meanwhile, China's Tiangong Space Station should be the second space station in orbit shortly. The Tianhe core module was launched into LEO earlier this year, and the next two modules are due for launch in 2022. An additional three modules may be added in future. According to Tiangong operator China Manned Space Agency (CMSA), the space station will target: Further development of spacecraft rendezvous technology; breakthrough in key technologies such as permanent human operations in orbit, long-term autonomous spaceflight of the space station, regenerative life support technology, and autonomous cargo and fuel supply technology; test of next-generation orbit transportation vehicles; scientific and practical applications at large-scale in orbit; development of technology that can aid future deep space exploration.

Exciting space station news came in October, when Blue Origin and Sierra Space revealed the Orbital Reef project, a commercially developed, owned, and operated space station destined for LEO. Backed by teammates including Boeing, Redwire Space, Genesis Engineering Solutions, and Arizona State University, the station will provide anyone with the opportunity to establish their own address on orbit. This unique destination will offer research, industrial, international, and commercial customers the cost competitive end-to-end services they need including space transportation and logistics, space habitation, equipment accommodation, and



Engineering collaboration with vaccinations and masks. Photo courtesy Eric Schmidt ●●●

"I'm so filled with emotion about what just happened. It's extraordinary, extraordinary. It's so much larger than me and life. It hasn't got anything to do with the little green men and the blue orb. It has to do with the enormity and the quickness and the suddenness of life and death... To see the blue colour whip by you, and now you're staring into blackness ... everybody in the world needs to do this. Everybody in the world needs to see this."

operations including onboard crew. The station will start operating in the second half of this decade.

Orbital Reef will be operated as a 'mixed use business park' in space with shared infrastructure that efficiently supports the proprietary needs of diverse tenants and visitors. It features a human-cantered space architecture with world-class services and amenities that is inspiring, practical, and safe. Orbital Reef will provide the essential infrastructure needed to scale economic activity and open new markets in space. Reusable space transportation and smart design, accompanied by advanced automation and logistics, will

minimize cost and complexity for both traditional space operators and new arrivals. The open system architecture will allow any customer or nation to link up and scale to support demand.

In the same month, Lockheed Martin, Nanoracks and Voyager Space announced that they have formed a team to develop the first-ever free flying commercial space station. The Starlab space station will be a continuously crewed commercial platform, dedicated to conducting critical research, fostering industrial activity, and ensuring continued US presence and leadership in LEO. Starlab is expected to achieve initial operational capability by 2027. Nanoracks will prime the Starlab development effort leveraging over a decade of experience as the pathfinder of and global leader in commercial ISS utilization. Voyager Space, the majority shareholder in Nanoracks, will lead strategy and capital investment and Lockheed Martin, a leader in developing and operating complex spacecraft, will serve as the manufacturer and technical integrator.

The basic elements of the Starlab space station include a large inflatable habitat, a metallic docking node, a power and propulsion element, a large robotic arm for servicing cargo and payloads, and a state-of-the-art laboratory system to host a comprehensive research, science, and manufacturing capability.

Starlab will be able to continuously host up to four



Starlab, a commercial low-Earth orbit space station is being planned for use by 2027. Photo courtesy Lockheed Martin 🖜 🌑



astronauts for conducting critical science and research.

Socioeconomic challenges

Since the COVID-19 pandemic started to gain traction at the start of 2020, the world has become a very different place. It's been almost two years now of masks and social distancing, of vastly reduced opportunities for both work and play, of a whole new way of life. The sudden, unanticipated changes have placed huge pressure on many industries, ours included.

Confusion and delay

In the aerospace sector, work largely ground almost to a halt as people scrambled to adapt. No one knew what to expect, or what was to come.

"Some of our employees got sick and had to stay home for 14 days to recover, causing loss of productivity. Orders for products slowed down as some funding destined for product was diverted to fight COVID. The lack of air cargo flights into the many countries we sell to slowed down our sales. In addition to this the cost of shipping has skyrocketed making products much more expensive to ship," said Leslie Klein, President and CEO, C-COM Satellite Systems.

Søren Aarhus, Chief Operating Officer at QuadSAT, tells a similar story: "Like most other companies, QuadSAT was hit hard by the global lockdown in the spring of 2020. From one day to another, all external appointments and customer interactions where cancelled, and we immediately had to introduce restrictions of where and when to work, for our employees."

"The beginning of the pandemic was a challenge for every business and more precisely, every individual around the world. So many variables, so much uncertainty," said Mitja Lovsin, STN General Manager. "We needed to ensure our team had a safe and supported working environment as per strict regulations and that our client services continued seamlessly and uninterrupted especially during this time of

pandemic when communications and information flow was critical."

Some companies such as Santander Teleport were designated as 'essential' or 'key' workplaces, meaning that they were empowered to work as normally as possible throughout the pandemic and lockdowns.

"Our day-to-day operations are mostly based at our teleport facility," David Andres, Santander Teleport VP Sales and Business Development, told us. "We were very agile in adopting effective measures to reduce the risk of contagion at work. During the lockdown period in Spain, our business was included in the category of 'essential activities' which included telecom operators of different classes, so we could attend our offices and operational centres."

"Initially, and even well into the pandemic, our day-today operations were minimally impacted. CPI was deemed an essential business, enabling us to keep our North American manufacturing facilities open during the pandemic and to adapt quickly when new health and safety regulations were issued," said Timir Chokshi, Director of Business Development and Marketing, CPI SMP Satcom Products Group, "In addition to benefiting from a robust supply chain that allowed our manufacturing and other operations to continue uninterrupted, CPI implemented guick measures to ensure the health and well-being of our employees and stakeholders. The combination of existing best practices along with swift adherence to science-based precautions meant that the CPI SMP Satcom Products Group was able to continue supporting customers during the pandemic with little deviation from our typical operations."

Others who saw what was coming managed to better prepare themselves before the worst hit. "We could see what was happening in other countries and knew the same would happen in the UK eventually so began preparing our contingency plans. We got ahead by procuring and installing an IT infrastructure ready for most staff to be home based and even had some people working at home before the official



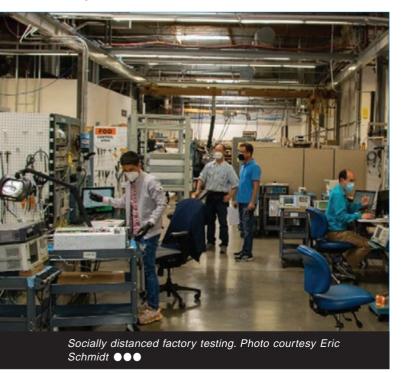
lockdown was enforced. All the staff worked very effectively from their home bases," said Martin Ryan, Managing Director, ViaLite. "Our production also continued throughout the lockdowns with the production team remaining on-site, adhering to COVID-19 measures. We had a significant order book entering COVID-19 which we delivered on time for our customers."

Onwards and upwards

After the initial shock felt by many at this unprecedented situation, organizations began to explore 'COVID-secure' workplaces and WFH where possible in many parts of the world. Our conversations with manufacturers, service providers and operators indicate that these new measures were quickly achieved.

"We had time to anticipate and mitigate risk areas when it came to our operations. We prioritized safeguarding the health of our employees, followed by remaining a stable and sustainable partner to our customers. This was proven to be key as we have seen increased stress on the global commodities market throughout most of 2021. CPI SMP Satcom Products was able to make the necessary changes to our processes to quickly and effectively merge into this 'new paradigm' that we all are navigating, even as it continues to change," shared CPI SMP Satcom Products Group's Timir Chokshi.

"Where we had to adapt more was in our human interactions, as meetings became online and external visits to our facility were cancelled unless truly essential," said David Andres from Santander Teleport. "We moved to online business meetings and virtual events. I personally found virtual networking not being as effective as personal face-to-face meetings, however for the first time I could get a list of the attendees to an event which in incredibly useful, something which I have been asking for to event organisers for years."



"Where we had to adapt more was in our human interactions, as meetings became online and external visits to our facility were cancelled unless truly essential."

It was a common theme throughout respondents that employees were incredibly flexible. "We are incredibly proud of how our global workforce responded — our entire team didn't miss a beat in making the transition to telework and remained as committed as ever to keeping our customers and partners supported, informed, and connected," reported Samer Halawi, EVP and Chief Commercial Officer, Intelsat. "We also realized how difficult it is to send to the field and install equipment that was needed to upgrade services where customers needed more bandwidth. The logistics were challenging due to COVID. This is fuelling our drive to virtualize our network moving forward, in order to drive services and upgrades through software."

Søren Aarhus at QuadSAT also spoke highly of their team: "We experienced an amazing level of flexibility from our employees. They were able and willing to change their everyday routines from one day to another, and that helped us stay efficient and available for our customers. Overall, the whole work-from-home setup worked well for us, and it has inspired us to change or procedures on that subject."

"During lockdown our engineering staff had to make use of the labs in small groups only, but through working flexibly we managed to keep all development programs on track and have launched new products on time," agreed ViaLite's Martin Ryan.

Referencing a common catchphrase from the COVID-19 pandemic, STN observed early that a 'new normal' was likely upon us. "One of the main experiences from the early onset of the changes to the working practices was how well our team here at STN united and quickly stepped up to meet the new required changes to a working global pandemic situation," shared Mitja Lovsin from STN. "Already, in the initial phases, it was becoming clear that these new safety measures would last longer than we all first expected or hoped and this new and what seemed forever changing environment was most likely to become a new reality."

"As changes were made to manage employee safety during the pandemic, it was discovered that some remote work was more productive, while other areas required onsite support," said Mark Schmeichel, Chief Operating Officer at Comtech Satellite Network Technologies. "New tools such as virtual meetings allowed us to carry on even when the worst waves of pandemic were rolling through. Allowing personnel to work remotely kept the staffing levels at the plant manageable. Through this adaptable approach Comtech was able to meet customer demand and increase our business during a very challenging time."

What's coming round the corner?

2022 holds an immense amount of promise for the aerospace arena as a whole; set to significantly exceed 2020-2021 business levels, continued advances are expected across all focus areas, including the space tourism and space station

concepts, but also ground segment technologies such as high frequency V/Q-band equipment and flat panel antennas to meet demand from the onslaught of LEO constellations coming online.

As far as the satellite sector at large is concerned, 2022 holds the potential to be a fantastic year! Most of those we spoke to were overwhelmingly positive about the future, citing expectations of 'business as usual' and a return to prepandemic times.

"We are seeing a surge of new and repeat orders already and expect things to get back to normal in 2022," Leslie Klein from C-COM Satellite Systems told us.

"We plan to stay on our pre-COVID business course," said STN's Mitja Lovsin. "Throughout this world scale of endurance, companies have been truly tested and STN has proved itself as a strong, agile, and responsive long-term business partner."

"All our expectations are based around continued growth. We are currently expanding our main site and that will allow us to continue the growth path we have been on. In fact, most recently we have had an acceleration in customer orders, so our expansion comes just in time," agreed Martin Ryan from ViaLite, while highlighting the challenges that remain. "Some of the current disruption in supply chains will begin to smooth out, although that will take most of 2022 to achieve. I expect more stock will be held at all stages of those supply chains in future, we are already seeing our customer base doing this."

QuadSAT's Søren Aarhus reported similar thoughts: "Our headquarters and the majority of our operations are in Denmark, where we are fortunate to have low infection numbers... Therefore, we expect to be at 100 percent

operational capacity at home. However, we still expect to be affected by the COVID-19 situation in other parts of the world; travel bans, and other restrictions can still cause us to postpose or cancel both commercial and operational activities."

"While we anticipate continued volatility in the commodity markets as well as in other materials supply systems, we believe CPI is adequately prepared for the challenges ahead," said Timir Chokshi from CPI SMP Satcom Products Group. "We have seen similar swings in the market in our more than 50 years of providing high powered amplifiers for satellite uplink applications; while the cause of this new volatility may be different than other factors that typically impact our markets, our ability to manage the dynamic market conditions has not diminished. We continue to expect growth in the key market segments for the amplifier products CPI offers."

Comtech Satellite Network Technologies' Mark Schmeichel stated that: "We expect 2022 to be a strong but challenging year. Fortunately, Comtech has been proactive in its planning for the pandemic and will continue to adapt quickly as needs arise. As we come out of the pandemic, supply chain robustness, transportation shortages, inflation and other factors will all need to be managed."

"It seems as if things are beginning to open up and we are hopeful we can get back out and meet members face-to-face," said SIG's Helen Weedon, sharing her thoughts on the networking and working group side of things. "We will of course need to keep some level of online presence to enable members to engage when they cannot travel. I can see the future SIG workshops being much more hybrid with in-person discussions but enabling remote participation wherever feasible."



The Inspiration4 crew inside a model Crew Dragon spaceship. Left to right Chris Sembroski, Sian Proctor, Jared Isaacman, and Hayley Arceneaux. Photo courtesy SpaceX ●●●

Microgravity as a service

Space Forge is a world-first startup based in Wales hoping to bring microgravity-as-a-service to the global space economy. The company uses a returnable small satellite, ForgeStar™-1, capable of running automated manufacture and microgravity experiment projects. The technology could streamline the processes usually performed at the ISS at lower costs, potentially revolutionising manufacturing, and leading to the production of never before seen spaceborne materials. Andrew Bacon, Co-Founder and Chief Technology Officer explains the business, and what it means for the industry.

Laurence Russell, Assistant Editor, Satellite Evolution Group

Question: The UK has only begun strongly prioritising its space economy in the last ten years. What's your assessment of how far it's come since then? How has it been achieved?

Andrew Bacon: We've witnessed the introduction of the UK Space Agency first-hand, and the change in priorities for the UK space sector that involved. In the eleven years since it was founded, we've seen the establishment of the Satellite Applications Catapult and similar national programs built to accelerate space business cases and the research supporting them. Many of the things we have seen in the British space industry have government funding to thank for their success, not least our upcoming sovereign launch capability.

Today, the UK Space Agency's budget has more than doubled since its inception in 2010. That has helped us nationally, but also has allowed us to buy into all sorts of European Space Agency (ESA) initiatives, which has helped cement us on the global stage thanks to the expertise of continental talent.

Since we've started showing these results there have been increasing calls for greater capability in space technology both inside the UK from groups like Innovate UK or Defence Science and Technology Laboratory (DSTL) and outside it from our NATO

peers and trade partners.

Because of the UK's high academic standards, and dedication to sustaining its technical advantage, I don't think there has been a single large-scale scientific mission in Europe that hasn't involved the UK in some capacity. You can actually trace the lineage of the Ariane 5 back to the Black Arrow, which the UK developed in the 1960s when we were contenders in the Space Race before that kind of funding dried up. We've reignited the spirit of that period

in the last ten years, with a greater focus on nurturing business and economic efficiencies.

Of course, space itself has not fundamentally changed in the last ten years; it's just as challenging a frontier as it's always been for our technology. What has changed is the ways you can make money in space. Consumer technologies and services delivered from orbit have really started to show results lately, and that's thrown open the door for commercial thinking to apply itself and drive progress.

Question: Space Forge is a worldfirst pioneer for developing a microgravity-as-a-service business case. Could you describe it for us in your own terms?

Andrew Bacon: Space Forge is developing what we like to call space-to-Earth-manufacturing. In the last five years, we've seen more discussion and theoretics around space-to-space-manufacturing, in concert with in-orbit servicing and repair technologies. We've seen conversations proposing the construction of extruding aluminium struts for basic constructions or complex devices and components which could be too fragile to survive the extreme vibrations of launch, which could then be assembled and activated





in orbit. Some have even suggested the local construction of small satellites in orbit.

To actualise those kinds of ideas it's important to understand the environment you'd be building in. Space has unprecedented access to solar energy, microgravity, ultra-vacuum, and extreme temperatures.

Microgravity eliminates buoyancy, which causes convection. That can be invaluable if you're trying to create complex alloys or grow large crystals. If you wanted to create a lead-aluminium alloy for example, 1G gravity will cause the lead to sink to the bottom and the aluminium to rise to the top, which is the opposite of what you want in the mixing process. It can take very expensive technologies to prevent things like that from happening on Earth, but of course the problem would simply not exist in space.

Earth also has vast quantities of oxygen, which is often a good thing outside of smelting metals. At a certain temperature, oxygen will start to seep into materials, oxidising them, which can cause a lot of unwanted brittleness and other unfortunate properties. Space of course has no significant

atmosphere. In low Earth orbit, you'd only have to open a door to make use of an ultra-vacuum that would be very costly to simulate on Earth.

Finally, on Earth, it's a design challenge to create and sustain temperatures lower than -50 degrees without the use of cryogenics but in orbit, if you shade your spacecraft from the sun you can achieve temperatures as low as 10 Kelvin (-263 degrees Centigrade).

Of course, we can, and have, done all of these things on Earth, but when it comes to design processes that require two at once, or even all three, the process becomes wildly cost-prohibitive. I'm not aware of any manufacturer that's ever sustained an ultra-vacuum at cryogenic temperatures on a parabolic flight, for example. After tackling the cost of launch, all these manufacturing conditions exist naturally in space, as they have since the dawn of time.

The International Space Station (ISS) does experiments and projects under some of these conditions, but it's a laboratory rather than a factory, and the need to protect astronauts can lead to delays of years in getting approval

for new experiments.

That's why Space Forge wants to make these manufacturing conditions available to designers with a reusable, uncrewed, small satellite optimized for research and manufacturing materials and components in clean orbit, which can perform functions and return to Earth to deliver its yields before being re-launched.

Question: What sectors and businesses would benefit most from research and development facilities in microgravity?

Andrew Bacon: The existing ones here are pharmaceuticals, biological research, or growing crystals, all of which has seen pioneering work via the ISS, but we're seeing new markets emerging too. Fluoride-alloys based optical fibres offer dramatic improvements over traditional silica fibres. On Earth, fluoride-alloy glass is notoriously difficult to create, however manufacturing has been demonstrated to be successful in microgravity.

Of course, nearly everyone has a use for powerful optic fibre connectivity, so the ability to exclusively construct the next generation of that technology with our platform is a big market advantage. But that's just one example of a product appropriate for Space Forge to produce. Making larger semiconductor wafers from next-generation materials is another, as well as is super-alloys for use in aircraft engines and renewable energy generation.

In our research, we've found many other examples of alloys, compounds, parts, and so on, which are of high enough value to industry to justify the cost of launching and returning from orbit. There are also many which have a significant net-negative impact on the ${\rm CO}_2$ generation of those industries, even including the emissions of launch.

Microgravity essentially enables the mixing of vastly different elements in unprecedented ways. Lead and aluminium are one example, but the periodic table is a lot bigger than that and includes combinations that have never been possible on Earth. We're talking about compounds and alloys that simply haven't been able to be made on Earth before and have therefore never been experimented on.

We're already talking to academics on that front that have long been trying



to establish a process for creating certain exotic materials who could finally be seeing their solution in Space Forge, and the microgravity-as-aservice solution. Space manufacturing has the potential to change the world.

Question: Quantum is an example of an area of research with several proposed experiments requiring microgravity. Given the UK's already heavy investment in quantum technologies, do you anticipate Space Forge providing a missing link capability that could grant Britain an edge in the development of quantum technologies?

Andrew Bacon: People all over the world have been hunting the proverbial holy grails in quantum research for some time now, uncovering the secrets that will make quantum technologies reproducible and reliable.

Maintaining states of quantum entanglement is very difficult in areas of high noise and disruption, such as those that occur pretty much everywhere on Earth. Quantum states tend to degrade and decohere quickly after being established, limiting how long a computation can take.

Microgravity, ultravacuum and extremely low temperatures all assist with quantum research. Microgravity will help maintain the Bose-Einstein condensates often used for experiments, the purity of a vacuum makes for a cleaner environment to test in, and every quantum computer I've seen has required the kind of expensive cryogenic cooling that can be achieved naturally in space.

I'm not sure if we'll see quantum computers being run from space, but it's a safe bet to assume a lot of the research that goes into working out how to run them will occur in orbit. We can also use space to make new higher purity materials that the next generation of Earth-based quantum computers could run on.

Question: Does Space Forge have any particular interest in regional UK spaceports? Do you hope to work more closely with Cornwall for instance, or are you keen on supporting Spaceport Snowdonia to build relationships in Wales?

Andrew Bacon: We're very lucky to be set up in Cardiff, where we've enjoyed

some incredible support from the Welsh Government and the Development Bank of Wales, which was one of our original funders. I would recommend any aspiring entrepreneurs look to Wales as the site of their enterprise because it's been very responsive to fuelling growth.

The country is advantageous geographically too. Spaceport Snowdonia is very well placed in terms of restricted airspace, which will become very competitive for the testing of reusable spacecraft and drone systems in the future.

In terms of cost, the most effective method is via rideshare as part of large-scale launches, which is a service SpaceX and Arianespace have cornered. That said, we cannot ignore the environmental costs involved. Launching locally from the UK could be more carbon-efficient than relocating everything to a US launch site and doing it all there. Space Forge aims to be the first net carbon-reducing space company in the world, and we cannot do that by flying back and forth around the world.

In terms of sites, Space Forge will not be playing any favourites, but we're very impressed by what we've seen at Cornwall, as well as at the Scottish sites.

Question: Could you also introduce us to the Aether prediction system for providing satellite and spacecraft re-entry landing locations?

Andrew Bacon: Aether was not a service Space Forge was expecting to create, but while doing our research we recognised that there is no off-the-shelf solution for predicting where satellite and spacecraft derelicts will land.

Many will be able to remember the falling Chinese Long March rocket booster earlier in 2021 which had predictions saying it could land virtually anywhere in the middle hemispheres of the planet, which encompassed virtually all major Earth cities. Of course, this isn't the first time something like this has happened, and China is just one of many powers that have had these issues.

Accurate re-entry prediction is a huge challenge, with the main obstacle being our lack of insight into the pressures and temperatures of the lower thermosphere, between about 40400km. That area is below the lowest orbiting satellites, but above where the highest weather balloons can reach. That region is sometimes called the ignore-osphere because nothing really flies there. It's here where re-entry occurs and small errors in our knowledge of the atmosphere density compound to give big errors in potential landing zones.

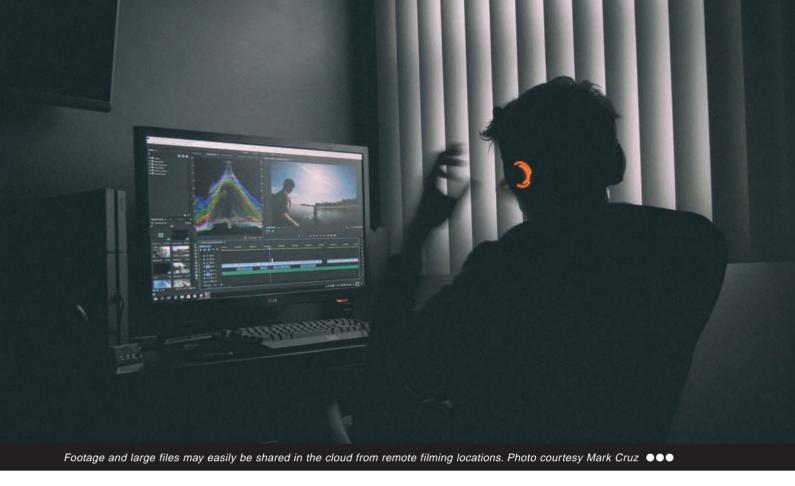
Aether is software which layers many atmospheric models in real-time to build, and more importantly, rebuild projections very quickly to provide up-to-the-minute analysis. Given the danger of large-scale falling debris, we see this as a crucial technology to assuring the safety of the planet.

Question: What are your predictions for what Space Forge will achieve in the next decade thanks to this new wave of funding?

Andrew Bacon: We are extremely grateful to ESA for believing in the Space Forge project, along with all our other generous public and private investors. We are using that to develop space manufacturing and re-entry technology, both of which are technically challenging. That is why we're going to be beginning our work with a series of test flights to best understand these world-first systems, in the interest of gaining confidence in routinely building orders or running experiments and bringing the results back to Earth. That begins with ForgeStar-1, aimed at the market for researching new spaceborne materials.

It is difficult to say what these wholly new alloys and compounds will be worth since we just don't know about their properties as no human has ever been able to make them before. That is quite a challenging commodity to price. We hope to develop enough of these materials for researchers to define their applications so that reliable markets for them can be established.

The myriad possibilities for microgravity-as-a-service are such that we predict everyone on Earth will end up benefiting from a spaceborne material in the next ten years, whether that be an aircraft part, a high-speed optic fibre, bolts to hold together wind turbines or more efficient space made semiconductors. These materials are so revolutionary think they'll soon be vital to solving the climate crisis on Earth.



Satellite: Enabling the future of remote production

The cloud has really taken hold of the world over the last decade, forever changing the way we work, live and study. Nowhere is this truer than in the film and photography world, where cloud technology has enabled remote production like never before.

Hans Massart, Head of Media and Broadcast, ST Engineering iDirect

The pace of innovation in satellite connectivity is facilitating disruption across many industries and the film and photography world is no different. Remote production – or Remote Integration Model (REMI) – allows live content to be captured from a remote location and managed from a master control room. Today, when remote production takes place, cloud computing is an incredibly powerful tool in any producer's arsenal.

For example, it can allow sound or video editors that are working from home to pick the files from the cloud and process these at their location, wherever that is. A production crew can be anywhere and work and collaborate effectively with the rest of their team, as long as they have access to the cloud.

From film productions to news crews, cloud access is such a powerful enabler of productivity that the demand for satellite

connectivity as part of a blended all-IP solution is well justified, especially in remote areas.

COVID-19 has also played a part in changing the production landscape, acting as a catalyst of sorts, as people had to innovate to remain productive. On the one hand this has boosted demand, subscriptions and the number of people using streaming services in general. However, it's not uncommon for this new influx of activity to cause congestion and overload terrestrial networks. Equally, the pandemic influenced outside broadcasting (OB) when the number of sports events, and other large, broadcasted gatherings were reduced.

Three REMI options for production crews

While the world is still recovering and events are taking place once more, satellite has an important role in solving the remote production problem due to its inherent advantages. Delivering content to vast geological areas and to the four corners of the world, including the most remote places, means it can extend far beyond the reaches of any existing terrestrial network. High throughput satellites (HTS) simply compound these advantages, offering greater throughput at low latency while being more financially efficient.

The contribution of content from remote regions presents its own set of challenges. Connectivity is integral to run any remote broadcasting application and the necessary bandwidth must be made available at all times. Today, production crews operate in areas that are often located in

hard-to-reach areas and therefore equipment must be highly portable, compact, and lightweight in order to make it easy to transport and then operate once it is on location.

Ultimately, to meet all of the above requirements, the ability to blend different technologies, including cellular, terrestrial and satellite - frequently presents the most attractive and versatile solution.

When the situation calls for remote production either by a news crew or film company there are currently three options that have become available over time:

The traditional approach

This involves the use of vehicles, usually vans decked out with advanced pieces of kit for the purposes of two-way audio and video, such as transmitters and receivers with dish antennas directed toward satellites. However, this solution is both costly and requires a very high skill threshold for the personnel running the equipment. Not to mention, the sort of vehicle required may simply be unsuitable for certain terrain in the first place, rendering it ineffective for truly remote productions.

Cellular bonding

Later, cellular bonding became ubiquitous, using 3G and 4G cellular networks to fetch video back from remote locations. But it's not just video that is exchanged. It also allows large file transfer, Internet and intranet access, archive browsing and social media.

This has greatly reduced the skill threshold involved and uses dedicated equipment via all-IP transmission, but the big drawback is that there is often no 4G connection available and 5G, even when it arrives, will not solve this situation. If a



given network is contended it will badly affect transmission quality.

Blended all-IP networks

This leads us to the modern solution. By blending all available IP networks, we can mitigate the risk of damaging the quality



of the transmission associated with cellular bonding by allowing satellites to be used instead when IP terrestrial networks are not up to scratch. The ability to easily blend with satellite for a reliable connection is facilitated by recent developments in satellite technology that support high quality video such as the prevalence of higher throughput satellites with a lower power draw than the Ku-band satellites often found on traditional SNG vehicles.

Truly remote production

This blending of all-IP networks has been used to great effect in areas that are truly hard to reach such as in the case of commercial productions on wild mountain ranges. The remote mountainside often has little to no cellular reception and when the clients themselves are not able to be present on the mountain, a production company requires an online collaborative solution. To guarantee the kind of connection they need, a blended all-IP solution can use a portable satellite and dynamically amalgamate the available cellular networks with satellite signal to deliver high quality connectivity in an incredibly isolated location. The crew can then stream the video from set to the platform for real time collaboration. Media production, whether that be commercial television or film, are switching to these cloud-based workflows and this blended solution is the key piece of tech that makes it all possible.

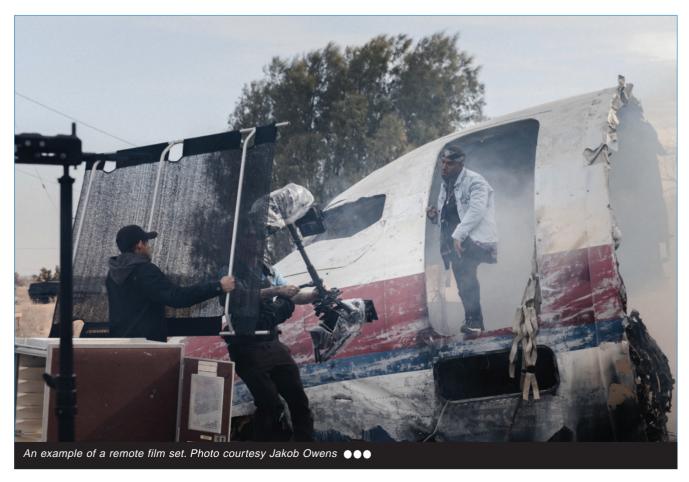
ST Engineering iDirect's partner, Dejero, recently used Newtec Dialog® technology to great effect to support one such commercial production company in the Canadian Rocky

Mountains. The end result meant that they were able to flawlessly stream to offsite clients without worrying about latency or shaky connection. This means that the real time feedback facilitated the same kind of conversation that would occur if all parties were in fact on set.

The flexibility and reliability of the blended all-IP approach also manages to reduce the costs previously associated with satellite solutions and HTS have made waves by improving the price and user experience. More satellite constellations are launched frequently, and this is particularly true in the case of LEO and MEO satellites resulting in a projected 14x increase in capacity before the end of the decade. This will further reduce the costs involved and pave the way for more deployments.

Performance and agility for any environment

Satellite has become a vital component of any producer's toolkit and is making waves for the versatility it offers. ST Engineering iDirect is now able to provide a portfolio of products and technologies that can meet the needs of any remote production scenario or application. ST Engineering iDirect's Mx-DMA technology can offer a single return link suitable for most use cases while reducing operational complexity and offering the highest bandwidth efficiencies. Where other solutions like terrestrial or cellular connectivity struggle satellite is here to guarantee the quality connectivity required is available not only with the performance but agility to suit any environment better than other existing connectivity platforms.





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Satcoms innovations: Stepping into 2022

The Satcoms Innovation Group (SIG) is an open forum generating innovative thinking to improve operational efficiency within the satellite sector. The group's aim is to foster relationships between operators, manufacturers, and solutions providers by providing a forum for debate. Helen Weedon, Managing Director at Satcoms Innovation Group, outlines the group's ongoing initiatives and priorities.

Amy Saunders, Editor, Satellite Evolution Group

Question: What are the standout industry trends that Satcoms Innovation Group has witnessed over the course of the pandemic?

Helen Weedon: As with many industries, satellite has been challenged by the pandemic. Operators are under more pressure than ever before and many of them are trying to achieve as much with fewer resources. Although initially the pandemic drastically affected the industry, satellite has become more important than ever to keep people connected through challenging times.

At the same time, we have seen a lot of innovation still happening that will help to drive the industry forward in the coming months.

There are a couple of standout

trends. One is the continued rollout of 5G networks and services, which will inevitably have an impact on satellite. Whether that is positive or negative remains to be seen, but it is an area that certainly requires a great deal of effort on behalf of the satellite industry.

There is also a shift in perspectives around cloud-enabled satellite. We are already starting to see a change in the major operators, with many starting to employ IT experts at the helm rather than satellite veterans. The transition to more cloud-based workflows will be a massive shift in mindsets for this industry but that is starting to happen.

Question: Satcoms Innovation Group has a number of working groups driving forward initiatives discussing 5G, cloud and Al. Could you tell us a bit about those projects?

Helen Weedon: One of the main goals



of SIG is to drive innovation forward within the satcoms industry, as well as finding resolutions to technical challenges. We do that in a number of ways. Often the most effective is getting the technical people in a room together, something that has of course not been easy recently. The other part to that is ensuring we have dedicated goals to ensure innovation happens in those important areas. We have identified a number of areas where we feel our input

When it comes to the move to cloudbased one of the most challenging things, especially for smaller operators, is understanding what is involved in making that transition happen. Our cloud working group is therefore going to be focusing on educating the industry on what that means.

would be valuable in some way or

Our AI working group is yet to be established but will be intended to both educate the industry and review if there are collaborative projects that we should be undertaking to advance the use of AI in satcoms.

Question: Industry collaboration built around making the 5G tech generation widely compatible and sustainable seems vital. Have you fostered many conversations like that at the Satcoms Innovation Group?

Helen Weedon: 5G has both the potential to cause harmful interference while at the same time being an area where satellite can enable the



technology and carve out an important role for itself. The answer to both of those lies in closer cooperation with the mobile industry, something that seems to have been a challenge for many and something we are working to resolve. As yet those discussions have been fairly limited, but my hope is that our 5G working group can address that as part of is remit.

Question: One of your working groups is focused on flat panel antennas, which some commentators have heralded as an important leap forward in antenna technology, held back only by affordability - Is that the case?

Helen Weedon: Flat panel antennas (FPAs) are certainly an important development, but as yet no-one has managed to match performance and price. Affordability is definitely a key issue but so is the ability to perform as it should, and without causing interference.

At the same time, customer expectations are high and occasionally not realistic and testing is costly and complex. We need to have a unified industry-wide approach to ensure standards are in place for FPAs, which dictate not only the performance requirements but the data that needs

to be provided to prove they meet those criteria. We also need new ways to test these types of antennas that make it simpler and more cost-effective. Our Flat Panel Antenna working group has a great deal of work in front of it, together with SOMAP, but we hope that the two groups can achieve some good outcomes to benefit the entire industry.

Question: The Satcoms Innovation Group is for companies and organisations at every level, with memberships for multinationals all the way down to startups. Have you found that scope has led to a strong diversity of thought?

Helen Weedon: Definitely, and that is part of what makes SIG so great. We have everyone from large to small satellite operators, tech vendors, startups, and even universities. We are hoping to have the opportunity to get everyone together in one physical location very soon. Although we have had some successful online sessions and discussions, nothing quite beats getting all of those people in the same room.

Question: What can you tell us about the SIG awards?

Helen Weedon: The SIG awards have been a concept for several years. We

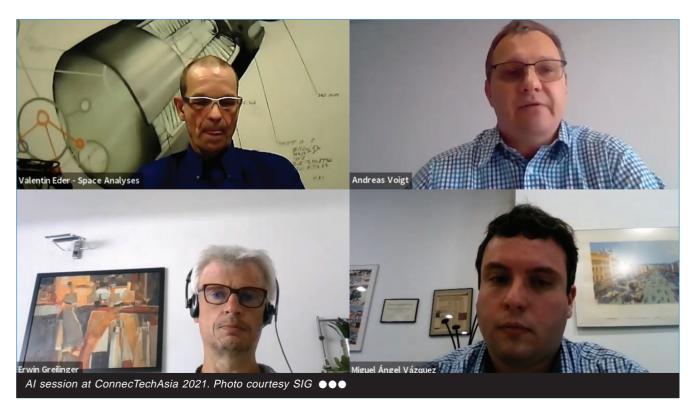
see so much innovation from our members that we wanted to recognise those. Last year was our first edition and we were really impressed by the entries that came in.

We will be launching the awards before the end of the year, but we are hoping to be able to present them in person early next year.

We have four categories aimed to reflect the diversity within the group. These include innovation of the year, educational project of the year, young engineer of the year, and the cooperation award, which is awarded to two or more companies for a project where cooperation was key to solving a challenge.

Question: As the UK begins to ease out of the pandemic in 2022, what are your plans to support the satcoms community?

Helen Weedon: As with most people, I'm really hoping that 2022 will bring the chance to get back to seeing people in real life. Exactly what that will involve it is difficult to predict but I'm hoping we will have the return of our workshops, as well as supporting our members at the industry events. Our working groups will be working alongside this to help drive innovation and change where needed within the satellite industry.



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From January 2022 we will be merging Satellite Evolution Asia, Satellite evolution EMEA, Satellite Evolution Americas and NewSpace International into one magazine -Satellite Evolution Global

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