

ISSN: 1745-5502

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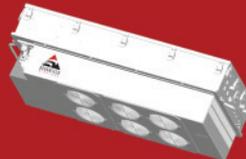
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Editor - Amy Saunders ●●●

Happy holidays!

I can't believe it's this time of year again – Thanksgiving and Christmas are upon us, and we've successfully navigated our way through another twelve months.

It's been a pretty big year for the space sector. SpaceX has launched a Tesla Roadster with the 'Starman' mannequin into space during a Falcon Heavy test flight; the company faced some pretty big stock dives in the second half of the year, although successfully launched its Falcon 9 from the West Coast of the USA for the first time in October. The International Space Station (ISS) sprung a leak in September – at the time of going to press, no cause has been confirmed. Meanwhile, a Japanese team has taken another step forwards in the push for a space elevator with the launch of a new experiment to the ISS. In other news, the RemoveDEBRIS mission, which will explore methods for tackling space debris, reportedly captured its first piece of space debris back in September, using a space net. Richard Branson made the news in October with the claim that Virgin Galactic is just weeks away from its first trip into space, bringing his company's planned space tourism business that one step closer to reality. And at the end of the year, China announced plans to launch an artificial illumination satellite that will shine some eight times brighter than the moon, reportedly to reduce the cost of streetlights.

All in all, it's been a busy year. At *Satellite Evolution*, we've kept ourselves occupied attending all the major trade shows, catching up on the latest news and developments with anyone who's anyone in the space sector, and making sure to keep our readers up-to-date on technologies, trends and analysis. As always, we welcome feedback from our readers on any topics they'd like to hear more about, or any new projects they've been working on.

If you've been keeping your eyes peeled, you'll also have noticed the launch of our new sister publication, *NewSpace International*, back in March. With this new publication, we've expanded our focus beyond the traditional satellite sector to keep abreast of current NewSpace developments; small satellites, mega-constellations, asteroid mining, additive manufacturing, space tourism, etc. The NewSpace industry is deeply intertwined with the satellite sector, and we're really looking forward to seeing how it develops in the years to come.

As the proverb goes - which can apparently be traced back to 1659 - all work and no play makes Jack a dull boy. We've all worked hard for the last year, and it's time for a break to refresh ourselves, and start over again in 2019. So, from all the team at *Satellite Evolution*, we wish you a Happy Holidays! 🌟



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Front cover photo courtesy of
Blue Origin

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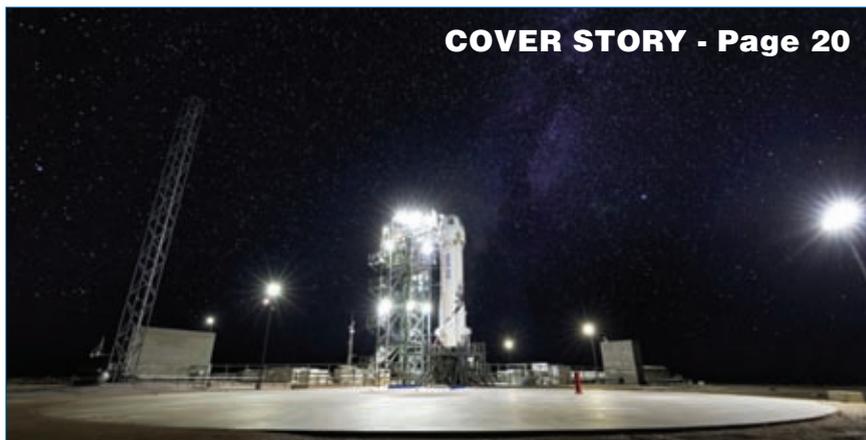
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ISSN: 1745-5502

Printed by:
**Times Printing
Singapore**



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West Sussex, RH12 4QD
United Kingdom
T: +44 1403 273973
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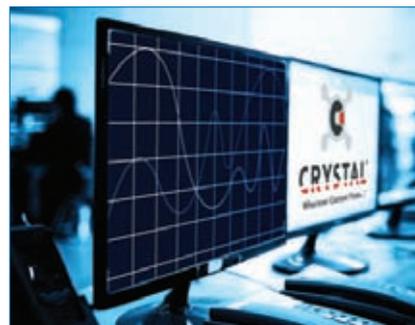
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Competition Appeal Tribunal rules comprehensively in favour of Ofcom's EAN authorisation decision

The Competition Appeal Tribunal (CAT) in London handed down its judgment dealing with ViaSat's challenge to Ofcom's January 2018 authorisation of Inmarsat's UK complementary ground component (CGC) forming part of Inmarsat's European Aviation Network (EAN).

The Tribunal comprehensively found in favour of Ofcom and Inmarsat and determined that all of ViaSat's arguments failed. On that basis, the Tribunal dismissed ViaSat's case.

The CGC authorisation granted by Ofcom to Inmarsat for the EAN system remains in full force and effect.

Rupert Pearce, CEO of Inmarsat: "We welcome today's decision and look forward to the European Aviation Network delivering a world-class WiFi experience to airline passengers in the UK and throughout Europe.

"Today's judgement clearly highlights the diligent work undertaken by Ofcom in the process by which they awarded the CGC authorisation to Inmarsat.

"EAN represents an outstanding technological innovation, which has taken years of hard work and commitment to deliver and I am delighted to say it will very shortly be available to passengers across Europe." ■

exactEarth AIS payload on the PAZ Radar Satellite is now live

exactEarth has announced that its advanced AIS payload onboard the Spanish radar satellite, PAZ, has completed its commissioning phase and is now fully-operational. The PAZ satellite is owned and operated by Hisdesat Servicios Estrategicos S.A. and hosts an AIS payload owned by exactEarth, which is the first commercial AIS payload to be in operation onboard a radar satellite.

Launched earlier in 2018, PAZ is in the dawn-dusk sun synchronous orbit that is occupied by a majority of the world's radar satellites. With an AIS payload onboard, for the first time AIS vessel signals and Synthetic Aperture Radar ("SAR") imagery can be combined to enhance global maritime monitoring capabilities. Supported by exactView RT, the Company's superior

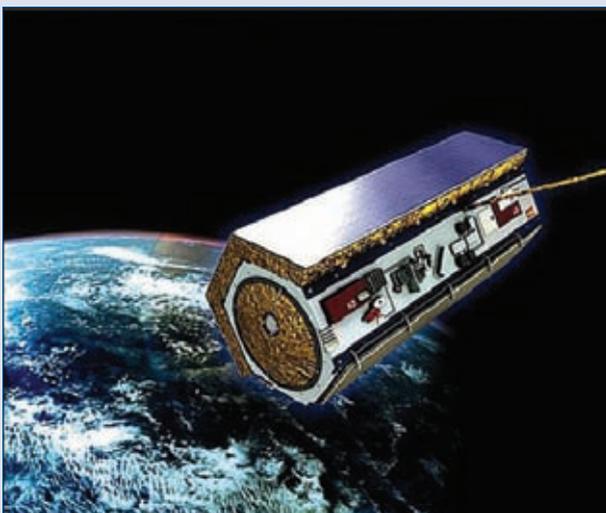


Photo courtesy of Hisdesat

real-time satellite AIS service, the fusion of these two data sets can better assist maritime security and surveillance by rapidly correlating two data sources to identify so-called 'dark targets', which are vessels that should be transmitting AIS signals, but are not.

"Our thanks and congratulations go out to Hisdesat on the successful launch and commissioning of the PAZ satellite," said Peter Mabson, CEO of exactEarth. "We now have 54 high performance satellite payloads in orbit capturing AIS data on more than 250,000 vessels daily and this announcement helps to further solidify our leadership position in the industry and our differentiated technological capabilities. With the world's first AIS payload onboard a radar satellite, exactEarth is uniquely positioned to help its customers leverage the combination of AIS data and radar imagery to develop advanced maritime surveillance applications that enhance the security and safety of their interests." ■

Harwell Campus Space Cluster grows by 19 percent creating 150 jobs in Oxfordshire

Harwell Campus has announced that employment within the Harwell Space Cluster grew at 19 percent over the last 12 months. 150 new posts have been filled as the Cluster has grown from 80 organisations in December 2018 to 89 as of today.

Collectively employing over 950 people, the 89 organisations that make-up the UK's most concentrated Space Cluster are a group of commercial, public and academic organisations focused on driving innovation in the UK space market and supporting the UK space sector as it aims for a 10 percent share of the global market by 2030.

With the central stakeholders of the Cluster being the European Space Agency, Satellite Applications Catapult, UK Space Agency and STFC RAL Space, the Cluster is attracting many companies to set up operations at Harwell Campus. Funding and collaboration opportunities are extensive and businesses from start-ups to multinationals all benefit from being co-located with over £2billion of national science facilities.

Announcing the figures at the annual RAL Space Conference, Dr Joanna Hart, Harwell Space Cluster Development Manager said: "Today we are celebrating job creation in Oxfordshire as well as the vital role that space organisations based at Harwell Campus take in shaping the UK space sector. We have a unique talent pool in the area and, as the Space Cluster continues to grow, we want to create more jobs, taking advantage not only of the science and technology capabilities of people in the region but also the entrepreneurs and people working in the knowledge economy that enable the Space Cluster to thrive."

David Kenyon, Managing Director of MDA a global company developing advanced surveillance and intelligence solutions, defence and maritime systems, radar geospatial imagery and space robotics said: "We are excited to grow MDA's innovative and world-leading communications, robotics and sensor technology at the Harwell Campus. It's an ideal location for us to grow our UK base and explore collaboration with the Space



industry in the United Kingdom.”

Harwell Campus is home to over £2 billion of scientific facilities and 5,500 skilled people, with new facilities such as the £99 million National Satellite Test Facility expected to further attract more companies. To drive collaboration and knowledge sharing, ‘clusters’ have been developed in Space, Healthcare Technology (HealthTec) and Energy (EnergyTec). Each cluster brings together co-located industry, academia and public sector with investors and entrepreneurs, leading to a powerful combination to tackle global challenges.

Dr Barbara Ghinelli, Director of Harwell Campus Cluster Development linked the growth to the uniqueness of Harwell Campus and the strategic decision to create an environment where multidisciplinary collaboration is encouraged between the EnergyTec, HealthTec and Space Clusters: “Close interaction between people working in health, space and energy accelerates the translation of ideas between these disciplines creating new commercial opportunities for businesses on Campus as a result of knowledge exchange with peers in other sectors.” ■

Universal Electronics award-winning products and technology continue to drive adoption of entertainment voice control across Europe for pay-TV operators

Following the launch of six new voice-controlled remotes with leading Pay-TV operators across Europe in the past six months, Universal Electronics Inc. (UEI), a worldwide leader in universal control and sensing technologies, continues to lead the industry in delivering the control platforms that are changing the way consumers interact with their entertainment worldwide.

According to market data, today’s global TV audience spends an average of 4.4 hours per day watching TV and nearly 28 minutes per day searching for content. Voice navigation and control, introduced in 2015, has brought a new dimension to the TV watching experience. In a

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matter of a few years, voice technology has evolved from an add-on feature to becoming an essential-tool consumers rely on in their daily lives for accessing entertainment, information, and services.

UEI’s advancements in contextual voice navigation have quickly become a disruptive force changing how consumers interact with their devices and TV content. Today the company has deployed one of the most experienced and knowledgeable development teams in the industry to deliver highly dependable voice interactions with home entertainment devices. Since 2015, UEI has delivered more than 60 million voice-enabled remote-control solutions to the entertainment industry.

Through consumer-focused research and development, UEI has continually uncovered and delivered meaningful innovations that simplify daily experiences within the connected smart home. UEI has diligently expanded optimized voice remote offerings with state-of-the-art microprocessors, tightly coupled with software and acoustic design, to enhance the accuracy of daily voice interactions.

Packaged with UEI’s world-leading QuickSet® technology, advanced voice-enabled entertainment platforms offer consumers an unparalleled entertainment experience bringing TV, set-top, and content control into a single user interface.

Today, UEI engineers are actively working on next-generation voice platforms for operators worldwide, including Android TV platforms, which represent the fastest growing Pay-TV platform, over the next five years. As more operators launch their advanced services platforms and usher in new standards in the industry over

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the next twelve months, UEI expects to expand its leadership in voice control and will continue to bring new innovations to market.

“By 2023, it is estimated that there will be over 1 billion Pay-TV subscribers globally with a sizeable segment actively using voice as their natural user input. Voice control technology has the power to make the average consumer’s home viewing experience more intuitive and more enjoyable, and its adoption will boost subscriber satisfaction,” said Kuldip Singh Johal, Vice President Sales - Subscription Broadcasting in EMEA for UEI.

“As with any technology, it is important that the end user experience is a positive one. It leads to frequent use of the service. We work with our partners to ensure that our products provide the right level of performance and reliability for voice control. Our efforts have been recognized within the entertainment industry as we were recently awarded a Technology Emmy® for our work relating to voice navigation technologies for discovering and interacting with TV content. UEI was selected for its excellence in engineering and creativity that has materially affected the television viewing experience,” added Johal.

The future for voice control promises to be bright. For example, voice biometrics can be employed to authenticate users in the home, offering personalized content recommendations and secure services ranging from banking to online shopping to food ordering. Today, 2.7 million UK households use a voice-activated smart speaker while 22 percent of UK consumers use a virtual assistant on their smartphone. This number is set to increase as more products and services enter the market, and the race for convergence intensifies with manufacturers exploring new ways to help users easily configure smart devices and create an integrated smart home experience. ■

SpaceX rocket launches satellite payload designed and built by University of Surrey students

The European Student Earth Orbiter satellite (ESEO), which contains a vital payload designed and built by students from the University of Surrey, was launched into space on Monday 3 December 2018 by the SpaceX Falcon 9 rocket from the Vandenberg Air Force Base in California, USA.

ESEO is part of a European Space Agency project that aims to prepare the European space workforce of tomorrow – with University of Surrey students getting the kind of hands-on, real life space engineering experience – through access to the Surrey Space Centre – that students elsewhere simply can’t get. The radio and computing payload was designed and built by undergraduate and postgraduate students at the Surrey Space Centre and was achieved without central ESA funding.

The joint Surrey and AMSAT-UK payload transmits key information to the ground - such as vital power, temperature and speed - and is designed to use very low energy, allowing it to remain in a permanently on state. This allows members of the public to track the satellite with low tech equipment such as a direct amateur radio connection to the satellite’s internal data.

The mission is already part of history as it was the

first time a rocket, the Space X Falcon 9, has been used on three missions.

Dr Chris Bridges, project lead and Senior Lecturer in On-Board Data Handling at the University of Surrey, said: “Here at the Surrey Space Centre we are accustomed to building and launching small satellites that have been engineered by seasoned experts and professionals. This project is unique as it has been achieved on a shoe string budget and completely led by students. This is the culmination of several final year students working to create something that will be flown in space.”

“Students simply don’t get this type of experience elsewhere - here at the University of Surrey we believe in honing their skills on real industrial missions.” ■

Arianespace orbits GSAT-11 and GEO-KOMPSAT-2A for Indian and Korean space agencies

Arianespace has successfully orbited two satellites: GSAT-11 for ISRO (Indian Space Research Organisation), and GEO-KOMPSAT-2A for KARI (Korea Aerospace Research Institute). With this mission dedicated to space applications for telecommunications and meteorology, Arianespace once again contributes to the improvement of life on Earth. The sixth Ariane 5 launch of the year took place on Tuesday, December 4 at 5:37 pm (local time) from the Guiana Space Center (CSG), Europe’s Spaceport in French Guiana (South America).

This 10th mission in 2018 reflects the availability and flexibility of Arianespace, which has performed a launch every two weeks since November 6.

Arianespace, a key partner of ISRO

Since the launch of India’s APPLE experimental satellite on Ariane Flight L03 in 1981, Arianespace has won nearly all of India’s geostationary orbit launch contracts opened to non-Indian launch vehicles and has signed 24 launch contracts with the Indian space agency.

GSAT-11 is the 22nd satellite from ISRO to be launched by Arianespace, and the largest and heaviest satellite ever built by India’s space agency. Arianespace has two other ISRO satellites in its order book to launch: GSAT-30 and GSAT-31. The latter, GSAT-31, will be lofted by Arianespace early next year.

GSAT-11, configured on the new-generation I6-K satellite bus, will provide communications services with multi-spot beam coverage of the Indian mainland and nearby islands. With this new satellite, ISRO will help bridge the digital divide in India within the scope of a program that capitalizes on space technology to support national development, while also pursuing space science research and planetary exploration.

Arianespace helps South Korea develop its ambitious space program

GEO-KOMPSAT-2A is the second satellite from the South Korean space agency KARI to be orbited by Arianespace, following the multi-mission COMS (Communication, Ocean, Meteorological Satellite), launched in 2010 by an Ariane 5.

Arianespace has two Earth observation satellites from KARI in its order book for future launches: GEO-KOMPSAT-2B on Ariane 5 and KOMPSAT-7 on Vega C.



Since launching South Korea's first satellites, KITSAT-1A in 1992 and KITSAT-2 in 1993 using Ariane 4 launch vehicles, Arianespace has become a major partner to the Korean space program.

Arianespace also has orbited three satellites for the telecom operator kt sat: KOREASAT-3 in 1999, KOREASAT-6 in 2010 and KOREASAT-7 in 2017.

GEO-KOMPSAT-2 is a national program developed by KARI for the South Korean government, involving the development and operation of two civilian geostationary satellites, GEO-KOMPSAT-2A and 2B. GEO-KOMPSAT-2A is designed to conduct meteorological and space weather monitoring missions.

Another launch for a better life on Earth

With this latest launch, Arianespace continues its vocation of using its launcher family to make life better on Earth. The GSAT-11 satellite, which will help reduce the digital divide in India, is only the latest in a long line of communications satellites that connect people and enhance Internet access worldwide, including for people on the move. With the COP24 Climate Change Conference now taking place in Poland, the GEO-KOMPSAT-2A satellite reflects Arianespace's commitment to sustainable development. It is the 67th Earth observation satellite to be launched by Arianespace.

A launch every two weeks

Flight VA246 is the 10th launch performed by Arianespace in 2018: six using Ariane 5s, two with Vega and two with Soyuz. In the fourth quarter of the year, Arianespace has once again proven its flexibility and reliability by carrying out five launches in two-and-a-half months (September 25 – December 4), with launches coming every two weeks since early November. The last launch of the year will

continue this momentum, as Arianespace will use a Soyuz rocket to launch the CSO-1 spacecraft for the French defense procurement agency DGA (Direction générale de l'armement) and the French space agency CNES.

Shortly after the orbital injection of the GSAT-11 and GEO-KOMPSAT-2A satellites, Stéphane Israël, Chief Executive Officer of Arianespace, said: "With this 10th launch of the year, Arianespace is glad to support two major space agencies: ISRO of India and KARI of South Korea. We are very honoured by the renewed confidence of ISRO. GSAT-11 is the heaviest communications satellite ever built by the agency, and the first to be carried in the upper position on Ariane 5. We are also very proud to launch the GEO-KOMPSAT-2A weather satellite, in our second mission for the Korean space agency KARI. My congratulations to these agencies for the construction of these advanced satellites, which will help reduce the digital divide in India and improve Korean weather forecasts.

"Today's launch marks the latest mission for a better life on Earth, and we are both pleased and proud to have performed it in the presence of the Chairman of ISRO, Dr. K Sivan; of the Vice President of KARI, Mr. Sang Ryool Lee. This launch also took place in the presence of Mr. François Garay, Mayor of Les Mureaux and President of the Community of Ariane Cities in 2018, whom we thank for his constant support.

"I would like to thank all of our partners in this latest success, which confirms the exceptional reliability of Ariane 5: ArianeGroup's teams and all companies involved in the construction of Ariane, ESA, CNES, our ground segment companies and all staff at the launch base. And congratulations to everybody at Arianespace for this perfect penultimate launch of the year and for maintaining such a sustained and successful rapid pace." ■





Anthony Baker,
CEO, Satellite Vu ●●●

Q&A

Observing the Earth

NewSpace pioneer Satellite Vu was recently launched to apply new technological developments to monitor plastic, pollution and pirates from space. In the last decade, humans have produced more plastic than in the entire 20th century and plastic constitutes approximately 90 percent of all waste floating on the ocean surface. By 2050, there could be more plastic in the world's waters than fish, measured by weight. This is just one of the challenges Satellite Vu means to meet, as CEO, Anthony Baker, explains.

Question: Can you provide an overview of Satellite Vu's capabilities and expertise?

Anthony Baker: Satellite Vu is developing a small satellite fleet which will eventually comprise seven satellites. These satellites will be capable of delivering constant, near real-time information on target sites over a 24 hour period, day and night.

Typically, current satellite technology allows a target re-visit of just once per day, often around mid-morning, and therefore you only get that snapshot for a very restricted time period. If you want to carry out pattern

of life analysis – things that are going on all day and all night – you must have remote sensing capability that can deliver consistent, reliable frequent data. Plus, if you are capturing this imagery every hour, you have to deliver that information in a way that is meaningful to your customers. Satellite Vu has developed unique algorithms that help us to analyse data in a timely way. We are harvesting billions of pixels from thousands of locations - and this all needs to be analysed. We will use machine learning and automation to enable us to process it. The human element is important too, but we need help to process the data into trends so that we can look at activity and changes in trends to help us to alert customers when a change is anomalous.

Satellite Vu will offer activity-based intelligence which looks at the pattern of life, so we are trying to determine the economic activity by looking at stationary pictures. This data must then be converted into something that end users understand, particularly if you're looking at the stock market or commodity brokers, for example that need to determine what's going on, on the ground and give it some economic value.

Question: What are the benefits of Satellite Vu's technology compared with other satellite operators, or competing technologies?

Anthony Baker: As I mentioned, as it stands today, Earth observation (EO) satellites typically re-visit a location just once a day, mid-morning when the air tends to be clearer and the shadows prominent. These observations cannot deliver the temporal pattern of life



The value of plastic pollution is reportedly US\$139 billion per year. Photo courtesy of Adobe Stock Images ●●●



insights that Satellite Vu can deliver. It is the constant stream of information that is required to gain understanding of changes that are happening on the ground. Furthermore, our use of algorithms and automation to help to process the data and bring insights to end users is a real differentiating factor. We can also overlay this data on existing data to provide even more meaningful insights dedicated to specific customer requirements. If the information is rapid, precise, very clear and therefore actionable, it has a greater commercial value. That is the most important aspect of what we do – delivering information that is useful to the user in a timely manner.

Question: What can you tell us about Satellite Vu's funding arrangements? We understand you've looked at crowdfunding?

Anthony Baker: We did look into crowdfunding, but it's a lot more effort than we expected; to make a success of it we would need to dedicate considerable effort on PR and

managing the expectations of the potential investors. To make a meaningful difference, we would likely need several hundred investors which would become a significant task in itself. We need to focus our energy on our technology and more importantly our customers requirements.

Currently, we are funded by seed funds, but we anticipate that we will close on a grant and a large revenue generating contract this year, thereafter we will seek new investors probably early next year.

Question: Why is Earth observation so important in the modern world?

Anthony Baker: There is no better way to look at the world as from space. EO data provides vital information on even the most minute changes that happen here on Earth, which means that these changes can be monitored and acted upon if necessary. Nothing else can give the same perspective, and the developments in EO capabilities over the last few years alone have been phenomenal. Resolution has got much

higher so that we can see features in great detail and the sensors on board the satellites have become ever more sophisticated. Algorithms take the Big Data produced by the satellites and convert this into meaningful information that can be used by a plethora of industries and sectors from environmental, agricultural all the way down to businesses such as insurance companies.

The other important trend in the EO sector to point out is that the cost to manufacture an EO satellite has dropped. This is due to the advent of NewSpace innovations. Small satellite technology has skyrocketed in popularity and is at the centre of a paradigm shift in the EO market which has lowered the cost and time taken to manufacture spacecraft. This transformation is significant because it is making space accessible to all and is giving less developed countries the opportunity to tackle some of their greatest problems. Satellites can now be built in just 6-12 months, yet can give excellent resolution in comparison with

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their large counterparts. Small EO spacecraft can produce imagery down to one metre, and in the best cases, up to 30cm resolution.

Earth Observation has a huge amount to offer the modern world, but challenges still remain to provide night and day vision, and to optimise the latency of information in order to make EO information relevant to more users; Satellite Vu is addressing these challenges.

Question: Looking at the problem of plastic pollution specifically, how can Satellite Vu take a role in meeting this global environmental challenge?

Anthony Baker: Plastic is a massive problem. The value of plastic pollution is reportedly US\$139 billion per year. This is the main area of focus for us at the moment.

The technology offered by Satellite Vu significantly decreases the time in which it takes to measure the plastics problem. We are looking at reducing the process from years to weeks. If we can enable rapid identification of where the plastic is located and where it is originating from, governments and organisations can act. This is where our rapid re-visit times are so critical, because we build up a real-time picture of where the plastic is becoming built up we can track it as it happens.

Measuring the distribution of plastics is also essential in enabling us to tackle it. We will provide direct multispectral measurement of the plastic contamination providing actual, rather than simulated data therefore giving the true scale of the problem. Infrared sensors, that will be built into the Satellite Vu payload, are able to detect the presence of floating debris and ultimately the type of plastic.

Then there is the data analysis. If the data is not processed quickly and precisely, the problem is simply allowed to grow, costing economies even more and resulting in wasted efforts. Satellite Vu offers both speed and precision, helping users to better identify the source.

This early detection aids in more accurate localisation of the plastic before it drifts away. Our fast and reliable data processing will provide accurate and actionable data that speeds up decision-making and the delivery of solutions that can help to tackle what is

a huge task for humanity. The point is that if we start this process now, we can do something about it. We can turn it around.

Question: In June, Satellite Vu won first prize in the European Space Agency's (ESA) Ocean x Space competition. What can you tell us about the competition, and this achievement?

Anthony Baker: The competition was held during the 8th edition of ESA's annual Business Applications Conference, held in Stavanger from 22-24 May, which brought together companies, users, experts, entrepreneurs and investors to foster partnerships and new ideas. The Ocean x Space competition invited small companies of 50 employees or less, to submit ideas for innovative, space-enabled services in the maritime sector. Amongst other criteria, the judges were looking for clarity of value proposition, the problem to be tackled, the use of

space assets, technical feasibility and the maturity of the idea.

The award is very important to Satellite Vu as it reinforces the importance of what we are doing and striving to achieve. Plastic pollution is a massive challenge for the maritime environment and our solution provides a means to tackle it rapidly and affordably. Gaining recognition from ESA meant a great deal to us and further validates what we are doing.

Question: What do you expect Satellite Vu to achieve in 2019 and beyond?

Anthony Baker: 2019 will be a pivotal year for Satellite Vu. We aim to have our platform operational, we will be generating revenue and our future satellite sensor will be in the final stages of completion. It is set to be an exciting and ambitious year and the team is very much looking forward to making it a success and seeing our technology doing good things for the planet. 🌱



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The winds of change

Earth observation is a key application of satellite technology – weather forecasting, disaster recovery, environmental protection and resource monitoring, the applications are endless. The Earth observation market has matured immeasurably in recent years, with more focused applications becoming increasingly in demand.

Satellites have brought about many capabilities that could only have been imagined 50 years ago; always-on communications, satellite TV, ubiquitous Internet connectivity, etc., the list could go on and on. Earth observation was one of the earliest applications for satellites orbiting the Earth, with weather forecasting being a prime example that remains important today.

A developing market

According to Euroconsult's *'Satellite-Based Earth Observation; Market Prospects to 2026'* report, the Earth observation market is expected to grow to US\$8.5 billion by 2026. An alternative value-added services (VAS) model also presented has a combined market potential of US\$15 billion; this upside model considers the implications of new supply solutions being able to open further markets.

The defence sector still dominates the market for commercial data, accounting for more than US\$1 billion in sales, with a focus on very high resolution and high accuracy data sets. VAS' markets include infrastructure and natural resources monitoring, but the report highlights the need to offer lower-cost or free data solutions to build these applications.

"Companies (both operators and new service providers, such as Orbital Insights, AllSource Analysis, etc.) are building

algorithms to detect changes in multisourced data to detect patterns and build predictive analytics," said Pacome Revillon, CEO of Euroconsult. "Bringing higher-frequency collected data into these models, the so-called 'Big Data' environment will further aid developments, with the potential to open new services areas based around location-based systems such as financial intelligence and site monitoring, among others."

Advancing wind monitoring capabilities

In August, two significant developments for the future of Earth observation capabilities, specifically in the monitoring of wind patterns at sea and on land, were announced.

Surrey Satellite Technology Ltd (SSTL) and the National Oceanography Centre (NOC) launched the first global GNSS-Reflectometry ocean wind data service with support from the ESA. The data service is free and is hosted at www.merrbys.co.uk, where users can access measurements of wind taken by a specially designed Global Navigation Satellite Systems (GNSS) receiver hosted on SSTL's TechDemoSat-1 satellite, which collects GNSS signals, such as GPS, reflected off the surface of the ocean. TechDemoSat-1 is also collecting GNSS reflections off land and polar regions, opening the door for new applications of this technology, such as soil moisture and ice measurements.

TechDemoSat-1 was launched in 2014 and carried eight



TechDemoSat-1. Credit SSTL ●●●

payloads from different UK organisations. On successful completion of the satellite's original mission, a life extension now allows the GNSS Reflectometry payload to be operated 24/7 continuously. On-board processed GNSS-R data is relayed to SSTL's ground station in the UK and inverted for geophysical parameters using NOC retrieval algorithms for the estimation of near-surface ocean wind speed. Users have access to data from the past three years and new data is added daily with a latency of 30 days. Users can also register for a fast service allowing retrieval of data with a shorter delay - currently 48 hours, but with a target of less than 24 hours as the service matures.

The current service is a pilot demonstration showing the potential for a new source of wind and wave measurements from in orbit using a small satellite. In future, a constellation of low cost small satellites carrying enhanced instruments could provide measurements in near-real time to support weather and wave forecasting.

In other news, the ESA's Earth Explorer Aeolus satellite has been launched into polar orbit on an Arianespace Vega rocket. Using revolutionary laser technology, Aeolus will measure winds around the globe and play a key role in the quest to better understand the workings of our atmosphere. Importantly, this novel mission will also improve weather forecasting.

Highlighted by the World Meteorological Organization, the lack of direct global wind measurements is one of the major deficits in the Global Observing System. By filling this gap, Aeolus will give scientists the information they need to understand how wind, pressure, temperature and humidity are interlinked. This new mission will provide insight into how the wind influences the exchange of heat and moisture between Earth's surface and the atmosphere – important aspects for understanding climate change.

Named after Aeolus, who in Greek mythology was appointed 'keeper of the winds' by the Gods, this novel mission is the fifth in the family of ESA's Earth Explorers, which address the most urgent Earth-science questions of our time. "Aeolus epitomises the essence of an Earth Explorer. It will

fill a gap in our knowledge of how the planet functions and demonstrate how cutting-edge technology can be used in space," said Jan Wörner, ESA Director General.

Aeolus carries one of the most sophisticated instruments ever to be put into orbit. The ALADIN instrument includes revolutionary laser technology to generate pulses of ultraviolet light that are beamed down into the atmosphere to profile the world's winds – a completely new approach to measuring the wind from space. "Aeolus carries the first instrument of its kind and uses a completely new approach to measuring the wind from space. Such pioneering technology has meant that it has been a demanding mission to develop, but thanks to all the teams involved we are thrilled that this extraordinary satellite is now in orbit," commented ESA's Director of Earth Observation Programmes, Josef Aschbacher.

While Aeolus is set to advance science, it is set to benefit society as well. While weather forecasts have advanced considerably in recent years, Aeolus will provide global wind profiles to improve the accuracy even further. In addition, its

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data will be used in air-quality models to improve forecasts of dust and other airborne particles that affect public health.

Providing easy access to data

The fact that this level of satellite imagery is available today is a major feat in and of itself, however, the ability to access this imagery is just as important. Accordingly, late in July it was announced that under contract with the ESA, Indra is developing an innovative new terminal which will enable governments, organizations and companies to directly and autonomously retrieve data from Earth observation satellites.

The terminal will consist of two elements; an antenna to download the telemetry and a Direct Access Terminal (DAT), which will process the data retrieved from the satellites to generate images. After signing agreements with satellite operators, users will be allowed to independently connect to satellites, rendering the process of retrieving information of interest more agile and a matter of minutes from the data acquisition.



Ready for launch - The Aeolus satellite. Credit ESA ●●●

Indra's system reduces the elements necessary to access Earth observation imagery to the absolute minimum. This capability had thus far only been within the reach of satellite operators equipped with expensive and sophisticated infrastructures that include control stations deployed around the globe and huge data processing centres.

Indra's terminal was initially conceived to receive data from Spain's PAZ radar satellite and the twin systems, TerraSAR-X and TanDEM-X, which began operating jointly as a single constellation capable of observing any point on the Earth earlier this year. However, Indra designed the system to be easily adaptable for receiving and processing data from other satellites as well. This renders Indra's system as one of the most advanced and versatile solutions on the market. In less than 15 minutes from the data acquisition, users can get the image of the constellation that they need. The system's daily surveillance capability will cover an area of approximately 300,000 km², equivalent to 60 percent of the size of Spain.

Miniaturizing existing technologies

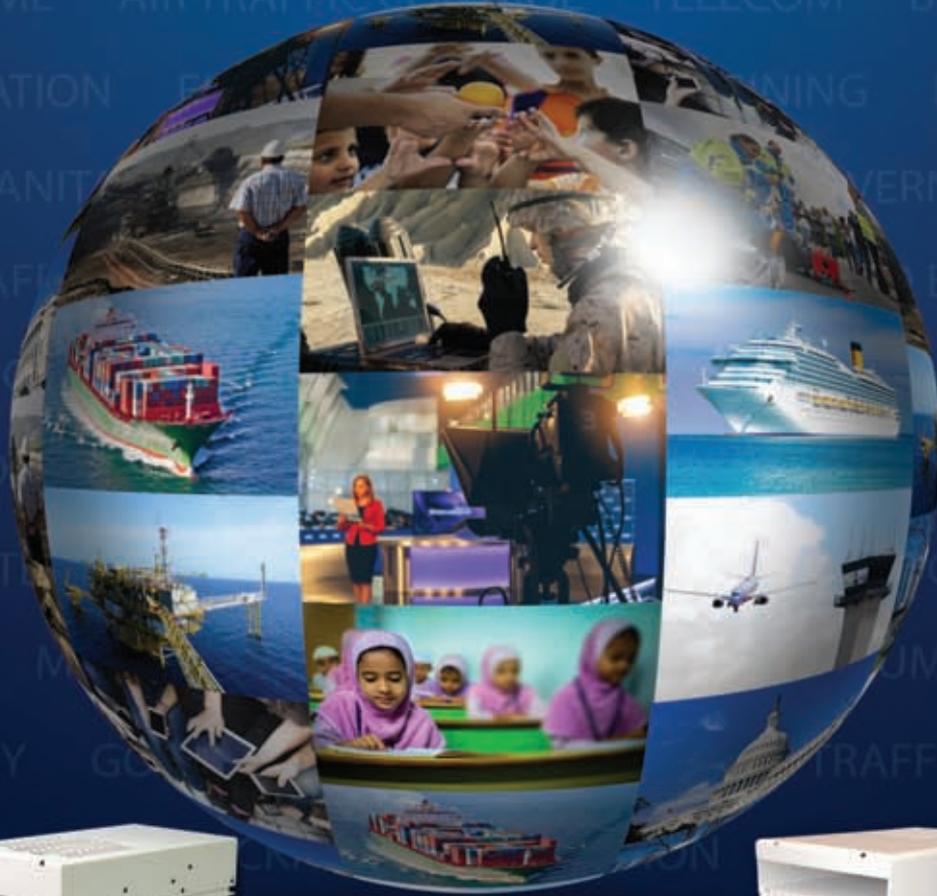
There are some truly incredible instruments orbiting the Earth in GEO and LEO already, delivering vital data sets to enhance Earth observation capabilities. However, it's important to move with the times, and in order to get the most out of the new wave of small satellites and CubeSats, a lot of this equipment is facing miniaturization.

A new project from the University of Strathclyde was announced recently, which will see the development of a multispectral imaging (MSI) device a fraction of the size of conventional instruments available today. The concept is that these smaller, more compact devices could be used in nanosatellites to monitor climate change, observe ocean activity, detect forest fires and track shipping traffic.

The study has received £719,000 as one of seven successful projects to secure funding from the UK Space Agency's (UKSA) Centre for Earth Observation Instrumentation (CEOI). Researchers from the University of Strathclyde's Department of Physics are working with partners, led by product design company Wideblue, to produce MSI technology with a compact payload. It will be designed, built and then tested by taking images during a flight attached to a drone. A commercial MSI satellite can be up to 5.7x2.5x2.5m and weigh as much as 2.8 tonnes. In comparison, the new device could fit on a more affordable 4kg satellite of 10x10x30cm size and would orbit around 500km above Earth.

"Because of the novel way it operates, this instrument could open up ways of doing Earth observation which are different from conventional operations," said Dr Daniel Oi, a Physics Lecturer at Strathclyde and Lead Researcher in the project. "As nanosatellites are smaller, they don't have the capacity to take a lot of data, process it and communicate it. The technology we are developing allows us to reduce the amount of data collected, with sensitivity to specific events or targets, and will enable more efficient monitoring of Earth. Instead of a small number of very expensive MSI satellites, our instrument could be mounted on many nanosatellites to monitor the globe continuously. No satellite can be in two places at once, so operating in this way can enable the right data to be collected at the right time."

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Alex Pannell, Managing Director of Satellite and Media ●●●

Q&A

Supporting the broadcast world

Arqiva is a leading UK communications infrastructure company pioneering an always-on, always-connected world. Its infrastructure and associated services enable millions of people and machines to connect wherever they are through TV, radio, mobile and the Internet of Things. Alex Pannell, Managing Director of Satellite and Media at Arqiva, opines on the rapidly-evolving broadcast sector and the involvement of blockchain technologies.

Question: Can you provide a brief overview of Arqiva's capabilities and expertise?

Alex Pannell: We primarily address two markets. We have a telecoms division, and in that part of the business, we serve the mobile operators and UK utility sector with managed communications services. Through our infrastructure in the UK, those mobile operators deploy equipment and connectivity to deliver voice and data services to their customers. The other part of this business is to target and

address the utility market, where we have Smart metering capabilities. We hold the contract for the North of the UK, to 10-11 million homes, delivering Smart metering for the gas and electricity sector. Using common technology platforms, we also serve the water utility market, for Thames Water and Anglian Water, for Smart water meters.

We also serve the needs of content owners and broadcasters, both in the UK and around the world. We help these clients get their content to the point of monetisation through our UK digital terrestrial TV (DTT) network, digital satellite delivery, fibre, Internet and OTT services. Also, within the satellite media division, we have a datacoms business where we support the oil and gas industry, the utility sector, and the maritime and aviation industries. We effectively get data to hard-to-reach places, whether that's a plane in the sky, an oil rig in the middle of the ocean, or a gas node in the middle of the countryside.

Essentially, we're a managed services business

Question: The broadcast sector has seen a great deal of change in recent years, with OTT and VoD really shaking things up. What's your assessment of this change, and the opportunities for companies like Arqiva?

Alex Pannell: The change is coming from the fact that there are new ways to view content. People are viewing content differently now to how they were five years ago with YouTube, Netflix, etc.



For us, whether it's 500 or 1,000 or 10,000 live events a year, the process is the same, and it's entirely scalable ●●●

The proliferation of high-speed broadband connections has changed everything.

The needs of the content owners are changing as their models are changing. They're having to invest more and more in unique content models, and that's putting pressure on more traditional services. They're spending more on content, therefore they need more efficient delivery models, but they also have to invest more to get their content onto OTT systems.

We're lucky today that we're operating in a growing market. The transition from traditional core services to new OTT services is going very well. That's been going on for the last five years.

What's really different now for us is down to the advancements in cloud technology and services, and that's enabling us to make more efficient models, more flexible commercial models, through the use of those software-based solutions. We need to make sure they interoperate at a technical level with the more traditional service models. That's a big opportunity for us, but we've got to make sure that we're delivering managed services across that value chain, whether it's traditional DTT, satellite, fibre, or Internet and OTT. In the last few years, we've been investing heavily in new software solutions with this in mind. We don't have to deploy thousands of people in order to deploy thousands of IP streams, and that really is fundamental towards our ongoing success in the market.

Question: Arqiva recently launched its first suite of virtualised media management services covering playout, OTT managed head end and VoD processing using Amazon Web Services (AWS). What can you tell us about this suite, and the benefits for customers?

Alex Pannell: We've announced a big programme and we're now launching the first new services with AWS.

What's really different is the customer experience; if you're a live sports broadcaster, you've spent millions on sports rights, and you're trying to launch a new online service where people consume that content over the Internet. You've got to get those feeds from the sports stadiums to

delivery over the Internet in a scalable way. If you are working out your schedule and are not yet clear if you are supporting 5-20, or even more concurrent events, that becomes quite complex, especially if you're trying to avoid building lots of up-front infrastructure. The way we use the cloud makes that a completely different experience. For example, if you're growing your live sports content market, you need to have confidence that you're working with someone who can scale up, but without lots of up-front costs. That's really about the commercial model.

On the operational side of things, if you need to support 30 live events, the old model would have required at least three to six months of planning ahead because the service provider has to build encoding streams, do a lot of

preparation and testing, and make sure everything is ready. Our model is different. What we deliver to the customer is a host of technical interfaces and APIs, which means that the client can spin up the services on the day before broadcast to test that everything is working, and then spin them up again an hour ahead of the event and keep it running until after the event. With this, the client only pays for a small amount of usage and cuts out a lot of human interaction and preparation. The customer experience is completely different. The ability to monetise their rights more quickly is what we're using the cloud for.

For us, whether it's 500 or 1,000 or 10,000 live events a year, the process is the same, and it's entirely scalable. The cloud has completely changed the commercial and operating models.



Photo courtesy of Arqiva ●●●

Question: Why are so many companies basing their technologies on AWS right now?

Alex Pannell: It's true to say that not all clouds are equal. If you compare Amazon with the next nine cloud operators, Amazon's infrastructure is 15-20 times bigger than the next nine combined. Amazon also has a number of tools that we could use and integrate to build services that we felt were far better suited to the nature of our business. They also had a very good insight in the media streaming workflows, so we were able to work with them and another company called Cloudreach to build an integrated toolset.

Question: As technologies have advanced, the broadcast sector has been increasingly moving towards virtualised cloud services. What's your assessment of this trend?

Alex Pannell: I think there's going to be a massive continued trend towards using more software services. On the public cloud, the commercial models are more modelled towards ad-hoc events and sports events, just because of their nature. It's true to say that putting the infrastructure on the site today is probably better for setting up a permanent channel, but for one-offs, virtualised services are a great solution. Because of the commercial pressures of the industry, we've all got to create more efficient systems with more automation. This software is going to lend itself to that.

Going forwards, because of the continued convergence between content and connectivity, mobile and content, all the IP and software is where we're going to get interoperability at a technical and commercial operator level. All those things are going to come together, so it's not just a trend in virtualised environments, it's also going to include the hardware and software. The whole industry is going to have to move more towards a software model.

Question: Blockchain technology has come on in leaps and bounds in recent years, finding new applications in a whole host of sectors. Can you outline blockchain's role in the existing video value chain?

Alex Pannell: Most people know about

blockchain from cryptocurrencies. It's the underlying distributed ledger that makes cryptocurrencies work. If you think about the concept of a distributed ledger, it's constantly updated, very hard to hack, and that has some interesting applications.

There's a lot of activity in the music industry right now about how you monetise and pay for use of music rights. There are various digital formats, there are lots of different players, and there's a lot more standardisation in the marketplace. Blockchain is a good technology because it allows you to have that single ledger of truth that shows who's used it and can be a great help in monetisation and showing payment transactions. A lot of people can be removed from the traditional process using blockchain.

If we think about how that could apply to the broadcast industry, how can we track who's using OTT content? Usually, there's a transaction, someone pays for the content and then receives that content, and most people don't try to abuse those rights. In more complicated markets, where you might not be able to employ sales and legal people, the blockchain can be used as a safe distributed ledger to automate the process, create commercial content models, and perform all the transactions in a safe way. A lot of the costs of that process can be cut, enabling content owners to reach much wider markets where traditionally they would need sales people, lawyers, and complex distribution chains. That's one user case of blockchain in broadcast.

The other potential user case is in peer-to-peer (P2P) networking. There's a company in France called Streamroot; rather than having all the costs related to content delivery networks, they're using P2P technology in a neighbourhood area to stream content from one point to another. In order to establish which set top box homes have access to which content, these types of content optimisation models could use blockchain to control the process and user groups in a much more accurate and secure way – ensuring viewing and content rights are logged, tracked and updated using such distributed ledger capabilities that blockchain provides and also scale up very, very quickly. It also helps them control, audit and fulfilment the

“Going forwards, because of the continued convergence between content and connectivity, mobile and content, all the IP and software is where we're going to get interoperability at a technical and commercial operator level.”

monetisation process, for example.

Another conceptual user case can be found in the satellite world. If the Internet of Things (IoT) is going to keep growing, then satellite and mobile networks, as part of the communications infrastructure, will need new commercial models that can bridge that infrastructure. We can expect to see complex revenue sharing models between these different infrastructures which could be simplified and secured using a distributed ledger. It's an interesting idea, particularly for the satellite industry.

Question: What are your expectations for Arqiva for 2019 and beyond?

Alex Pannell: In my part of the business, satellite and media, I'm expecting that we will make very big strides in helping our content owners take their content across new forms of distribution and help monetise them. Ultimately, my real expectations are that we will have quite a different commercial model spreading across the market and our range of technologies.

I also hope that we'll be able to develop a whole new set of applications for the data world, relating to the IoT, GEO and MEO satellites. Ultimately, I think the data market will become a lot more relevant in the satellite industry as new applications gain traction.

I also think people underestimate how much of a growth opportunity that HD remains today. There's all this hype around UHD, but Sky UK is still only broadcasting 20 percent of its channels in HD. I think it's important to highlight the potential for growth in this area. 🌟



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Electron 'Its a Test' at Launch Complex 1 ●●●

Modernizing the launch sector

The satellite launch industry has had decades to shroud itself in tradition; beyond the standard updating of vehicles and technology, there was very little change in the sector for many years. All that has changed now that we've entered the era of small satellites and constellations, and significant opportunities are available for those bold enough to grab them.

The satellite launch market is a costly place to do business. Designing, developing and manufacturing the launch vehicles is just the start of it; then there's the associated costs, the insurance, the launch pads, the regulations, the list goes on and on... However, as satellite trends move beyond traditional GEO satellites and high throughput satellites (HTS) towards small satellites, the launch sector must modernise to keep up with demand. Those companies that are slow to react will be left behind, as new start-ups, eager to get in on the action, make a killing.

A US\$27.18 billion market (in 2025)

It's clear that the launch market is a great place to be doing business right now, as demand rises and technologies advance, making more launches possible than ever before, and with more choice for satellite operators.

ResearchAndMarkets' *'Space Launch Services Market by Service Type (Pre-Launch, Post-Launch), Payload (Satellite, Human Spacecraft, Cargo, Testing Probes, Stratollite), End User, Orbit, Launch Vehicle Size, Launch Platform, and Region – Global Forecast to 2025,'* expects the launch services market to grow at a CAGR of 15.01 percent in 2017-2025 to US\$27.18 billion.

North America is expected to lead the launch services market owing to increased launch service demands for

satellites, human spacecraft, and space probes. In addition, the rise in the number of spaceflights to the International Space Station (ISS) and increased investments in space exploration missions are additional factors projected to drive the growth of the market in North America. However, the Asia-Pacific market is projected to grow at the highest CAGR from 2017-2025 due to the increased demand for launch services from the space industry in this region.

More specifically on the small satellite front, Frost & Sullivan's *'Small-satellite Launch Services Market, Quarterly Update Q1 2018, Forecast to 2030,'* report expects an estimated 11,631 launch demands by 2030 for new constellations and replacement missions, which could take the market beyond US\$62 billion. The current rideshare capacity, wherein small satellites are launched as secondary payloads on existing launch programmes, is insufficient to meet upcoming launch demand.

"While North American and European companies will be the leading developers of flexible, dedicated launch vehicles, players in Asia-Pacific are looking to follow suit," said Vivek Suresh Prasad, SpaceIndustry Principal, Aerospace & Defense. "Many players are also analysing the feasibility of the small-satellite spaceport business model to provide dedicated launch services to small-satellite operators."

Frost & Sullivan expects significant market opportunities



New Shepard Crew Capsule, July 18, 2018, prior to a safe landing on Mission 9 where the escape motor was fired in-flight ●●●

to be created by the high-volume demand created by the next wave of satellite constellations. Some 32 small satellite operators are expected to generate more than 90 percent of launch demand, with small satellites in the mass segments of 0-15kg and 150-500kg accounting for 65 percent of the launch demand. The projected launch capacity of existing and planned launch providers is expected to reach 11,640 small satellites, capable of launching 2,473 tonnes.

Arianespace prepares for a new era of satellite launches

One of the most well-established satellite launch companies on the market today, Arianespace has a great history in successfully and reliably launching satellites into a variety of orbits. The traditional launch provider has branched out in recent years, and while it has yet to make any announcements about reusable launch vehicles, Arianespace has proven itself more than capable of adapting to a new era for the satellite launch market, filled with small satellite launches for a wealth of new constellations and technology demonstrators.

In 2018, Arianespace successfully launched four additional O3b satellites for the constellation operated by SES Networks. The launch provider has now placed all of the 16 satellites in the current O3b constellation into orbit, demonstrating Arianespace's expertise in NGSO launches. The launch provider also orbited four more Galileo satellites for the European Space Agency (ESA); it has now launched 26 satellites for the constellation, with more to come in 2019.

Arianespace is building up to a Small Spacecraft Mission Service (SSMS) Proof Of Concept (POC) flight in 2019, due for launch from Europe's Spaceport at the Guiana Space Centre. The Vega POC flight will also be the first mission of the SSMS, a modular carbon fibre dispenser, a program initiated by ESA in 2016, with the contribution of the European Commission. For all the European partners involved, its purpose is to address the burgeoning institutional and commercial small spacecraft market with a new rideshare concept. Participants of the SSMS POC flight include:

- Spaceflight: The rideshare and mission management provider has will launch one microsatellite and several CubeSats on board the SSMC POC flight in early 2019. Spaceflight will also launch further small satellite payloads on subsequent Vega missions one year later.
- D-Orbit: D-Orbit's ION CubeSat Carrier, a free-flying CubeSat deployer and technology demonstrator that will host several CubeSats once deployed in orbit, will be launched on the SSMC POC flight. D-Orbit's InOrbit NOW is a revolutionary launch and deployment service designed to transport CubeSats to space and release them into independent orbital slots. The launch contract includes a significant number of CubeSats with an overall separated mass of about 100kg. Positioned in a sun-synchronous orbit at 500 km., ION CubeSat Carrier will deploy the hosted CubeSats along the orbit over a period of approximately one month. After completing the CubeSat deployment phase, ION CubeSat Carrier will initiate the in-orbit validation phase of payloads directly integrated on the platform.
- SITAEL: The first small satellite delivering STRIVING services will be launched on the SSMC POC flight. STRIVING is a new one-stop-shop commercial service

offering to both private and public entities affordable and effective access to space for testing, validating and/or operating their innovative technologies and solutions. SITAEL, the Space Mission Provider (SMP), acts as a single interface to customers, leading an industrial team composed also by IMT, Planetek and Tyvak International. The service infrastructure is currently under development within a public-private partnership between ESA/ASI and SITAEL in the frame of the ARTES PIONEER Initiative. Built by SITAEL using its S-75 microsat platform, the first STRIVING satellite will weigh approximately 70kg at launch and is designed to have a nominal service life of at least two years once positioned in a sun-synchronous orbit at 500km.

- Innovative Solutions in Space (ISIS): ISIS' QuadPack deployer for multiple CubeSats will be launched on the SSMS POC flight, along with options for several microsatellites and more QuadPack deployers for the SSMS POC mission – as well as for subsequent Vega SSMS launches.
- Spire: A multi-launch contract will see several CubeSats launched on the SSMC POF flight, as well as options on subsequent Vega flights. Built in-house by Spire using its LEMUR2 CubeSat platform, the nanosatellites will weigh approximately 5kg at launch and are designed to have a nominal service life of two to three years once positioned in a Sun-synchronous orbit at 500km. Each satellite carries multiple sensors, making them capable of performing data collection for all of Spire's data products.

Arianespace is also well on its way with the development of its new Vega C and Ariane 6 launch vehicles. The first launches are expected in 2019 and 2020, respectively. Ariane 6, which comes in two versions, has already won two launch contracts from the European Space Agency (ESA) for four additional satellites for the Galileo navigation system, while

Vega C has won three contracts; two to orbit satellites for the Airbus Earth observation constellation Pléiades Neo, and one to launch the COSMO-SkyMed satellite for the Italian space agency (ASI) and Italian Ministry of Defense.

Northrop Grumman: Full steam ahead with Omega launch vehicle

Not as ostentatious a player in the satellite launch sector as some of its competitors, Northrop Grumman's expertise stems from the production of the Pegasus, Minotaur and Antares launch vehicles by its Flight Systems Group, as well as the Cygnus spacecraft from its Innovation Systems group – newly-formed from the 2018 acquisition of Orbital ATK.

In addition to its existing capabilities, Northrop Grumman is also developing a new rocket, the Omega. Originally an Orbital ATK design, Omega is a new intermediate-and large-class launch vehicle, capable of launching the full range of national security missions required by the US Air Force, as well as scientific and commercial payloads. An Evolvable Expendable Launch Vehicle (EELV), the Omega will launch from both East and West coast launch facilities and will be the largest and most capable of Northrop Grumman's rocket range.

In April 2018, Northrop Grumman provided a detailed update on its Omega launch vehicle system. In the previous three years, Orbital ATK and the US Air Force have invested more than US\$250 million into its development, and the vehicle is on track to begin ground tests in 2019, and to conduct its first launch in 2021.

The rocket configuration consists of Orbital ATK-built first and second solid rocket stages, strap-on solid boosters and a cryogenic liquid upper stage. Orbital ATK recently selected Aerojet Rocketdyne's RL10C to be Omega's upper stage propulsion engine. The RL10 has provided reliable upper stage propulsion for more than five decades and provides a low-risk, affordable engine with outstanding performance. The



New Shepard on the launch pad the morning of Mission 9, July 18, 2018 ●●●



next phase of the Omega program began in the middle of 2018, when the US Air Force awarded Launch Services Agreements, including the remaining development and verification of the vehicle and its launch sites. After initial flights of its intermediate configuration in 2021, Omega will be certified for operational EELV missions starting in 2022 with initial heavy configuration flights beginning in 2024.

In other news, July 2018 saw the ninth successful cargo supply mission to the ISS under NASA's Commercial Resupply Services (CRS-1) contract. The Cygnus spacecraft removed more than 3,000kg of disposable cargo, a new record for Cygnus. The 'S.S. J.R. Thompson' Cygnus vehicle also successfully executed secondary missions that included the demonstration of Cygnus' ability to reboost the space station and the deployment of six CubeSats into orbit from a NanoRacks CubeSat deployer.

The mission started on 21 May, when Cygnus launched aboard a Northrop Grumman Antares rocket from NASA's Wallops Flight Facility in Virginia. Upon arrival at the orbiting laboratory, Cygnus delivered approximately 3,350kg of cargo, supplies and scientific experiments to the astronauts. The spacecraft remained docked for 52 days at the orbiting laboratory and departed the ISS on 15 July. The mission officially concluded on 30 July, when Cygnus performed a safe, destructive re-entry into the Earth's atmosphere over the Pacific Ocean East of New Zealand.

"From launch to our safe re-entry, the 'S.S. J.R. Thompson' performed every phase of this mission perfectly," said Frank Culbertson, President, Space Systems Group, Northrop Grumman. "We now turn our attention toward final preparations for the next Cygnus cargo mission later this year with a continued focus on supporting the needs of the crew members aboard the International Space Station, as well as enabling crucial research programs in space."

Also, in August, Northrop Grumman demonstrated its capability to develop booster systems and key launch components for use in other launch provider systems. The company provided the fully-integrated third stage propulsion system of the ULA Delta IV Heavy rocket, giving a critical boost for NASA's Parker Solar Probe spacecraft on its journey to study the sun. The spacecraft was successfully launched aboard a ULA Delta IV Heavy rocket, for which Northrop Grumman also provided several large composite structures.

The goal of the Parker Solar Probe mission is to increase understanding of the sun, where changing conditions can propagate out into the solar system, affecting Earth. The spacecraft required a third stage to provide the necessary velocity to place it on a heliocentric, Earth escape trajectory toward the sun, making it one of the fastest human-made objects ever launched with a top speed of over 121mps. At that speed, it could travel from the Earth to the moon in under 30 minutes. The third stage system includes a Northrop Grumman STAR 48BV solid rocket motor configured to enable precise insertion of the spacecraft into its final trajectory. This mission marks the first time the Delta IV rocket has flown with a third stage.

"It has been an honour to work on a historic program that will provide major advancements in the understanding of the sun," said Phil Joyce, Vice President, Small Space Launch Systems, Northrop Grumman. "The team was able to draw on its expertise in developing mission-unique stages for our

own launch vehicles and applied that knowledge to building the first ever third stage for the Delta IV Heavy."

Under a subcontract from ULA, Northrop Grumman designed and manufactured the third stage using the company's flight-heritage components with some modifications to withstand the higher radiation environments unique to the Parker Solar Probe's Earth escape trajectory. This included all stand-alone avionics, ordnance, structures and flight software. It also included guidance, navigation and control systems, and instrumentation, telemetry and the separation systems for third stage and spacecraft. Northrop Grumman also provided 14 key large composite structures for ULA's Delta IV Heavy rocket. These structures include the following on each of the three Common Booster Cores (CBC): A thermal shield that house and protect the RS68 engine during flight, the centerbody that connects the liquid oxygen (LO₂) tank and the liquid hydrogen (LH₂) tank, the nosecones on the strap-on CBCs, the interstage on the core CBC that connect to the Delta Cryogenic Second Stage (DCSS), and the X-panel structures that connect the DCSS LO₂ tank and the LH₂ tank. Additional contributions include the approximately 63ft long payload fairing, payload attach fitting, and payload attach fitting diaphragm, all of which encapsulate and protect the payload. These large-scale composite structures measure up to 15ft in diameter and range from three to 63ft in length.

In addition, Northrop Grumman manufactured the propellant tank for the Delta IV second stage roll control system and a diaphragm tank for the Parker Solar Probe spacecraft and designed and manufactured the nozzles for the Delta IV's RS-68A engines. The company also designed and produced the nozzles' thermal protection material, which is capable of shielding the nozzle from external temperatures that can exceed 4,000 degrees Fahrenheit during launch. In addition, Northrop Grumman manufactured the eight booster separation motors for the Delta IV Heavy.

Rocket Lab announces significant contract wins

Founded in 2006, Rocket Lab has become a major player in the global launch sector in recent years, with a mission to open access to space to improve life on Earth. The company develops and launches advanced rocket technology to provide rapid and repeatable access to orbit for small satellites.

Rocket Lab's first launch vehicle, the Electron rocket, was explicitly designed to serve the small satellite market with dedicated high-frequency launch opportunities, delivering payloads of 150kg to a 500km Sun-synchronous orbit. The two-stage launch vehicle utilizes Rocket Lab's Rutherford liquid engines in both stages, using pumps which are uniquely-powered electric motors instead of a gas generator, expander or pre-burner. The engine is fabricated largely with 3D-printing methods. January 2018 saw the 500th test fire of the Rutherford engine, which saw a 100 second burn.

Although the company remains in its infancy compared with industry stalwarts like Arianespace, Rocket Lab has already signed an impressive number of launch deals.

In April, Rocket Lab and spacecraft platform developer York Space Systems entered into a Memorandum of Understanding (MoU) to develop a universal Interface Control Document (ICD) and supporting Concepts of Operations

(CONOPS) that will streamline the manifesting process for small satellite launch customers.

By removing the time spent in selecting a bus and launch provider, and developing the standard products required to get a spacecraft programme off the pad. Rocket Lab and York are establishing a framework to shorten the integration process required for York spacecraft on the Electron launcher. Currently the mission integration campaigns take months, adding to the lead time on top of that required for regulatory approvals. By creating standard launch integration products that have already established compatibility, many months of mission integration can be cut. Standard interfaces, requirements and capabilities will be pre-verified, and a set of operational services and enhancements will also be defined.

“Sending a satellite to orbit used to mean commissioning a large, one-off spacecraft that required a purpose-built payload adaptor and often a tailored launch vehicle. By developing an optional standardized launch vehicle and bus ICD, we can radically reduce the customer costs and speed up the manifesting process to get satellites on orbit faster,” said Rocket Lab CEO Peter Beck.

In June, Rocket Lab announced a partnership with rideshare and mission management provider Spaceflight for three orbital launches across 2018 and 2019. The first mission, scheduled for the end of 2019, was for a BlackSky microsatellite and several rideshare customers. The missions join a busy manifest which will see Rocket Lab launch monthly by the end of 2018, and every two weeks in 2019. All three missions will be launched from Rocket Lab's Complex 1 on the Mahia Peninsula in New Zealand, deploying the satellites

into low Earth orbit (LEO). Spaceflight will provide mission campaign services, while Rocket Lab will assist with vehicle integration on the Electron vehicle.

Later in August, Rocket Lab signed an agreement with Circle Aerospace for ten dedicated Electron launches, with the first scheduled for launch in the fourth quarter of 2019. Circle Aerospace is a new turnkey launch brokerage and satellite development company from Dubai which aims to catalyse the growth of commercial space and small satellite industry across the UAE. Circle Aerospace's contract will see most of the missions launched from Rocket Lab's New Zealand site.

Blue Origin nears suborbital space tourism flights

Blue Origin was founded by Amazon Founder and CEO Jeff Bezos back in 2000 with the aim of providing private human access to space with dramatically lower costs and increased reliability. The company has two launch vehicles; the New Shepard, a reusable suborbital vehicle with more than a handful of successful flights; and the New Glenn, an orbital two or three-stage vehicle with a reusable first stage, expected to enter the market in the 2020s.

In July 2018, the New Shepard achieved its ninth successful flight, which delivered its third round of commercial payload customers with the following missions:

Schmitt Space Communicator Xperimental (SC1-x)

Solstar (Santa Fe, NM), developed with private funding and with support from NASA's Flight Opportunities Program
On New Shepard Mission 8, Solstar demonstrated the first commercial WiFi in space. On this reflight, they will take



Rocket Lab Electron 'It's Business Time' on the pad at LC-1 ●●●



advantage of the Crew Capsule's high altitude escape and continue testing WiFi access throughout the flight.

GAGa (Granular Anisotropic Gases)

Otto-von-Guericke University (Magdeburg, Germany) with end-to-end service provider OLYMPIASPACE (Darmstadt, Germany) and funding from German space agency, DLR

The GAGa payload investigates the statistics of granular gases, dilute collections of solid grains that interact by random collisions. Data from GAGa on New Shepard Mission 9 will help validate existing theoretical models and contribute to understanding the dynamics of related systems like avalanches and cosmic dust clouds.

Suborbital Flight Experiment Monitor-2 (SFEM-2)

NASA Johnson Space Center (Houston, TX)

SFEM-2 was first flown on Mission 8 of New Shepard and will collect additional data on Mission 9. The experiment will record vehicle conditions including cabin pressure, temperature, CO₂, acoustic conditions, and acceleration.

Condensed Droplet Experiment for NASA in Sub-Orbital Spaceflight (ConDENSS)

Purdue University (West Lafayette, IN), funded through NASA Flight Opportunities Program

ConDENSS will examine the behaviour of small droplets of water in order to support the development of small and efficient heat transfer systems for spaceflight. These systems, called phase change heat transfer systems, provide more uniform surface temperatures and higher power capacities.

APL Electromagnetic Field Experiment

Johns Hopkins University Applied Physics Laboratory, funded through NASA Flight Opportunities Program

This experiment marks the first flight of the JANUS 2.1 platform with sensors to monitor magnetic fields and ambient pressure inside the vehicle. Previous versions of JANUS were flown on New Shepard Missions 6 and 7.

Vibration Isolation Platform Data Logger

Controlled Dynamics, funded through NASA Flight Opportunities Program

VIP DL is a technology demo for an active stabilization platform that aims to allow the most sensitive payloads flying on *New Shepard* to be isolated from ambient vibrations, allowing for even higher precision microgravity studies.

mu Space-1

mu Space Corporation (Bangkok, Thailand)

The first of Blue Origin's New Glenn customers to purchase a slot on New Shepard, mu Space's payload includes an assortment of scientific and medical items, several textile materials they plan to use on their future space suit and apparel, and other special articles for their community partners.

Blue Origin 'Fly My Stuff'

A special addition to the Mission 9 payload manifest is a suite of payloads from Blue Origin employees as a part of our internal 'Fly My Stuff' program.

Mission 9 also saw the latest launch of its Crew Capsule 2.0, Blue Origin's first plan for suborbital space tourism. The capsule seats six astronauts and is large enough for passengers to float freely. Sitting on top of the New Shepard rocket, Crew Capsule 2.0 was ejected safely and extensively stress-tested before it was successfully landed back on Earth with the help of a retro-thruster system. The capsule also features three independent parachutes for redundancy. According to recent reports, Blue Origin plans to start selling tickets on the Crew Capsule 2.0 in 2019, with prices estimated anywhere from US\$50,000 to US\$250,000.

SpaceX sends Tesla into space in world-famous Falcon Heavy launch

Another famous business name, Elon Musk's SpaceX company was founded in 2002 in order to reduce space transportation costs and enable the colonization of Mars. The company has come a long way in such a short time, with the development of several launch vehicles and crew capsules. Falcon 9, the world's most famous reusable launch vehicle, has now successfully launched hundreds of satellites into orbit, and SpaceX is going full steam ahead with its next vehicle: The Falcon Heavy.

Back in February, SpaceX successfully launched the Falcon Heavy launch vehicle into space for the first time, delivering its cargo, the Tesla Roadster, into orbit. The three-stage Falcon Heavy, the first heavy-lift capability launch vehicle seen in space in decades, is set to change the path of human space exploration. The vehicle exceeded expectations during the launch: The first two stages were successfully re-landed, while the third was lost during the attempted re-land at sea due to too high speeds. SpaceX has stated that it expects to cut launch costs from tens of billions to US\$90 million with the Falcon Heavy, compared with US\$1 billion for NASA's comparable SLS rocket (currently under development).

The Falcon Heavy successfully launched its ostentatious cargo, a Tesla Roadster, towards Mars; however, due to slight overthrust, the Roadster is unlikely to orbit Mars as planned. Its current trajectory is uncertain, although it could well end up in an asteroid belt.

Although no dates have yet been made available, several commercial Falcon Heavy spaceflights are on the books at SpaceX, for Arabsat (Arabsat 6A), Inmarsat, US Air Force (STP-2) and Viasat.

2018, a hugely successful year for SpaceX, which achieved a large number of commercial and governmental satellite launches – the Merah Putih mission for PT Telkom Indonesia, tens of Iridium NEXT satellites, Telstar 19 VANTAGE, SES-12, two GRACE-FO satellites, Bangabandhu Satellite-1, NASA's TESS, HISPASAT 30W-6, PAZ and GOVSAT-1, in addition to Dragon resupply missions for the ISS – pales into comparison with what the company has planned next.

With the Falcon Heavy nearing commercialization, Elon Musk's team is rapidly developing its next step forwards: The BFR, which SpaceX President Gwynne Shotwell has insisted stands for 'Big Falcon Rocket,' in contrast with less polite, but more popular, thoughts on the abbreviation. The BFR is Musk's next step in realizing the goal to colonize Mars; the reusable launch vehicle will be capable of lifting as much as 150,000kg

into orbit, and will ultimately replace the Falcon 9 and Falcon Heavy vehicles, as well as the Dragon spacecraft. Testing is expected to start in 2019, with cargo flights to Mars pegged for an optimistic 2022 launch date.

Virgin Galactic nears suborbital space tourism readiness

2004-founded Virgin Galactic is Richard Branson's spaceflight company within the Virgin Group. The company plans to provide suborbital spaceflights to space tourists, as well as for launching science missions.

Unique in its approach, Virgin Galactic's launch vehicle, SpaceShipTwo, is air-launched from a carrier airplane called WhiteKnightTwo. Virgin Galactic works in harmony with its sister company, The Spaceship Company, an aerospace-system manufacturing organization.



The ULA Delta IV Heavy rocket launches NASA's Parker Solar Probe to touch the Sun

In April 2018, VSS Unity, the first SpaceShipTwo built by The Spaceship Company, successfully completed its first supersonic, rocket-powered flight. This flight milestone was the result of many years of extensive design, manufacturing, ground testing and flight-testing activities. The flight starts the final phase of VSS Unity's flight test program before the vehicle is delivered to Virgin Galactic for commercial service.

VSS Unity was launched from the WhiteKnightTwo carrier when the vehicles had reached 46,500ft over the Sierra Neva Mountains. After a few seconds to ensure adequate separation, VSS Unity's rocket motor was brought to life and the pilots aimed the spaceship upwards into an 80-degree climb, accelerating to Mach 1.87 during the 30 seconds of rocket burn.

The hybrid nitrous oxide/rubber compound rocket motor, which was designed, built and tested by The Spaceship Company, powered VSS Unity through the transonic range and into supersonic flight for the first time. On rocket shutdown, VSS Unity continued an upwards coast to an apogee of 84,271ft before readying for the downhill return. At this stage, the pilots raised the vehicle's tail booms to a 60-degree angle to the fuselage, or into the 'feathered' configuration. At around 50,000ft, the tail-booms were lowered again and, while jettisoning the remaining oxidizer, VSS Unity turned to glide home for a smooth runway landing.

The flight has generated valuable data on flight, motor and vehicle performance. It also marks a key moment for the test flight program, now entering the exciting phase of powered flight and the expansion to full duration rocket burns. Further VSS Unity test flights were completed throughout 2018, and in July, the spacecraft broke Mach 2 when released from carrier aircraft VMS Eve at 46,500ft. The planned 42 seconds rocket burn took pilots and spaceship through the Stratosphere and, at an apogee of 170,800ft, into the Mesosphere for the first time. This region, often referred to by scientists as the 'Ignorosphere,' is an understudied atmospheric layer because it is above the range of balloon flight, and in the future is an area we can help the research community explore further.

Looking ahead, once in commercial service, Virgin Galactic's spaceships are designed to be turned around and flown at a higher frequency than has traditionally been the case for human spaceflight.

Later in July, Virgin Galactic, The Spaceship Company, Altec and SITAEL signed a framework agreement to bring Virgin Galactic spaceflights to Italy. The agreement comes after two years of business discussions, government regulatory analysis, studies on potential operations and market assessment. The agreement envisions a dedicated space vehicle system being positioned at the future Grottaglie Spaceport, which will integrate significant technological and industrial contribution from SITAEL and the rest of Italian Aerospace industry, pending regulatory approvals. The space vehicle would be utilized by customers like the Italian Space Agency as a science platform for high-frequency space research, as well as private individuals to experience space. This dual nature is expected to drive innovation, spur industrial development, STEM education, as well as promote further investments and economic growth in Puglia and Italy as a whole.

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4K - here to stay

4K, or Ultra High Definition (UHD), has been in the making for a long time; it's been decades since HD came into effect around most of the world, and the next evolution of TV viewing is here at last. With four times as many pixels as HD, content quality has seen a significant increase. However, it's not all smooth sailing; there's a lot still to consider before 4K can truly take over the world.

4K has been lauded as the next 'big thing' in consumer experience for some years now, but it's yet to catch on in the way manufacturers and content producers imagined. When 3D TVs were introduced, a certain sub-set of tech-loving consumers rushed out to buy 3D ready TVs and content, even though the fad was short-lived. Perhaps it's a good thing, then, that the move to 4K is a much more gradual transition, with consumers mostly waiting until their TVs and devices naturally needed upgrading. It's certainly more indicative of a successful, long-term step forwards, rather than a flash in the pan.

Market forces

Of course, every new technology that comes to market must meet market needs and be in demand from consumers for continued investment and development.

According to Research and Markets' latest report, *'Global 4K Technology Market – By Industry, Product, Region – Market Size, Demand Forecasts, Company Profiles, Industry Trends and Updates (2017-2023)'*, the global 4K technology market stood at US\$35.95 billion in 2017 and is estimated to achieve a CAGR of 22.11 percent to US\$119.21 billion by 2023. Growth during the period is expected to be boosted by growing demand for 4K TV, camera and projectors. According

to the report, the main market for manufacturing Smart 4K TVs has been dominated by Japan, North America, and Korea, with Hisense, Chang Hong, and Seiki Corporation dominating the market. South Korea and Taiwan are also in the list of manufacturing the smart 4K TVs, where Samsung, Sony, and LG are leading the way.

Another report from ABI Research exploring the flat panel TV market, which has achieved more than 85 percent penetration in homes around the world, has forecast that 44 percent of global flat panel TV shipments will be 4K TVs, surpassing 102 million units, in 2018. Indeed, more than 33 percent of flat panel TVs shipped in 2017 were 4K-ready. Geographically, the Asia-Pacific region leads in 4K shipments, representing 37 percent of global shipments in 2018. The market in this region is mainly driven by China, where low-cost 4K TVs are prolific. North America and Western Europe, meanwhile, have the highest 4K market penetration right now, accounting for almost half of global 4K flat panel TV shipments in 2018. Going forwards, ABI expects consumer demand to drive 4K flat panel TV shipments to grow at a CAGR of 17.3 percent to reach 194 million shipments in 2022.

"Better visual experience and availability of 4K content together with declining price points are driving 4K TV set shipments," commented Khin Sandi Lynn, Industry Analyst



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at ABI Research. “As expected, 4K is quickly becoming the standard for TV sales. Just like HD before it, hardware technology reached the market far before any content did, placing an impetus on content creators and providers to catch up, while also allowing for a time of transition. While some of the satellite and cable providers are lagging behind major streaming services for 4K support and content, that too is shifting. As 4K becomes the norm, questions surround HDR and its many forms will become the focus.”

Technical challenges

High Definition (HD) has become ubiquitous in much of the world now, delivering five times as many pixels as Standard Definition (SD). However, consumers might be surprised to know that there are in fact three different standards for HD:

- 1080p: 1920x1080p – 2,073,600 pixels per frame;
- 1080i: 1920x1080i – 1,036,800 pixels per field (2,073,600 pixels per frame); and
- 720p: 1280x720 – 921,600 pixels per frame.

While three different standards make things slightly more complicated than if there was a single, cohesive standard, it's still pretty straight-forward for content producers to make programmes that will reliably play on all HD devices, and for device manufacturers to design products that will play all HD content.

4K roll-out, in contrast, is quite a bit more complex. Although officially there are just two standards, one for home viewing and one for cinemas, simply squeezing in four times as many pixels is not the answer to an improved viewing experience:

- Cinematic 4K: 4096x2160 - 8,847,360 pixels per frame
- Home UHD: 3840x2160 - 8,294,400 pixels per frame

Indeed, contrast ratio, compression artefacts and colour all have a significant impact on picture quality, more so, some would argue, than resolution. The following points have been raised with regards to 4K roll-out:

The human eye is limited

Incredible as they are, the human eye does have its limits. To

fully-appreciate the increased resolution of 4K, the eyes need to be within a certain proximity of the screen. The norm in most Western homes is for viewers to sit some 8-10 feet away from the viewing device, at which distance, the screen would need to be at least 84 inches for the full effect of 4K to be felt. Smaller devices such as tablets and phones are getting in on the 4K action, and while here the effects may be better appreciated, the increased resolution in TVs is a little wasted for the majority of consumers.

Larger TVs are not the norm

With consumers in general living in increasingly small homes (anyone who has recently moved in to a New Build property in the UK can attest to this), TVs in the 84-inch region are considered a bit of a waste of space. The average living room in many developed markets is around 10 square feet, and most consumers are not rushing forwards to give up this space to a new breed of giant 4K TVs. Yes, TVs may be getting larger, but 84 inches is still a long way beyond the norm.

Quantity “Quality

Increasing the number of pixels fourfold does not lead to a fourfold increase in image quality. Indeed, some experts are calling for better colour, compression artefacts and contrast ratio; while the technology is getting there today with high dynamic range (HDR), wide colour gamut (WCG) and high frame rate (HFR), we're still not really where we need to be.

What about motion resolution?

Motion resolution is another area not addressed by 4K technologies. If you watch TV with some regularity, you'll notice that when there's significant movement on the screen, there's a big loss of resolution, around 40 percent. This has yet to be improved, even with the advent of 4K.

Lacking standards

While the pixel standards have been defined for both home and cinematic devices (see above), there is much more to standardisation which remains to be addressed. Even in 2017, 4K TVs were being manufactured with HDMI 1.4, which allows 4,096x2,160 pixels at a frame rate of 24fps. While this just about covers standard 4K content, it won't cover the higher frame rates required for 4K gaming; anyone playing online



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games with other players will be looking for at least 30fps. HDMI 2.0, which came into use in early 2017, enables more bandwidth, higher resolutions, and higher framerates, but these cannot be backwards engineered into existing 4K TVs.



Photo courtesy of Shutterstock ●●●

There's no doubt that 4K is a big step up from HD. However, there's still a long way to go to make it as good as it can possibly be. A fractured market with a whirling mass of varying standards is no good to consumers, device manufacturers or content producers.

Despite this, consumers and content producers alike are rushing forwards with the new technology. Any new step forward like this is a marketing team dream, and in the era of hash tags, #4K is big news. It's an easy sell, especially in-store, where consumers can stand within inches of a 100+ inch screen and really take in the improved picture quality.

Satellite operators jump on 4K

4K is a great opportunity for satellite operators the world over. With four times as many pixels, any 4K content in need of broadcasting takes up huge amounts of bandwidth, increasing revenues for satellite operators, and boosting capacity utilization. It's hardly surprising then that satellite operators are lauding the benefits of 4K content to its clients, investing in studies showing strong consumer demand for 4K, and ramping up their marketing activities in this area.

One of the areas 4K really comes into its own is in the world of sports, where higher resolution makes a big difference to the viewing experience. It's no wonder then that broadcasters have really ramped up their capabilities when it comes to major events such as the Olympics or the FIFA World Cup.

Throughout 8-25 February, NBC Olympics selected SES to provide 4K High Dynamic Range (HDR) satellite distribution for its production of the XXIII Olympic Winter Games, which take place in PyeongChang, South Korea. SES used its satellite platform to distribute the NBC Olympics HDR feed to their affiliates throughout the USA, utilizing the SES-1 satellite. As part of the implementation, SES provided preconfigured satellite receivers to the affiliates that received the HDR feed. SES's 4K platform provides multichannel video program distributors (MVPDs) in the USA access to the world's largest bouquet of linear 4K programming.

"NBC Olympics was pleased to work with SES to offer 4K

HDR coverage of the PyeongChang Games to our valued distribution partners," said David Mazza CTO & SVP, NBC Olympics. "The HDR feed distributed by SES, and presented by Xfinity, complemented our HDR Video On Demand offering available to MVPDs and satellite providers across the United States."

NBC Olympics distributed 4K HDR coverage, provided by Olympic Broadcasting Services (OBS) and Japan's NHK, to US distribution partners, who individually chose how to make the content available to their customers. NBC's 4K HDR coverage of the PyeongChang Games was made available on delay, and included 4K footage from the Opening Ceremony, hockey, figure skating, short track speed skating, ski jumping, and snowboard big air competitions.

Later in June, it was announced that Hispasat would provide the necessary satellite capacity to Portuguese communications operator MEO, in order to broadcast 28 matches from the 2018 World Cup in 4K via satellite.

The first match to be broadcast on the RTP1 4K channel was Russia versus Saudi Arabia, the opening match for the World Cup. In the following days, the most important games of the championship were offered, including all of Portugal's matches, three Round of Sixteen matches, three Quarter-Final matches, the Semi-finals and the Final. All the matches were broadcast on the Portuguese MEO platform through the Hispasat 30W-5 satellite.

Another interesting application of 4K technology over satellite was announced in April, when Eutelsat began the broadcast of NASA High Definition (NTV-3) and NASA Ultra High Definition (NTV-4) channels for the first time across Europe, the Middle East, North Africa and Sub-Saharan Africa. Notably, Eutelsat is the first satellite operator to make NASA TV channels accessible to a large and rapidly growing audience base across Europe, the Middle East, North Africa and Sub-Saharan Africa.

Viewers from across these regions can now enjoy exceptional images from the US space programme, including coverage of launches, life on-board the International Space Station (ISS), Earth views from space, deep space exploration, the solar system, Mars, replay of NASA classics such as the Apollo programme, and documentaries on NASA's latest R&D work.

NASA TV HD is transmitted free-to-air from the HOTBIRD video neighbourhood at 13° East for viewers in Europe, the Middle East and North Africa, and via the 7° East video neighbourhood for viewers in Sub-Saharan Africa. NASA TV UHD, meanwhile, is also broadcast on the HOTBIRD and 7° East video neighbourhoods, as well as the FRANSAT TV platform via the EUTELSAT 5 West A satellite, for subscribers equipped with an Ultra HD-compatible TV set.

4K: Here to stay

It's certain that, despite teething challenges for content producers, device manufacturers and broadcasters alike, 4K is here to stay for the long haul. The technology provides too many benefits to consumers in terms of quality, and for everyone else in the supply chain in terms of financials, for it to fall by the wayside. It's helpful, too, that like HD before it, 4K is being seen as the natural evolution of TV technology. There's even talk of 8K in some parts of the world, though implementation lies far into the future.

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Roger Franklin, President and CEO at Crystal ●●●

Q&A

Personalizing the viewing experience

Crystal provides software that automates the monitoring, control and metadata management of the end-to-end broadcast operation. From traffic, scheduling and playout through OTT/TVE, Crystal helps its clients capture new advertising revenue, speed time-to-market, increase advertising effectiveness and reduce costs. Roger Franklin, President and CEO at Crystal, opines on personalizing the viewing experience using existing technologies.

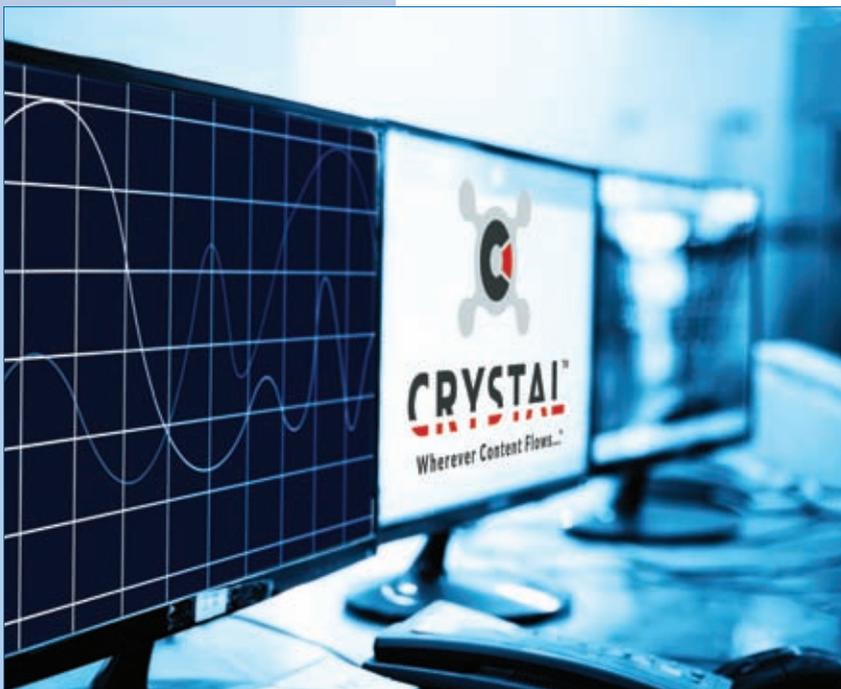
Question: What can you tell us about Crystal's foundation, and the key milestones achieved over the years?

Roger Franklin: Crystal's foundation is based on the ability to interface to just about any piece of equipment or system out there; to monitor, control and communicate with it. Everything we do is built on that core base. We've been providing monitoring and control systems for more than 30 years for some of the major broadcasters around the world.

More recently, we've extended that control to embedding signals in-band with the video and thereby effecting control on equipment at the distant end of a video transmission. Over the last few years, we've enabled the process to dynamically replace advertising in video, in a cable environment or over the air. Because we've been dealing with metadata that we've extracted from playout automation systems, we can resynchronize that metadata accurately with the video, anywhere along the distribution path. We know exactly what's playing, when. That gives us the ability to identify specific frames, when to pull a commercial out, when to put a new one in, and so forth.

Broadcast quality video needs to be frame accurate. The days of getting chopped commercials should be over, although it still happens from time to time when the timing isn't quite right. A lot of cable plants and satellite operators set up their system to be time accurate at one point, but over time, a piece of hardware starts to drift, and what used to be accurate to the frame is now 12 or 13 frames off, and it just gets worse. Advertisers are paying for a complete message; if they're paying for 30 seconds and its 30fps, they want 900 frames of video, because that's what they're paying for. The last thing we need to do is chop off the end of an advertisement, allowing the message to be misdelivered on misinterpreted.

Question: As a major player in the broadcast sector, Crystal must keep its eye on emerging trends and opportunities. What's your



Some of the technology Crystal provides makes it possible for those OTT providers to do dynamic ad insertion with personalized content for live streams ●●●

assessment of the market right now?

Roger Franklin: Broadcast video is essentially made up of three major business sections. At the beginning, you have the production of video content which are the programmes. Traditionally, broadcasters have packaged up that video, combined it with adverts, and put together a nice package with graphics, and called it a network. That network was handed off to a distributor to get it delivered to viewers via satellite, cable, and over the air. Those are the primary three functions: Production, network packaging and distribution.

What we're seeing now is that those last two functions, network packaging and distribution, are being combined through business mergers. Moreover, these combined businesses realize that sending the same channel to everyone in their viewership is not desirable. These days viewers are much more interested in receiving content that is more relevant to them, including targeted advertising. This means delivering contextual advertising that matches the content of what they're watching, and where they are watching it. The distributors know where the viewers are and what their preferences are, and can finish the final packaging of a video network to target that delivery. In order to do that, they need to replace content as well as make sure that the right commercials are in the right programmes.

So, distributors now have to do some of the jobs of traditional network packagers, but they don't have all the information that they need to accomplish that. It's therefore incumbent on the network to provide the correct signalling to those distributors so they can personalize the content. While there are standards in place to do that, they are not always able to survive today's modern distribution path, leaving them unreliable. Crystal's latest developments solve that problem for the distributors and network packagers.

Question: We're forever hearing about the 'global takeover' of OTT; what does it mean for Crystal as a service provider?

Roger Franklin: I separate OTT into two different types of video.

Video on Demand (VoD), where we're talking about Netflix and Amazon

Prime. The timing is not critical for this type of OTT, since the viewer sees whatever frame of video they like, whenever they want to watch it and companies like Amazon, Netflix and Hulu are doing a very good job at this.

The other side of OTT is live streaming, and for this, timing is absolutely critical. OTT also brings people together in communal viewing, but with a widespread community and viewers all potentially watching the same thing at the same time on individual screens. This form of OTT viewing has been challenging because it's difficult to take a live linear channel and stream it to very large number of viewers over the Internet and provide a high-quality experience with personalized adverts.

For streaming services like YouTube TV, local channels with local news and announcers are also necessary for the service to be compelling. The right systems and signals must be in place to do that dynamic advert insertion for local advertisers to frame accurately.

Some of the technology Crystal provides makes it possible for those OTT providers to do dynamic ad insertion with personalized content for live streams, and we're seeing a lot of interest there now. Last year was about distribution rights, making sure that these OTT providers didn't distribute video over the Internet that they didn't have the rights to. This year, of interest is dynamic advert insertion. And now that some of the signalling is in place, they can see the potential in generating their own ad revenue. I think that next year we'll see a lot more interest in

personalization with graphics and even more relevant content.

Question: What are your expectations for Crystal and the broadcast market in the years to come?

Roger Franklin: In the last year, Crystal has created some very interesting technologies that allows us to synchronize timing signals with any video channel, even if there are no signals in the channel. What this means is that we can do dynamic advert replacement on off-air received TV channels today. We don't have to wait for the next iteration of technology, we can take a cable channel, re-synchronize the signals so we know exactly where the adverts are, and replace those adverts in a Smart TV today.

We're going to be licencing that technology to Smart TV manufacturers, and we're going to be working with networks to deliver this out of band metadata to the Smart TVs so they can do dynamic advert replacement and personalized graphics on the TV itself, using today's signals and delivery infrastructure.

One of the things that's come to light in all this is, because of this technology, we don't have to wait for OTT to do personalized TV channels. We can truly take broadcast TV and personalize it at the home, much further down the chain than we ever have before. Satellite distributed video is extremely economical and reliable, and there's no reason to dismantle that in order to achieve that personalized viewing experience.

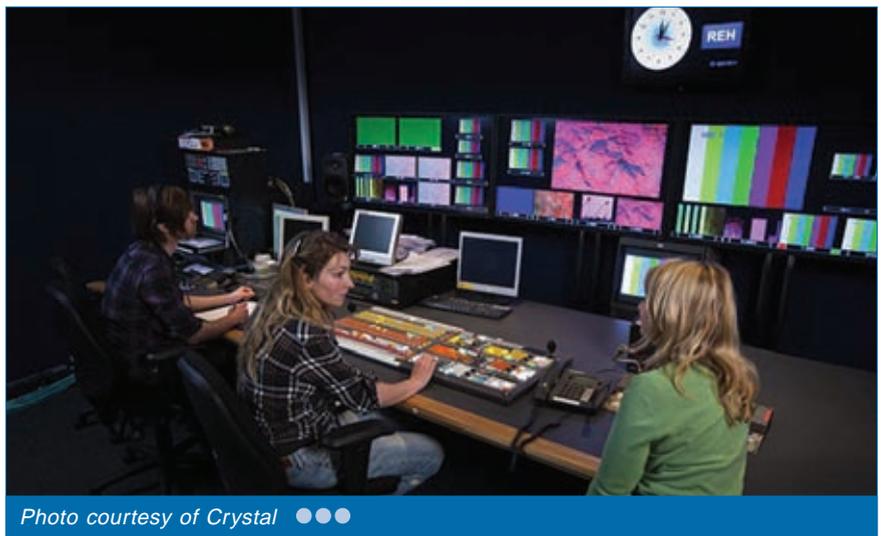
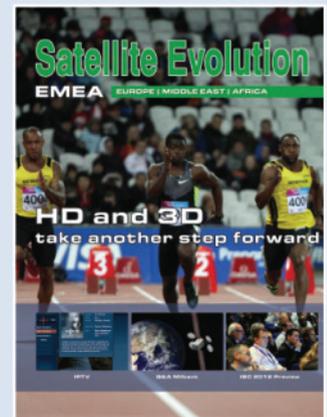
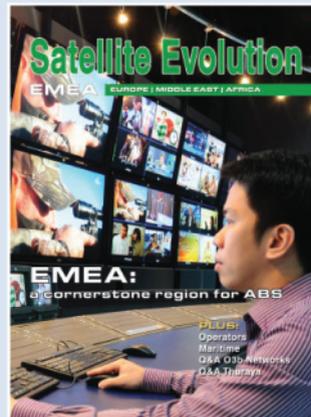
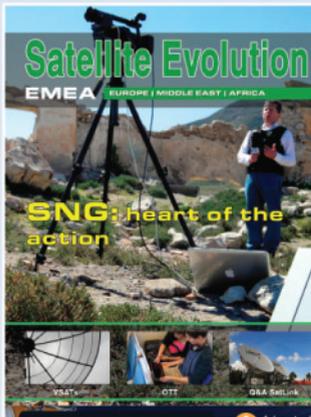
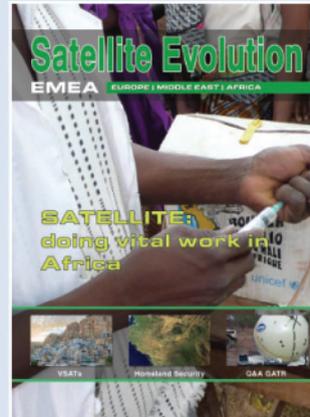
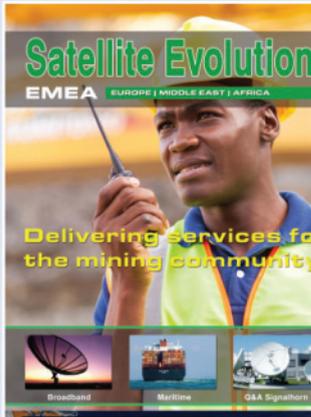


Photo courtesy of Crystal ●●●



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Advantech Satellite Networks

New name, New adventure

Advantech Wireless Inc., doing business as Advantech Satellite Networks™
is now

SpaceBridge Inc. doing business as **SpaceBridge™**

We thank all our partners, clients and suppliers for helping us significantly grow our business and we remain committed to the same degree of excellence, spirit of innovation and customer delight. Above all, we commit to reward our customers with unsurpassed technologies and solutions developed by our talented and loyal team that has earned your trust over the past 30 years

A new journey has begun





Best in class - size, weight and power performance



Outdoor High Power Amplifiers

- 1250W, 750W, 400W, 180W
- C, X, Ku, DBS, Ka, Q & V bands



Indoor Touch Screen Amplifiers

- 1250W, 750W, 400W
- C, X, Ku, DBS & Ka-band
- 1:1 & 1:2 Systems



Outdoor HPA Systems

- 1:1, 1:2 Redundant & power combined systems
- Small, lightweight
- Easy maintenance
- Quick Installation



1.5kW Ku/DBS System

2.5kW Ku/DBS System



Outdoor SSPBs

- Ka-band 10, 20, 40W
- Ku-band 16-200W
- C-band 40-400W

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