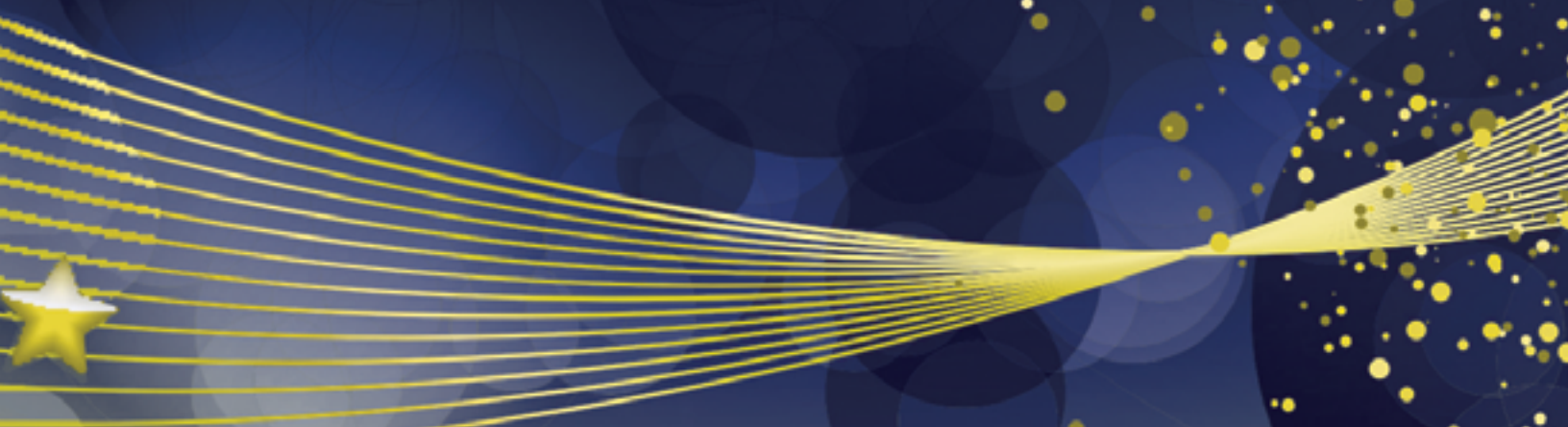


Worldwide Satellite Magazine — December 2018

SatMagazine

2018



YEAR IN REVIEW

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InfoBeam

Arianespace launches their tenth mission of 2018

Arianespace's 10th mission of 2018 orbited satellite payloads on December 5 for the Indian Space Research Organisation (ISRO) and the Korea Aerospace Research Institute (KARI), using the workhorse Ariane 5 on a launch performed from the Spaceport in French Guiana.

Designated *Flight VA246* in Arianespace's launcher family numbering system, it delivered the **ISRO GSAT-11** relay platform for Ku- and Ka-band communications, along with **KARI's GEO-KOMPSAT-2A**, which is to provide meteorological and space weather monitoring data.

"I want to express my deepest gratitude to two very special partners since the beginning of their space ambitions: ISRO and KARI," said Arianespace CEO **Stéphane Israël** in post-launch comments from the Spaceport.

Israël noted that GSAT-11 was the 22nd ISRO satellite orbited by Arianespace and Ariane-series launchers, tracing the relationship back to India's **APPLE** small experimental communications spacecraft, which had a liftoff mass of 670 kg. and was lofted in 1981 by an **Ariane 1** version rocket. On this Ariane 5 mission, GSAT-11 weighed in at 5,854.6 kg. — the largest and heaviest satellite ever built by the Indian space agency.

Deployed first during Ariane 5's 33 minute mission to geostationary transfer orbit, GSAT-11 will be positioned at 74 degrees East, providing communications services in Ku- and Ka-bands in both forward and return links.

The satellite was designed and manufactured by ISRO, with its multi-spot beam coverage over the Indian mainland and nearby islands to bring significant advantages to users when compared with existing India's **INSAT/GSAT** satellite systems. GSAT-11's design expected lifetime is more than 15 years.

GEO-KOMPSAT-2A was carried in Ariane 5's lower payload position and released second in the sequence for Flight VA246. Developed by KARI at its South Korean facility in Daejeon, this 3,507.2 kg. satellite will deliver meteorological and space weather monitoring from an orbital position of 128.2 degrees East as part of a Korean government national program.

"Arianespace is proud to maintain such a close bond with South Korea," Israël stated, adding that Flight VA246 marked the seventh time South Korea's flag has appeared on the fairing of an Arianespace launch vehicle.

In addition to the Ariane 5's payload fairing logos representing Flight VA246's two satellite passengers, also included was a decal recognizing the French city of Les Mureaux — home to the ArianeGroup site responsible for integration of Ariane 5 cryogenic main stages today and for Ariane 6 launchers in the future.

Israël noted that Arianespace has once again confirmed its flexibility and reliability by performing five launches in two and a half months — from September 25 to December 4 — with liftoffs coming every two weeks since early November.

"What an impressive tempo," Israël concluded, noting that Flight VA246's orbiting of the GSAT-11 and GEO-KOMPSAT-2A satellites for connectivity and weather data gathering fulfills Arianespace's motto: **"Space for a better life on Earth."**

Arianespace has one more mission scheduled before year's end, using the **Soyuz** medium-lift member of the company's launcher family to orbit the **CSO-1** spacecraft for France's **DGA (Direction générale de l'armement) defense procurement agency** and the French **CNES** space agency.



This close-up photo shows the Ariane 5 payload fairing logos for Flight VA246's GSAT-11 and GEO-KOMPSAT-2A passengers, along with a decal for the Community of Ariane Cities and Les Mureaux. Photo is courtesy of Arianespace.



The Arianespace flight VA246 lifts off from the Spaceport in French Guiana.

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InfoBeam

SpaceX launch is the biggest ever from the U.S. of a single rideshare mission

The successful launch, from Space Launch Complex 4E (SLC-4E) at Vandenberg Air Force Base in California on December 3 of the SpaceX SmallSat mission was the first of its kind in the U.S. and is the largest, single, rideshare mission from a U.S.-based launch vehicle — 64 smallsats from 17 countries were lofted to their respective, orbital destinations.

With a launch requiring 300,000 lbs. of thrust, the **Falcon 9** soared and separated its payload according to schedule — the ‘cherry on top’ of the launch was that this Falcon 9’s first stage returned and landed perfectly on the ‘*Just Read the Instructions*’ drone ship in the Pacific Ocean, making this the third successful return for the Falcon 9. Until this launch, no “repurposed” SpaceX rocket has flown more than two missions.

The original launch date was supposed to have been on November 19; however, SpaceX delayed the SmallSat Express mission to conduct additional tests. Then, incimate weather caused additional delays.

A series of six deployments occurred approximately 13 to 43 minutes after liftoff — then **Spaceflight** began to command the smallsat deployment sequences, which were expected to occur over a period of approximately six hours.

The smallsats mission includes 15 microsats and 49 cubesats from commercial and government entities, including universities, startups, and a middle school.

The payloads, which vary from technology demonstrations and imaging satellites to educational research endeavors, are from 17 countries, including the U.S., Australia, Italy, Netherlands, Finland, South Korea, Spain, Switzerland, U.K., Germany, Jordan, Kazakhstan, Thailand, Poland, Canada, Brazil, and India.

Some of the smaller satellites aim to build an internet network capable of supporting smart devices back on Earth’s surface.

Nearly all of the satellites on SpaceX’s payload aim to prove that a combination of smaller, simpler and less expensive satellites can perform similar, or the same, complex functions as much larger, more expensive satellites.



SpaceX Falcon 9 booster successfully landed on the drone ship (left), while the second stage of the rocket continued into space for deploying a record 64 satellites into low Earth orbit (right). Photo is courtesy of SpaceX.

Spaceflight also constructed a unique payload stack, which is one of the most complex and intricate endeavors that the company has undertaken. The smallsats will be integrated with a variety of dispensers and avionics.

www.spacex.com

spaceflight.com



The Falcon 9 blasted off from Vandenberg Air Force Base in California.

InfoBeam

SSL's robotic arm on NASA's InSight Lander gets a grip on Mars

SSL, a Maxar Technologies company (NYSE: MAXR) (TSX: MAXR), has congratulated NASA on the successful touchdown of the agency's **InSight Lander** on Mars, following the craft's six-month interplanetary voyage from California.

The lander is equipped with a highly capable robotic arm built by **SSL Robotics** in Pasadena, California, which has begun to perform mission-critical operations in support of NASA's goal to study Mars' deep interior. The mission underscores SSL's long legacy as a trusted contractor to NASA, having provided all five of the robotic arms used on Mars.

InSight, which stands for *Interior Exploration using Seismic Investigations, Geodesy and Heat Transport*, will collect seismic, rotational, and thermal measurements to determine the present level of tectonic activity on Mars.

Data of this sort is critical to understanding the processes that formed the rocky planets of the inner solar system approximately 4.5 billion years ago.

The SSL-built **Instrument Deployment Arm** is a lightweight, four-degree-of-freedom, two-meter class robotic arm, with joints at the shoulder, elbow, and wrist.

It has the mission-critical job of placing the lander's sensitive instruments onto the dusty Martian surface, a process that future landers are expected to repeat when offloading payloads onto the surface of the Moon.



The lander's instruments include a seismometer capable of detecting Marsquakes and a heat flow probe that will burrow as deep as 16 feet into the ground.

SSL's long history of accelerating innovation for advanced space robotics began well before InSight. The company has built every robotic arm used on the surface of Mars, including:

- **Curiosity** rover, launched in 2011 to explore Gale Crater;
- **Phoenix** lander, launched in 2007 to study the history of water in the Martian arctic and search for evidence of a habitable zone;

• **Spirit** and **Opportunity** rovers, which were launched in 2003 to search for answers about the history of water on Mars.

SSL is also building the **Sample Handling Assembly** robotic arm for NASA's Mars 2020 rover. The arm is designed to provide extreme accuracy under severe temperature variations within a dusty and dirty environment.

Richard White, the President of SSL Government Systems, stated that SSL is committed to providing innovative space systems that build a better world and advance humankind's understanding of the universe. SSL has a long and successful history as a trusted supplier to NASA and JPL, and that the company is delighted that the SSL-built robotic arm on InSight is beginning operations.



NASA's InSight Lander has begun operations on Mars with an SSL-built robotic arm.

Image is courtesy of NASA.



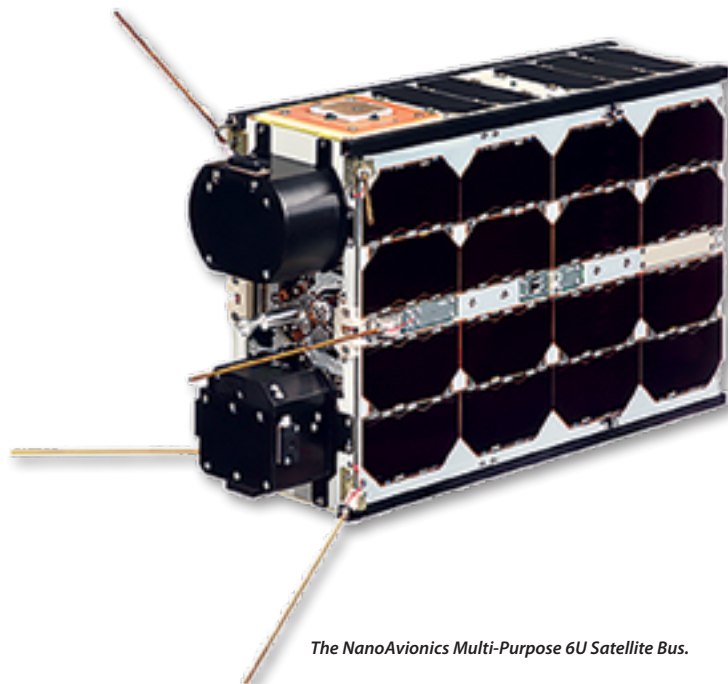
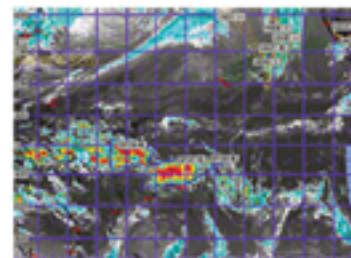
A crane hoists NASA's InSight lander inside its fairing for mating atop a ULA Atlas V rocket. Photo is courtesy of the USAF's 30th Space Wing.

InfoBeam

Orbital Micro Systems and NanoAvionics to partner on smallsat rideshare mission

Orbital Micro Systems (OMS) is partnering with NanoAvionics to conduct a rideshare mission to fly one of OMS's miniaturized passive microwave sensors — this mission will use the NanoAvionics M6P 6U satellite bus.

OMS is on track to launch multiple weather observation satellites in 2019. This mission will carry a humidity and precipitation monitoring sensor that will enhance the company's data collection capabilities. These important atmospheric parameters play a role in decision-making, affecting many industries.



The NanoAvionics Multi-Purpose 6U Satellite Bus.

NanoAvionics' innovations in bus technology include a green propulsion system, reliable avionics and control systems, and multiple transmission options.

The M6P bus provides up to 5U of payload capacity which can be segmented for multiple systems or applications with compatible orbital requirements.

William Hosack, CEO for OMS, said the company is delighted to work with an industry leader such as NanoAvionics in deploying an additional passive microwave sounder.

He added the M6P is quickly becoming the gold standard for flexible bus solutions and provides a high degree of reliability which enables the company to deliver better weather data collection technology.

Hosack noted this advanced bus architecture will help us accelerate OMS activities and enable the firm to quickly expand into multiple vertical and geographic markets.

Vytenis Buzas, CEO of NanoAvionics, said the goal at NanoAvionics is to provide a highly functional and reliable satellite bus which innovative payload developers, such as OMS, can use to deliver space-based applications quickly and frequently. Space missions leveraging the firm's services and buses can become much more economical for participants in shared missions through distributed launch costs.

InfoBeam

SpaceX launches again... to the ISS

The week of December 2 was rather momentous for SpaceX after the company completed a successful launch of 64 satellites from 17 countries on December 3, then on December 5, the company launched their 16th commercial resupply services mission to the space station from Cape Canaveral Air Force Station in Florida.

Onboard SpaceX's Dragon spacecraft are more than 20 payloads sponsored by the International Space Station (ISS) — a record breaker. This mission represents a diverse combination of science and technology research with the capacity to benefit life on Earth that include crystals, barley, and dental glue, among other things.

The Dragon spacecraft that supports the CRS-16 mission previously supported the CRS-10 mission in February of 2017. Contrary to Monday's performance by Falcon 9, when the first stage returned and landed perfectly on the 'Just Read the Instructions' drone ship in the Pacific Ocean (making that the third successful return for this Falcon 9), SpaceX was unable to recover Falcon 9's first stage on Landing Zone 1 (LZ-1) at Cape Canaveral Air Force Station, sending the first stage into the Atlantic. First reports indicate the hardware is undamaged and still transmitting and a recovery ship was dispatched to the location.

Dragon is filled with more than 5,600 pounds of supplies and payloads, including critical materials to directly support more than 250 science and research investigations that will occur onboard the orbiting laboratory.

CRS-16 is the sixteenth of up to 20 missions to the International Space Station that SpaceX will fly for NASA under the first CRS contract. In January 2016, NASA announced that SpaceX's Falcon 9 launch vehicle and Dragon spacecraft were selected to resupply the space station through 2024 as part of a second Commercial Resupply Services contract award.

Under the CRS contracts, SpaceX has restored the United States' capability to deliver and return significant amounts of cargo, including live plants and animals, to and from the orbiting laboratory. A variant of the Dragon spacecraft, called Crew Dragon, is being developed for U.S.-based crew transport to and from the space station.

On Saturday, December 8, International Space Station crew members will use the station's 57.7 foot (17.6 meter) robotic arm to capture the Dragon spacecraft and attach it to the orbiting laboratory.

Dragon will return to Earth with about 4,000 pounds of cargo after an approximately five-week stay at the International Space Station. About five hours after Dragon leaves the space station, it will conduct its deorbit burn, which lasts up to 10 minutes.

It takes about 30 minutes for Dragon to reenter the Earth's atmosphere and splash down in the Pacific Ocean off the coast of Baja California.

The International Space Station (ISS) U.S. National Laboratory is enabling a new era of research in space aimed at improving life on Earth. The SpaceX Commercial Resupply Services (CRS)-16 mission is slated for launch no earlier than December 4, 2018, carrying multiple ISS National Lab payloads.

The SpaceX CRS-16 mission includes a variety of payloads representing diverse science investigations, ranging from the life and physical sciences to Earth observation and remote sensing, as well as educational experiments intended to engage and excite the next generation of scientists and engineers.



InfoBeam

SSPI's 2018 Better Satellite World Award bestowed upon Kacific

Kacific founder and CEO, Christian Patouraux, has accepted the 2018 Better Satellite World Award at a ceremony in London in recognition of the company's work bringing affordable connectivity via next-generation satellites to the people of South East Asia and the Pacific.



Artistic rendition of the Kacific-1 satellite.

Bestowed by the **Space & Satellite Professionals International (SSPI)**, the award honors companies who use satellite systems to make the world a more prosperous, healthier, better-educated, sustainable and inclusive home for humankind.

Once launched in 2019, Kacific's first satellite, **Kacific1**, will help connect more hospitals, clinics, schools, libraries, post offices, police stations and many other public institutions in rural areas where terrestrial broadband infrastructure is not an option or not economical.

The satellite beams will cover previously isolated or underserved regions of South Asia, South East Asia, Melanesia, Micronesia and Polynesia, providing a channel for connectivity.

Christian Patouraux said that when he started Kacific, he wasn't interested in following the status quo. By serving only narrow, lucrative telecoms segments, the status quo was leaving many populations behind and increasing the digital divide. Kacific didn't re-invent the wheel, but the company's team took advantage of innovative new space technology and operated a lean organization to match the cost expectations of emerging markets.

Patouraux continued that the flagship project in this proof-of-concept service connects the Vanuatu Interisland Telemedicine and Learning Network.

He noted that the Network has already saved the lives of a number of people in emergency situations, because of the speed with which outer island health clinics can contact the main hospitals and specialist doctors. So, the company knows that Kacific1 will make a tangible difference to people's lives.

The company CEO added this service is just one of several community-based projects the firm is currently operating in the Asia-Pacific region.

He concluded his remarks by stating the company is honored to receive this award ahead of 2019, when the services of our next-generation satellite commence.



The Kacific team celebrate their Better Satellite World award.

InfoBeam

Spaceflight's 64 smallsat launch meets with success

Most will never know all that is necessary to plan a launch, and then add to that the challenge of managing and being responsible for the launch of 64 satellites, a record breaking event to be sure, but that's exactly what **Spaceflight** did.

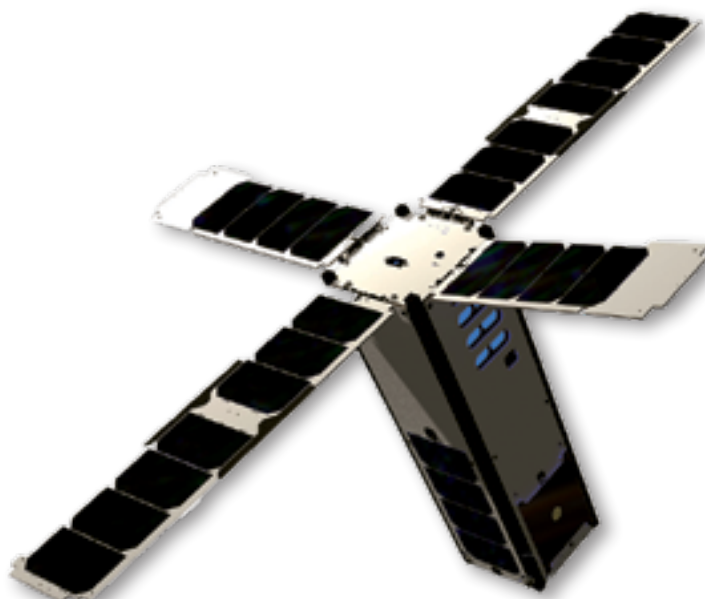
Spaceflight, the leading rideshare and mission management provider, is enjoying the success of their **SSO-A: SmallSat Express** mission, the largest single rideshare mission from a U.S.-based launch vehicle to date.

The company successfully launched 64 spacecraft to Sun-Synchronous Low Earth Orbit via a **SpaceX** Falcon 9 that launched from Vandenberg Air Force Base on December 3, 2018.

"This was an incredibly complex mission, and I'm extremely proud of what our talented team at Spaceflight has achieved," said **Curt Blake**, President of Spaceflight. "SSO-A is a major milestone for Spaceflight and the industry. We've always been committed to making space more accessible through rideshare. This mission enabled 34 organizations from 17 different countries to place spacecraft on orbit. It's also special because it was completely dedicated to smallsats."

Spaceflight launched 15 microsats and 49 cubesats from government and commercial entities that included universities, startups, and even a middle school. The smallsat payloads varied, from technology demonstrations and imaging satellites to educational research endeavors.

One research payload includes the **University of North Carolina Wilmington's** smallsat, **SeaHawk-1**, carrying the **HawkEye Ocean Color Imager**. UNCW has been funded by the **Gordon and Betty Moore Foundation**, and **NASA** serves in an advisory capacity to ensure the maximum scientific utility of the science data.



Artistic rendition of UNCW's SeaHawk-1 smallsat.

NASA's **Science Mission Directorate** and UNCW have created a partnership to expand accessibility to the data.

"We are thrilled to have SeaHawk-1 on orbit and to be part of such a historic launch superbly executed by Spaceflight," said Professor **John Morrison**, SeaHawk's co-project manager and lead principal investigator. "SeaHawk will make ocean observations at significantly higher spatial resolution and at much lower costs than standard satellite systems. Since the data collected will be publicly available, our hope is that it will benefit not only researchers, but policymakers and others to make informed decisions when addressing issues related to the environment."

Aperture Radar technology."

With the success of SSO-A, Spaceflight has now launched more than 210 satellites since the firm's founding in 2011.

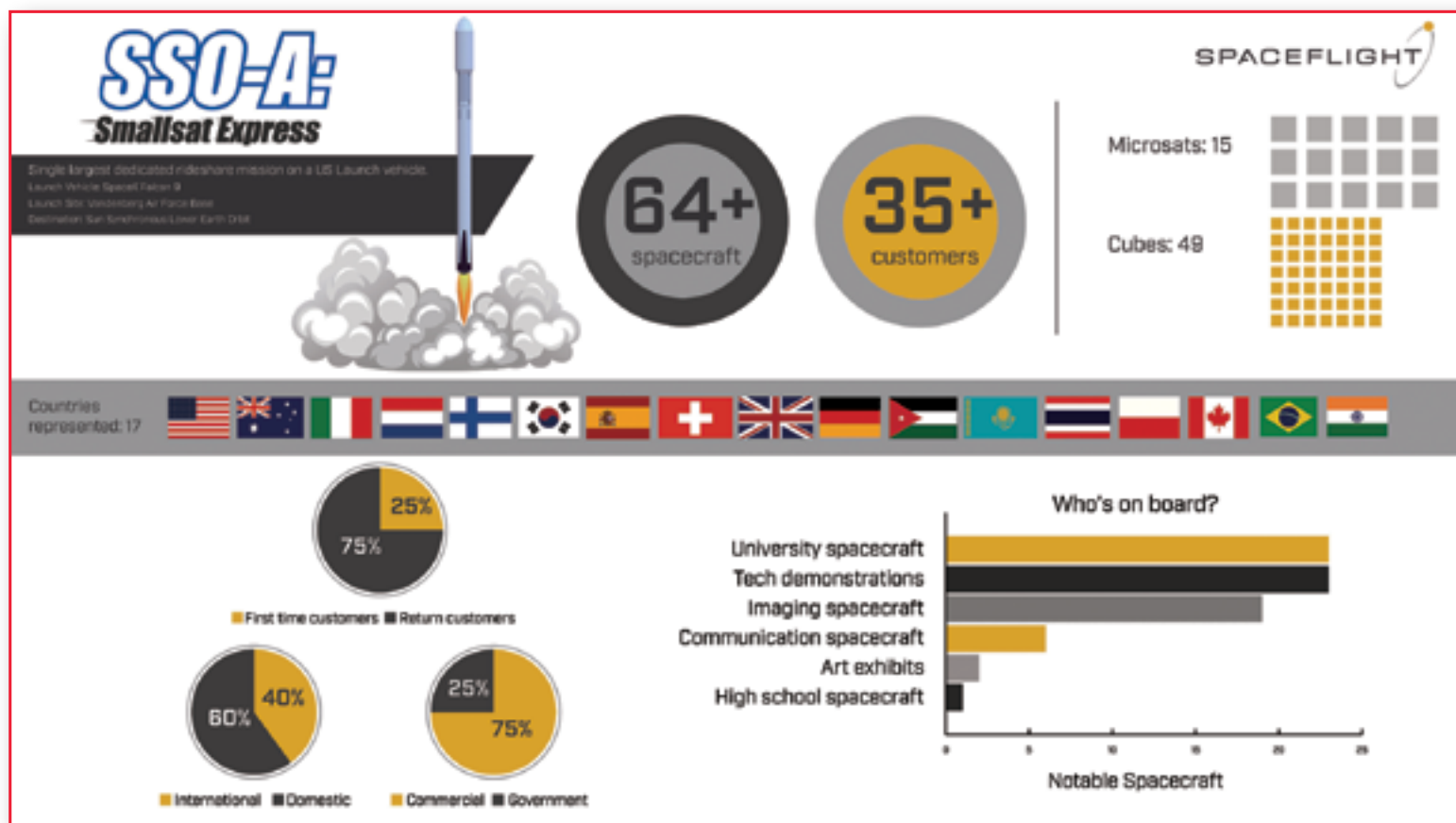
In addition, the company is contracted to launch nearly 100 satellites during 2019.

Among the upcoming launches is Spaceflight's next dedicated rideshare mission, which will occur in 2019 aboard a **Rocket Lab Electron** rocket.

To accommodate the large number of payloads, Spaceflight built an integrated payload stack that was nearly 20 feet tall. Once the launch vehicle reached orbit, the upper and lower free flyers separated from the vehicle.

The free flyers then successfully deployed all spacecraft, dispensing one payload every five minutes over five hours.

"This launch was an impressive undertaking and an important milestone for the smallsat industry as well as for many of the organizations involved," said **Payam Banazadeh**, founder and CEO of Capella Space Corporation. "Capella's first satellite is now on orbit and we are one step closer to our goal of providing timely, reliable, and frequent information using Synthetic



InfoBeam

Kepler's on the CASE with their second smallsat launch via the ISRO's PSLV-C43 rocket

Kepler Communications successfully launched their second, wideband satellite to LEO on the Indian Space Research Organization (ISRO) Indian Polar Satellite Launch Vehicle (PSLV) C43 mission that lifted off from the Satish Dhawan Space Centre in Sriharikota, India.

Lift-off of PSLV-C43 — HysIS Launch, with Kepler's CASE smallsat aboard.

Kepler's latest satellite within the company's network will be used to deliver service to early customers.

The first satellite was launched in January 2018. Both satellites carry a Ku-band payload onboard that is used for wideband connectivity.

The third satellite will launch in 2019 and will provide narrowband connectivity for the Internet of Things (IoT) devices.

The lessons learned from almost a year of operating the first satellite were incorporated into the development of the second to improve the reliability. Kepler has already demonstrated a capability to deliver upwards of 40 Mbps to 60 cm. diameter VSAT and more than 300 Mbps to Kepler's 3.4m gateway in Inuvik, Canada.

Kepler also became the first company to use a wideband LEO satellite to acquire, track, and communicate with an electronically-steered antenna when Kepler and **Phasor** performed their collaborative demonstration.

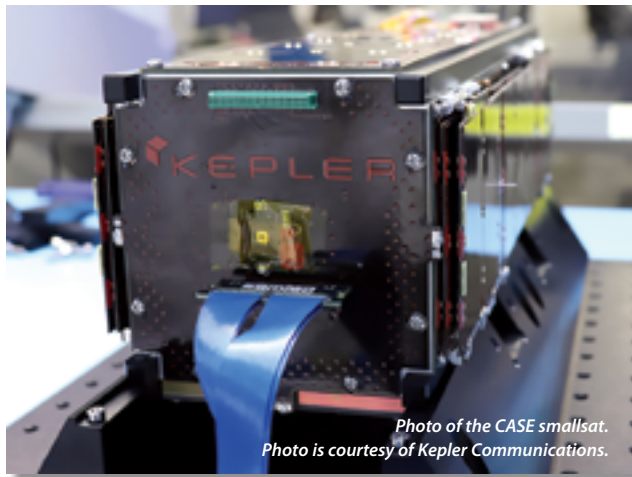


Photo of the CASE smallsat.
Photo is courtesy of Kepler Communications.

As Kepler builds out the capabilities on their satellite infrastructure, the company is also adding capacity on their ground segment.

In addition to their gateway deployed in Inuvik, Canada, Kepler has also recently deployed ground stations on Svalbard and in New Zealand.

As new ground stations and gateways are added, Kepler is able to increase the reliability of their communication service and decrease the latency of customer data delivery.

CASE was built in collaboration with **ÅAC Clyde** and **Bright Ascension Ltd.** The satellite payload is Kepler's proprietary software defined radio and antenna that uses Enclustra and AHA (of Comtech EF) components.

The Kepler ground support network was built in collaboration with **Comtech EF Data**, Kongsberg Satellite Services and **Innovative Solutions in Space**.

The satellite was launched by **Antrix Corporation Ltd.**, a wholly owned Government of India company, with the support of ISED, Canada for licensing.

Kepler's ultimate goal is to deliver in-space connectivity to address the data need from space faring assets, and support the future space economy. However, Kepler's network currently focuses on delivering wideband and narrowband connectivity.

With this launch on the back of receiving FCC market access authorization and the announcement of Kepler's 16M USD Series A round of financing, the company is well poised to take a leadership role in LEO communications.

Mina Mitry, CEO of Kepler, said this is an exciting month for Kepler. Following the company's recent FCC approval, the successful launch of the firm's next satellite marks an important milestone for the team to deliver Kepler's network on schedule. This is but the start of an upcoming and regular launch cadence. The company continues to increase network capacity and deliver a more persistent, reliable, service to our customers every step a long the way.

www.kepler.space



Surrey Satellite Technology Ltd. (SSTL) has launched their **KazSTSAT**, a small Earth Observation (EO) satellite jointly developed by SSTL and JV Ghalam LLP, a joint venture between JSC "National Company Kazakhstan Garysh Sapary" (KGS) and Airbus Defence and Space.

The satellite was launched into a 575 km. Sun-Synchronous Orbit on board a **SpaceX Falcon 9** from Vandenberg Air Base on December 3, 2018.



KazSTSAT with Ghalam-SSTL launch team.
Photo is courtesy of Spaceflight.

Sarah Parker, Managing Director of SSTL said "I am pleased to confirm that following separation from the launch vehicle a joint commissioning team here in Guildford have successfully made contact with KazSTSAT and established that all initial systems checks are nominal. I would like to congratulate our customer Ghalam on their new Earth Observation satellite and look forward to seeing the first mission results from the spacecraft soon."

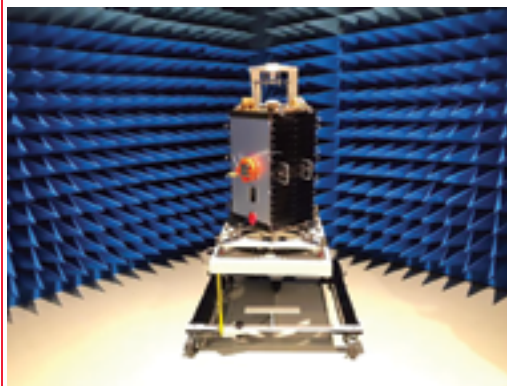
"It is a great event for us, this is the first mission in which the Ghalam team participated rather than being involved in its design, assembly and testing, and which also has a number of Kazakh technologies on board. We are very pleased with our partnership with SSTL and are grateful to our British partners for invaluable experience our team got in a truly collaborative environment," said Ghalam CEO, **Aibergen Ruslanuly**.

KazSTSAT has a mass of 105kg and will acquire image data at 18.7 m GSD with a swath width of 275 km. The spacecraft carries several experimental and demonstration units, including a beyond diffraction limit imager, a sun sensor, and a novel OBCARM. KazSTSAT will be operated by Ghalam, using a fully virtualized ground segment with S/X-band software defined backends deployed at KSAT ground stations in Svalbard and a technology demonstration ground station in Astana.

KazSTSAT is the second satellite SSTL has worked on with Kazakhstan; KazEOSat-2, a medium resolution satellite designed and manufactured by SSTL for KGS, was launched in 2014.



KazSTSAT during assembly at SSTL.
Photo is courtesy of SSTL.



The ESEO satellite in the anechoic chamber at the ESTEC test facilities, in the Netherlands.
Image is courtesy of AMSAT-UK.

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, December 3, 2018 by the **SpaceX Falcon 9** rocket from Vandenberg Air Force Base in California, USA, as one of **Spaceflight's SSO-A** mission payloads.

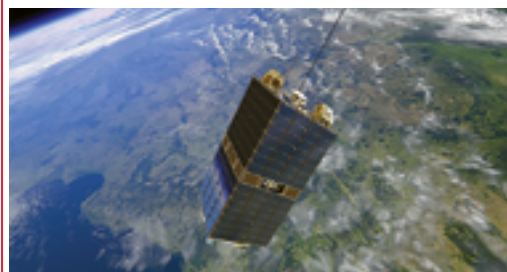
ESEO is part of a **European Space Agency** project that aims to prepare the European space workforce of tomorrow — with **University of Surrey** students getting the kind of hands-on, real life space engineering experience — through access to the Surrey Space Centre — that students elsewhere simply cannot receive.

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.

This mission is already part of history as it was the first time a rocket, the **Space X Falcon 9**, has been used on three launch missions.

Dr. Chris Bridges, project lead and Senior Lecturer in On-Board Data Handling at the University of Surrey, said that at the Surrey Space Centre, all 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, their skills are honed on real industrial missions.



RUAG Space has just passed a review for a very large part of what will become the **Payload Fairing** for ULA's Atlas V-500 at their factory in the U.S. furthering the company's focus on market growth in the U.S. This is the company's first piece of hardware that has been constructed in the U.S. The process involved many participants, and understandably, it is critical to pass every test to ensure safe transport into space.

A Manufacturing Readiness Review (MRR) is a formal examination of a program to determine if the design is ready for production and if the producer has accomplished adequate production planning. MRR topics presented included infrastructure, quality, safety, and all related aspects.

The MRR was conducted from November 6-8 in RUAG's facility in Decatur — which is a part of ULA's rocket factory — and approval of readiness to perform the bonding processes of the first U.S.-made United Launch Alliance (ULA) Atlas V-500 payload fairing. Participants included ULA, the U.S. Air Force, NASA, the **Aerospace Corporation** and RUAG Space were all in attendance.

Mike Morningstar, President and Country Manager for RUAG Space USA, Inc. said that this milestone emphasized his company's commitment and focus on market growth within the United States.

RUAG Space in Decatur began production of Payload Fairing flight hardware on November 26. Previous production deliveries from this facility were 5, 400-ISAs (Interstage Adapters for the 400 series of the Atlas V) built partially in Switzerland and the U.S., which were all successfully delivered on time.

The second half of the MRR process will occur tentatively in mid-February, 2019. The first full payload fairing is set to be complete in the fourth quarter of 2019, to support a launch in 2020.

The RUAG Space Atlas V-500 fairing is made with composite technology based on aluminum honeycomb cores with carbon fiber reinforced plastic face sheets. It uses a state-of-the-art process — called Out-of-Autoclave — that cures the structure in one piece in an industrial oven. A demonstration test fairing was completed through the bonding processes earlier this year. The demonstration test fairing went through the complicated production process seamlessly, leveraging the latest automation technology, and went through significant testing and inspection.

RUAG Space payload fairings come in flexible measurements to fit the respective launcher. For an Atlas V-500, the fairings have a diameter of 5.4 meters (17.72 feet) and have a height of up to 26.5 meters (87 feet). Payload fairings are designed to protect the launcher's payload on its way into orbit, from outside temperature and pressure during the launch.

RUAG Space has been supplying Atlas V-500 fairings, built in Switzerland, to ULA for more than a decade.



A Euroconsult Analysis: 2018 = Adaptation

by Dimitri Buchs, Senior Consultant



During 2018, a confluence of market and technology forces created turbulence in the satellite industry.

On the technology side, the space sector is pushing for substantially more productive satellite infrastructure and ground segment at a lower cost. The introduction of HTS systems is resulting in significantly more satellite capacity and higher bandwidth for end users at a reduced cost per bit with this trend expected to intensify in coming years.

On the market side, the satellite industry is increasingly embracing the changes to the ICT sector, with requirements of broadband connectivity “anywhere, anytime” opening new markets, while challenging its legacy businesses. This is obliging satellite operators to reposition their investments toward new growth segments, with the satellite market progressively shifting from video to become increasingly data centric.

As HTS systems are best positioned to address the majority of telecom demand, HTS capacity revenues are projected to progressively grow and surpass regular FSS capacity revenues within a few years.

The turbulence mentioned above is having an impact on players across the value chain both upstream (manufacturing and launchers) and downstream (operators and service providers).

On the upstream side of the value chain, uncertainties are pushing satellite operators to limit or delay orders of satellites. This can notably be seen with the number of GEO commercial satellites ordered in 2018. As of November 2018, eight GEO comsats had been ordered since the start of the year. This follows the low point of 2017, when seven satellites were ordered (lowest total in the past 15 years (see Figure 1 below) and indicates there is a change in strategy for commercial FSS operators. Future orders will be increasingly dependent on replacement rates and the competition from NGSO constellations.

Innovation and flexibility are two of the key words in the industry in 2018 to optimize CAPEX and mitigate uncertainties. Innovations are changing the economics of the industry in several ways, with this truer than ever in 2018. This is confirmed by the fact that HTS flexible comsat payloads have become an economic imperative for satellite operators looking for improved efficiency.

The industry is also increasingly privileging the use of **Electric Orbit Raising (EOR)** which results in lower launch costs. Also worth highlighting is that market uncertainties are boosting the interest of SATCOM operators for **In-Orbit Servicing**

(IOS). Through IOS satellites, operators are seeking to optimize investment and risks. Three customers have contracted IOS, including **Intelsat** and **SES**. The first demonstration mission is scheduled for 2020.

The future of the GEO comsat market was itself in question during 2018 (size of satellites, life time, servicing) and manufacturers were forced to adapt and diversify from GEO for their business to remain relevant. Manufacturers are increasingly implementing strategies targeting cost reduction and production efficiencies to adapt to customer requirements in terms of price and time delivery. Centralization of production, standardization across product lines and new manufacturing processes have been adopted by most manufacturers.

The focus in 2018 for manufacturers has also increasingly shifted toward building smallsats in a viable economic model and adapting their complex manufacturing capabilities into very rapid and simplified systems. This was confirmed by **Maxar Technologies**, which mentioned in the summer of 2018 that it was considering divesting or shutting down its geostationary manufacturing line as a result of an order drought.

In parallel, Maxar announced in July 2018 that it was setting up a new organization focused solely on smallsats. With the changes in the industry, the smallsats market is going through significant expansion in terms of capabilities and demand. After 201, which was a record year in terms of smallsats launched (330), the market is not expected to slow down much in 2018, with approximately 300 smallsats to be launched by the close of the year.

On the downstream side of the satellite value chain, the impact of the market and technology forces mentioned above on the SATCOM industry was particularly visible in 2018 with several indicators including:

- In 2018, combined GEO HTS and NGSO supply surpasses 1 Tbps outside the U.S., with global supply reaching more than 2.5 Tbps on a global basis, bringing the satellite communication industry in its terabit era as part of a broader telecommunication market that stands in its exabyte era. This situation, and the close to global coverage offered by several HTS satellite fleets (e.g. Intelsat EPIC constellation, SES through SES-14, SES-15 and O3b extension) gives room to the rollout of new generation connectivity services

- Overall, Euroconsult expects the total HTS capacity leased or used as part of vertically integrated services should stand over 750 Gbps in 2018 and increase to more than 1 Tbps by 2019. While capacity requirements in North America still represents a majority of that traffic, the other world regions should represent around 4 percent of the total demand in 2018, as a result of the larger availability of HTS capacity and of the take-up in capacity leases

- Satellite capacity is increasingly becoming a commodity product, resulting in rapidly falling capacity ARPU (Average Revenue Per Unit) globally. The arrival of HTS capacity, and overall of larger supply, has set new price references in the different segments and geographies. In parallel, the increasing maturity of certain services including TV broadcasting have made customers more cost sensitive and eager to optimize their transmission costs. One of the consequences is the structural move of many operators and organizations to more integrated services. A growing number of satellite operators (e.g., SES) are transitioning from wholesale bandwidth suppliers to managed service providers to increase the value added and avoid the commodity price trap.



• *The transformation of the satellite industry and necessary growing pains is expected to result in a decline in the wholesale market revenue in 2018 (net of the impact of some changes in reporting principles and exchange rate variations) despite a likely sustained increase in revenues from HTS capacity.*

• *New preparation milestones were reached in 2018 in regard to the larger availability of GEO VHTS platforms and the deployment of several "Terabit" NGSO constellations. In Europe, the signed agreement between Eutelsat, Orange and Thales for the Konnect VHTS program is evidence of this trend. Considering NGSO constellations, some progress was made in 2018 in terms of financing and regulatory achievements; however, there remains a great number of uncertainties for 2019.*

On the service provision side, 2018 was the year of satellite connectivity. Mobility services in particular were dynamic during the course of the year. Leading service providers started to leverage the commitments they had made for multiple Gbps.

As an example, **Gogo** started to use **SES-14** capacity on 200 aircraft as soon as the HTS payload became operational. To a larger extent, all the aero IFC service providers have released new generations of their services, such as **2Ku** for Gogo or **XTS** for **Panasonic Avionics** that will take advantage of the HTS satellites recently or currently deployed.

An identical pattern was observed in the maritime sector, with an even larger diversity in the requirements from the largest cruise ships that are now targeting hundreds of Mbps to the various types of merchant ships, support vessels and others.

Outside of mobility services, a set of contracts and network deployments were disclosed in 2018 by different operators and service companies for cellular backhaul and, to a larger extent, broadband access.

In advanced communication markets, the rollout of extended networks by **Sprint** and **T-Mobile** in the U.S. reveal how new solutions can contribute to the geographical extension in mobile coverage in order to follow mobile subscribers and offer a seamless 4G experience across territories.

In emerging countries, a combination of initiatives is being observed, from the WiFi community approach developed by **Viasat** in Mexico to government programs, and the extension of cellular networks to remote sites aiming at bringing services to the local populations (e.g., expansion of capacity commitment by **Vodacom** in Africa).

In parallel, a lack of dynamism was once again observed for TV broadcasting services during 2018, leading to an expected decrease in capacity revenues and limited growth in capacity usage. This is notably due to the limited number of new services launched and the progressive end of SD/HD simulcasts in a growing number of countries that include the U.S. and South Korea.

Simultaneously, the number of satellite subscribers should continue to decrease in mature markets in 2018 as households increasingly cut the cord to privilege OTT services. The U.S. is expected to be the most affected. During Q3 of 2018, the country's two DTH platforms lost a combined 726,000 subscribers.

For 2019, Euroconsult expects to witness some uncertainty in the SATCOM industry as market players continue to adapt their strategy to the deep changes that have impacted the market in recent years.

The improved value proposition of satellite connectivity, driven by the fast-increasing digitization of the ecosystem, should meet with the requirements of a larger customer base, enabling the rollout of new communication services. This, however, will not necessarily mean that SATCOM revenues will grow in 2019.

With the time for the new business opportunities to overcome the impact on legacy infrastructure, a progressive improvement is anticipated over the next two years before a more solid phase of revenue growth can occur.

euroconsult-ec.com

Dimitri Buchs is a Senior Consultant of Euroconsult, based in Montreal, Canada. He specializes in the digital broadcasting sector. Since joining the firm in 2007, Dimitri has worked on over 30 consulting missions. His expertise lies in analyzing market dynamics for video distribution and contribution services, regularly contributing to consulting projects and due diligence studies for satellite operators, service providers and equipment manufacturers where video broadcast is an essential part of the assessment.

The Forrester Report: Will Happy Days Be Here Again?

By Chris Forrester, Senior Contributor

The end of October saw the industry's 'big three' operators — Intelsat, SES and Eutelsat — unveil their latest quarterly results. They were not good. At best, the trio admitted that revenues would be flat, with each of them announcing falling Video/Media division revenues.

The only bright spot shared by all three were their 'Governmental' revenues, but it is fair to say those government increases are only recovering from the depressed 'sequestration' period which ended — more or less — a year ago.

The hard facts (in percentage)

	Overall Quarter's revenues	Video/Media	Gov't
Intelsat	-5%	-2%	+7%
SES	+3.2%	-5.2%	+10.8%
Eutelsat	-2.7%	-1.7%	+4.2%

However, and despite a few share price hiccups, optimism for their future trading during 2019 remains high from each of the three players and that optimism is hugely helped by the prospects of massive windfalls from the reassigning of C-band spectrum in the US.

Indeed, the potential rewards that could flow into each of three (plus Telesat of Canada) are so meaningful that the market has already started building in significant extra values to the share prices of all of those operators involved. One equity analyst said that the market was looking at the C-band prospects with "blinkers on" in regard to the underlying trading prospects.

Intelsat, SES, Eutelsat and Telesat have formed the **C-Band Alliance (CBA)** and have agreed to expand their original offering of 100 to 200 MHz of their capacity to help push 5G's speedy roll-out. October witnessed the CBA stress that a market-based approach represented the fastest way to repurpose C-band over the U.S., essential if a commercially sensible approach is needed to free up bandwidth for 5G telephony.



"The Market-Based Approach will minimize the need for Commission intervention and complex and lengthy oversight. Extensive FCC oversight of a Transition Facilitator will prove unnecessary and likely delay deployment of 5G service in the C-band Downlink," said the CBA.

Intelsat's C-band revenue prospects



Date: Intelsat/October 2018

Data chart is courtesy of NSR.

The phrase 'market-based approach' is another way of saying 'let us sell our spectrum ourselves.' The alternative is for the FCC to become involved themselves which, the CBA argues, would lead to "prescriptive mandates," which would be unnecessary, long-winded and likely to involve an army of lawyers.

The CBA, in a truly impressive 152 page document, stated, "The Commission should reject alternative transition mechanisms, including overlay auctions and variations on the incentive auction, which are slower, less efficient, and pose implementation challenges that the Market-Based Approach avoids. These alternatives require far more heavy-handed government intervention and would likely be tied up in litigation for years to come."

The CBA scheme has fresh support from chip-set giant **Intel**, the **IT Innovation Foundation**, the **World Teleport Association** and **GCI Corp**. The responses and comments from other interested parties were due to the FCC are due no later than November 27.

Intelsat's CEO **Stephen Spengler** told analysts during the firm's Q3 conference call that the CBA's plan to free up C-band capacity for the USA's speedy adoption of 5G would be limited to 200 MHz (made up of 180 MHz plus guard bands) and that this bandwidth was the highest slice of spectrum likely to be available in the short-to-medium term (see the chart in the adjacent column).



Spengler said that 200 MHz was the maximum available to be cleared in the target 18-36 month time-frame.

SES President and CEO Steve Collar had expressed the same view during his report to the market.

Intelsat says that neither they — or other members of the CBA — had done any work above the 200 MHz target and that freeing up additional spectrum would require a greater depth of technical development and, possibly, new satellites. As if to emphasize that point, anything above 200 MHz is **not** on the CBA's agenda, at least not for now.

Spengler specifically referred to the C-band restructuring and said, "The Comment Phase of the U.S. Federal Communications Commission C-band proceeding ended [Oct 29] a major milestone as we continue to advance our proposal. The formation of the C-Band Alliance, announced [in October], demonstrates that the continental US C-band satellite operators are in full agreement on the technical and operational steps necessary to clear 200 MHz of spectrum over the course of the next 18 to 36 months. We will continue to advocate for our breakthrough, market-based approach that is the best path to protecting incumbents while repurposing spectrum that will accelerate 5G deployment and innovation in the U.S."

Steve Collar of SES said much the same... "We continue to make strong progress with our C-band initiative in the US, aligning our proposal with the leading continental U.S. satellite services operators, founding the C-band Alliance (CBA) and hiring experienced U.S. executives to run the consortium. In comments to the FCC's NPRM due [in October] the CBA will confirm on behalf of its members that up to 200 MHz of mid-band spectrum could be cleared to support 5G wireless deployment nationwide in the U.S. while protecting the important broadcast and other communities that we serve today. I am increasingly persuaded that our market-based proposal is the best way to facilitate a leading position for the US in 5G and is the only way to repurpose spectrum in a timeframe consistent with the stated goals of the FCC."



The CBA's submission to the FCC, naturally, was ultra-polite, although stated that the FCC should "avoid prescriptive mandates" and that "The Commission should reject alternative transition mechanisms, including overlay auctions and variations on the incentive auction, which are slower, less efficient, and pose implementation challenges that the Market-Based Approach avoids. These alternatives require far more heavy-handed government intervention and would likely be tied up in litigation for years to come."

That warning — about the lawyers — is valid. Not only would legal arguments extend the project into the wild blue yonder, but such would also scupper the current valuations for satellite operators.

Intelsat said the company's costs to restructure their U.S. C-band spectrum, complete with filters and site visits to more than 16,500 dish installations, will cost as much as \$2 billion. Take the other operators into the equation and the overall costs will be significant. Add in the procurement of a few extra satellites to replace the 'lost' capacity and the overall bill starts looking quite expensive. SES estimates that there could be 30,000 C-band users in the U.S. — the American Cable Association, earlier in 2018, guesstimated that 90 percent of the organization's member 'receive only' Earth stations were unregistered.

At 40c per MHz/pop: Value per share

Intelsat	\$65.6
SES	€17.0
Eutelsat	€3.7

At 50c per MHz/pop: Value per share

Intelsat	\$83.0
SES	€21.5
Eutelsat	€4.7

Data: Jefferies, October 2018

Intelsat confirmed that clearing 200 MHz will, indeed, require the procurement of multiple satellites — the exact number has not been confirmed, but there are now RFP's that have been delivered to satellite manufacturers — in a discussion of the publicly mooted clearing cost figure of \$1 to \$2 billion, Intelsat management steered expectations toward "the higher end of that range." The CBA will be watching closely how 5G standards evolve to ensure that the spectrum blocks and interference measures are optimally configured; management are pleased with the FCC's (Notice of Proposed Rule Making) NPRM comments filed so far.

Spengler told analysts, "We have been very clear with our customers that we will make sure this is as painless and least disruptive as possible. We will provide compensation to them for the costs they incur to make sure this is not a financial burden to them."

Sami Kassab, an equity analyst at investment bank **Exane/BNPP**, in a note to investors on Oct 30, said, "Importantly, the National Association of Broadcasters also uses supportive language, in our view, as it objects to frequency co-sharing. Overall, we consider these comments as supportive. We also note that only 16,500 C-band Earth stations have registered to the FCC. Our current clearing costs assumed satellites would need to install filters on 33,000 C-band earth stations. This suggests repacking costs could be lower than our \$1.9 billion forecast and reach around 1.1 to 1.2 billion euros. This, in turn, could add around 0.5 euros per SES share of C-band spectrum value."

Giles Thorne, equity analyst at investment bank Jefferies, said, "In a tour-de-force 152-page submission, the CBA gives its most robust account to date. Tacked on to the well-aid merits of the CBA's proposal (fastest clearing of band, protecting incumbent users, creation of de facto transition facilitator thus rendering FCC oversight unnecessary) was a statement that the proposal was 'fully consistent' with the law and the Commission's statutory authority and would avoid 'anti-competitive outcomes'. Elsewhere, we note that the CBA has now come out more forthrightly on a wider range of associated regulatory proposals (don't over-burden the operators of the 16,500 C-band downlink Earth stations, rejection of point-to-multipoint co-existence in the downlink band)."

Thorne continued, "But for us, the most important comment appeared at the close - the CBA calls on the FCC to 'reject alternative transition mechanisms' such as overlay auctions or derivations of the successful 600 MHz incentive auction - this is the nexus of the C-band thesis as it is the transition mechanism where the FCC's desire to protect competition, the Executive's desire to raise funds, the MNO's desire to secure value-accretive spectrum and the CBA's desire to secure a windfall meet. The battle lines are drawn, the CBA must now hold its ground."

The FCC recognizes that the time for 5G investment is now. The prospects of maybe three million extra jobs is a tempting benefit. The additional benefits to the CBA members are obvious: a speedy freeing up of their 200 MHz as well as revenue valuations at anything between 40c-\$1 per MHz pop would dramatically reduce Intelsat's current \$14 billion debt burden and more or less wipe out SES borrowings. Eutelsat and Telesat would each receive a useful bonus windfall for their spectrum.

Then there's the real prospects down the line of a further 50 to 100 MHz which might be released and the impact from outside the USA to other countries where a readjustment of C-band might be beneficial.

A well-regarded industry name said that the re-allocation of satellite C-band frequencies for 5G could well be extended to other nations, according to analysis by **J. Armand Musey** of **Summit Ridge Capital**.



Musey explained the rationale in a highly detailed and compressive study in Summit Ridge's **2018 Spectrum Handbook** that was issued in October. Musey points out that global mobile data traffic, and thus spectrum demand, is growing at an explosive rate (63 percent up in 2016, and by a similar amount in 2017).

Video downloading represented 69 percent of consumer Internet traffic in 2017. More than 78 percent of the world's mobile data traffic will be video by 2021, said Musey, leading to a crunch for operators. "Mobile is a big industry. Today, it supports over 4.7 million jobs and contributes around \$475 billion annually to the U.S. economy. One study suggests that mobile carriers in the U.S. will spend \$275 billion building 5G networks, creating three million new jobs and adding \$500 billion to the economy. Thus, the mobile industry, by adding the new three million jobs that are projected to be created, will approach five percent of the total U.S. job market."

"Other countries, such as the European Commission through the CEPT (European Conference of Postal & Telecommunications Administrations), Australia, and Japan, are looking at reallocating the C-band as the 'first primary band for 5G'. Methods of reallocating the spectrum from satellite to mobile use could include FCC-type auctions or an innovative alternative to allow satellite providers to voluntarily sell spectrum through a secondary market method using an independent third party 'Transition Facilitator' to manage the valuation of the satellite spectrum and the sale of licenses to mobile carriers."

Musey added, "The Transition Facilitator would be a cooperative entity with expert knowledge of satellite spectrum valuation and the satellite operators. It would be created by the relevant satellite operators to coordinate negotiations, clearing, and repacking the band. A Transition Facilitator would be more efficient and faster than an FCC auction and create a more coordinated market than satellite vendors selling on their own spectrum with the potential for holdouts creating gaps in the available spectrum. On the other hand, the satellite auction process could be directed by the FCC using an auction process similar to the Broadcast Incentive Auction process."

In other words, this particular C-band-wagon might keep rolling for some time.

Senior Contributing Editor Chris Forrester is a well-known broadcast journalist and industry consultant. He reports on all aspects of broadcasting with special emphasis on content and satellite broadcasting, the business of television as well as emerging applications and technologies. He founded Rapid TV News and has edited Interspace and its successor Inside Satellite TV since 1996. He also files for Advanced-Television.com. In November of 1998, he was appointed an Associate (professor) of the prestigious Adham Center for Television Journalism, part of the American University in Cairo (AUC), in recognition of his extensive coverage of the Arab media market.

Advantech Wireless Technologies

By Cristi Damian, Vice President, Business Development

Disruptive technologies and innovative network architectures dominated the SATCOM industry during 2018 and dramatically changed the methods by which SATCOM businesses plan and operate.



In the well-established GEO Satellite world, discussions today are more about 5G, IoT, and LEO/MEO constellations than about High Throughput Satellites (HTS) or the launching of another GEO satellite.

As a company that thrives on technological challenges, Advantech Wireless Technologies ("Advantech") was part of this massive industry shift. As history shows, companies that have the DNA to adapt and thrive in adversity are those that will lead the innovation and industry evolution in the future.

2018 started on a highly positive note for Advantech. In January, **Baylin Technologies** purchased the company. The Baylin Group includes **Galtronics**, a 40 year veteran in the wireless communications business specializing in advanced antenna design and a pioneer in 5G MIMO technology. Advantech itself brings 30 years of expertise in active RF MW design in cellular, terrestrial point to point microwave links as well as SATCOM and RADAR technologies. The synergies between the two companies are dynamic and strategically aligned.

Advantech has a successful history of listening to the firm's customers and collaborating with them to successfully solve their challenges. Due to increasingly sophisticated customer demands, technologies in the SATCOM industry today can quickly become outdated.

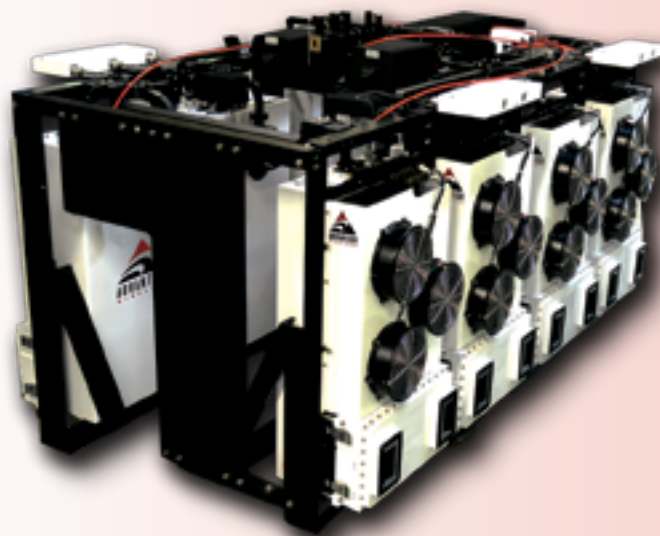
Only a few years ago a teleport operator or service provider could invest in a hardware solution and confidently know that it would safely last for 10 years or more. Today, this is not necessarily the reality. Fifteen years ago, data rate demand would range from a few kbps to 1 Mbps. Due to the introduction of HD video services, a single HD video channel — when compressed — would require as much as 7 Mbps. This demand required LTE cellular growth. Now, ultra HD 4K video requires an additional four times more bandwidth. Required data rates today range up to 30 Mbps. This demand brings challenges to older teleports, SNG trucks, and terrestrial wired IP networks.

Looking forward, 5G and IoT will require as much as 10 Gbps of aggregated data rates as well as low delay processing time for real time applications, such as autonomous vehicles. These technological advancements demand leading-edge solutions from service providers and satellite operators.

Higher data rates require higher bandwidth. Higher bandwidth means higher RF transmitted power and higher linearity. Improved data rates can also be achieved by using higher order modulation schemes, but these have a higher C/N ratio and therefore more RF power. This is where Advantech Wireless excels. In 2010, Advantech released a complete line of Gallium Nitride (GaN) based Solid State Power Amplifiers that addressed two separate markets:

- 1. The Mobility market, which required small and energy efficient but powerful SSPAs**
- 2. Large Teleports that required very high power SSPAs to efficiently support high bandwidth demand and high modulation.**

While hardly imaginable five years ago, installing SSPA technology with power levels of 6kW in large teleports has become the norm. These modular systems with built in redundancy provide 100 percent availability for critical video broadcasting events while drastically reducing OPEX at the teleport.



The initial investment in Advantech's **SapphireBlu™** GaN based technology is typically recovered in less than two years of electrical energy savings and overall operating costs because the system is capable of replacing tens of klystrons or traveling wave tubes (TWTs). The most critical advantage of the SapphireBlu GaN technology is the ability to support Ultra HD 4K 8K and higher order modulation rates such as 256 APSK.

In 2014, Advantech Wireless designed and built two teleports that were used for the first time to transmit major sporting events in Ultra HD. This was a milestone and an international achievement largely recognized in the industry.

The ability to design and manufacture SSPA technology that reduces OPEX and is future proofed against additional bandwidth increase demands puts Advantech Wireless in a commanding position. The company is currently actively involved globally in analyzing existing teleport architectures and providing consulting services for technology upgrades.

All teleports today struggle with high operating costs and reduced revenue due to customer migration to alternative technologies. Most of these teleports are using inefficient and often outdated RF technology.

As a major sign of market acceptance, in September of 2018, one of the largest worldwide video broadcasting companies installed a 3kW GaN based Ku-band system, capable of up linking more than 1 Gbps of Ultra HD video content.

The recognition of the company's state-of-the-art technology solutions and R&D innovations led several international customers to grant Advantech single source supplier status for all their RF needs. Successful organizations realize the benefit of reducing and consolidating their supplier chain while aligning their R&D road maps.

Advantech achieved an additional milestone in the summer of 2018. A 256 APSK link was achieved with just one 4.5 meter C-band antenna, equipped with only a 400W C-band SapphireBlu GaN technology. A remarkable efficiency of 8 bits per Hz was achieved with a much smaller EIRP (*Effective Isotropic Radiated Power*), which allowed the end user to employ only a portion only of the transponder, without taking the entire capacity from adjacent customers.

With 5G and IoT coming online, now data rates in excess of 1 Gbps will be economically feasible for a SATCOM Uplink. This solution was desperately needed by the teleport operators in order to remain relevant in the years to come.

In July of 2018, **Alga Microwave** ("Alga"), an RF and MW design and manufacturing company, also joined the Baylin Group. Alga Microwave brings unique expertise in SATCOM as well as the wireless and cellular market. Some of the world's largest cellular network manufacturers use Alga Microwave technology in their base stations, strategically positioned around advanced Microwave filters, combiners, and diplexers.

In December of 2018, Advantech will relocate with Alga to a new, state-of-the-art design and manufacturing facility to efficiently deliver one of the most ambitious R&D roadmaps in the industry. The future prospects for Advantech and the SATCOM Industry are extremely exciting.

advantechwireless.com

Mr. Cristi Damian joined Advantech Wireless in 1995 where he held various positions in Operations, Manufacturing, Sales, Engineering and Customer Support. Prior to Advantech Wireless, he acquired experience as a hardware engineer in various high-tech companies. Mr. Damian holds a Master's degree in Electrical Engineering from Concordia University.

ATLAS Space Operations, Inc.

By Sean McDaniel, Chief Executive Officer and Founder



2018 was a noteworthy year for ATLAS Space Operations™; having completed a Series-A round of investments, the company more than doubled in size to meet the demand for the firm's services — 2019 is projected to be an even bigger year for the company.

In 2018, ATLAS grew their Freedom™ Network of ground stations, bringing U.S. antenna locations in California, New Mexico, and Washington online as well as locations overseas in Ghana, Finland and New Zealand.

Most significant of these locations is the antenna array located in Albuquerque, New Mexico — **LINKS™**, the world's first commercially available, mobile, and rapidly deployable Electronically Steered Array (ESA).

This is one of the key pieces of game-changing technology that has earned ATLAS a spot as one of **Morgan Stanley's** top space-industry disruptors in 2017. Configured for either S- or X-band, LINKS™ is a unique antenna in that it breaks the one-to-one capability of legacy ground stations. LINKS is capable of simultaneously communicating with multiple spacecraft



Freedom does much more than provide clients full telemetry, tracking, command, and control capabilities; the software's advanced scheduling algorithm does all of the work for the user, making the entire process easier and faster as well as more cost-effective.

Gone are the days of needing a separate satellite modem for every antenna because Freedom requires only a single point of VPN access that integrates into the Freedom Network of global ground stations, making it far superior with ensuring data security.

However, the Freedom Platform and Network are only the framework of what the company set out to accomplish just three short years ago. With optical communications soon to be a necessity throughout the industry, ATLAS' engineers are already working on a game-changing optical communications solution.

Starting in 2019, ATLAS will install 30 additional ground nodes for the **Laser Light Communications HALO™ Network** as part of the joint venture between ATLAS, Xenosis and Laser Light Communications — the **Empower Space Alliance™**.

Empower is a turnkey, direct optical data distribution service for LEO, MEO, GEO, Cislunar as well as

deep space. As a result of the high capacity and low cost of optical data that Empower offers, future space missions will no longer be reliant on legacy radio frequency transmission and distribution — they'll be "empowered."

More information about ATLAS Space Operations, Inc. is available at www.atlasground.com.

Sean McDaniel is a serial entrepreneur and visionary innovator whose pedigree is steeped in success. He is the Founder and CEO of ATLAS Space Operations and he is also the President of Assured Space Access Technologies (ASAT). Sean first created the game changing space-to-ground communications company, ATLAS, as a subsidiary of ASAT, a company he put on the map as a prime contractor with defense contracts valued at more than \$150 million annually valued at more than \$150 million annually



ATLAS X-Band LINKS Array.

Currently, ATLAS is developing antennas for locations in Tahiti, Guam, Japan, and in Chile, as well as adding a ground station in Traverse City, Michigan — home to ATLAS' corporate headquarters.

The fully completed Freedom Ground Network of antenna will consist of no-less-than 30 ground stations, all strategically dispersed across the globe. The company will provide connectivity for a broad range of missions that include launch support, communications with spacecraft in equatorial or polar orbit, as well as spacecraft in deep space.

The other key-piece of game-changing technology for ATLAS is Freedom, ATLAS' cloud-based software platform that's aptly named because the offering breaks the antiquated norms of legacy software solutions.

AvL Technologies

By Krystal Dredge, Director of Marketing

2018 has been an adventure for the satellite communications industry. Unexpected mergers and acquisitions, innovative new products and services, and new growth markets – from the perspective of someone who watches the market closely, several happenings in 2018 caught us by surprise, but in a good way.

A few of AvL Technologies' high profile customers experienced dramatic transitions during 2018, including reorganizations and mergers. Though this is not uncommon with satellite businesses, this was not something the company expected key customers to experience this year.

Like it or not, consolidation and outsider investment will likely begin to happen more often as our industry innovates and grows and as companies from other industries find ways to enter satellite markets.

We also did not predict the growth at AvL that was achieved during 2018. Though the company annually forecasts revenues and units sold to better predict manufacturing volume and staffing needs, we dramatically under forecasted.

Yes, that is a good problem to have — AvL grew the Operations team by 25 staff members to maintain production schedules and the firm increased the Engineering team with several new additions in RF, product development and software engineering.

Demand for recently launched products was strong and growth was in military orders as well as for established products — growth also continued in the demand for customized products.

In 2016, AvL opened a new building, which was developed to be used as a technology incubator, a regional office for a key customer and as expansion space for the company. As AvL has continued to grow at a breakneck pace, the company has gradually started taking over this 60,000 square foot facility.

In 2018, AvL's electronics assembly, large reflector manufacturing, and large antenna assembly moved into the new building and the teams working on these products appreciate the high ceilings, natural light and state-of-the-art power systems.

New Products

AvL launched the development effort for several new products during 2018, with the highlights being **DarkWing™** and a 2.0 meter, ultra lightweight antenna. The company was also successful in transitioning a number of customers and legacy AvL antenna programs to a new auto-acquisition controller based on the firm's powerful AAQ platform.

DarkWing is AvL's foray into flat panel satellite communications terminals. In collaboration with **L3 GCS**, the new DarkWing terminal will be designed to meet customer objectives for a lightweight, small, rugged and portable system that

provides high-speed data communications for Internet, VPN connectivity and video transmission.

The Ka-band terminal will offer global coverage, is small enough to fit in a backpack and, in most cases, can be mission-ready in minutes. It's intended to be easy to operate, high performing, rugged and robust — and will be about the size of a laptop. AvL anticipates this product to be a key resource for many customers.

AvL's new 2.0 meter antenna will feature a segmented axi-symmetric carbon fiber reflector and a "space frame" base and positioner, making it ultra-lightweight. The easy-to-

point manual operation antenna will feature an RF package with a 55W Ku-band BUC located behind the hub, which makes it highly configurable.

The antenna can be assembled and on-network in less than 25 minutes and it packs into two checkable transit cases with each weighing 90 lbs. The AvL 2.0 meter ultra-lightweight flyaway antenna will be the most compact 2.0 meter antenna on the market and offers performance specifications comparable to competing 2.4 meter lightweight antennas with small pack-up.

The new AvL **AAQ** controller platform has gained rapid acceptance in the industry and is now the controller of choice for many commercial and military antennas produced by AvL. The controller comes equipped with a web-based plug-and-play graphical user interface (GUI).

The GUI can be expanded to provide terminal monitor and control (M&C) capability for various modems as well as an array of commercially available RF components. The latest version of software can support highly-inclined GEO satellite tracking and also uses a powerful new, standard, on-board AvL Receiver as well as a number of standard beacon tracking receivers.

Strong Demand for Established Products

AvL customer **SES** continued to see robust orders for its O3b network transportable terminals featuring AvL antennas. Most of this demand was from the U.S. military for 85 cm., 1.2 meter and 2.4 meter MEO tracking antennas.

These transportable, rapidly-deployable, tactical terminals feature a geared drive for continuous operation. The antennas operate in same size tandem pairs with make-before-break communications, are easily transportable in durable transit cases and can be set-up and on-the-air within two hours.

AvL also introduced a new **Family of Integrated Terminals**, or FIT, two years ago and that was the company's entrance into customer-requested product integration and axi-symmetric antennas. Through 2018, demand for these user-configurable antennas soared for both commercial and government customers and we added additional features and capabilities in response to customer requests.

The ultra-compact, ultra-lightweight, ultra-high performance FIT terminals offer aperture sizes of 0.75 meters, 0.98 meters and 1.35 meters and are available with standard manual or upgraded motorized operation. The FITs are designed to accommodate current and future modem, RF and satellite frequency options, and pack into two IATA checkable cases.

Celebrating 25 Years

In 2019, AvL will celebrate its **25th anniversary**. The company has grown dramatically since its humble beginnings in **Jim Oliver's** garage in 1994 and the company is now 230 employees strong.

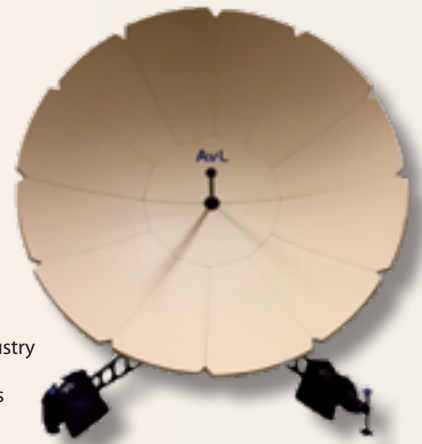
AvL Technologies has shipped nearly 30,000 antennas to customers across the globe and the company is proud to be the antenna provider of choice for military, government/civil services, SNG, Oil & Gas and other markets. In 25 years' time, AvL has transformed from a positioner company to an antenna innovator and trusted satellite communications collaborator for key customers.

Though AvL is proud to celebrate 25 years of business, the focus remains on the future. AvL's mission is to be the global leader in transportable satellite antenna design, production, delivery and support. The company's world-class engineering, manufacturing and customer service teams ensure the firm's antennas provide superior durability, dependability and performance.

Lives and livelihoods depend on the quality and reliability of AvL's transportable satellite communications equipment, and the company will continue to design, manufacture and support the best products in the industry.

www.avltech.com

Krystal Dredge is the Director of Marketing for AvL Technologies. Krystal has 15+ years of product marketing experience in satellite and wireless communications and, most recently, worked at Honeywell and EMS Defense & Space Systems prior to joining AvL in 2012.



Ball Aerospace

By Brad Tousley, VP and GM, Commercial Aerospace and Strategic Technology

From military leaders conducting operations across the globe to commuters streaming music on their way to work, the need for data and a reliable connection is ubiquitous.

The demand for data continues to grow — users want more data, received faster than ever before. Take the smartphone, for example. Many smartphone models now record and send massive 4K video files and users expect those transfers to happen in the blink of an eye. As technologies such as smartphones advance, more data is being generated and transmitted than ever experienced. One could say users are “gigahertz guzzlers.”

The problem is that current communications architecture, both satellite communications and ground, will not be able to support the speed, security and capacity needs of tomorrow. How those demands are met within the constraints of scarce radio frequency (RF) spectrum means bringing transformational communications technologies to market — and fast.

Ball Aerospace is developing two key technologies that are transforming communication architectures: optical communications terminals and inter-satellite links, and phased array antennas for SATCOM, in-flight connectivity and 5G.

Optical Communications

Free-space optical communication systems provide an innovative complement to traditional RF solutions, bringing the Internet speeds of terrestrial fiber optics to space. Using laser technology, optical communication systems offer a much narrower and more focused beam than traditional RF links, resulting in higher data rates, more capacity, greater security and smaller, lighter and more affordable terminals.

Satellite operators are looking to large LEO constellations and high throughput geosynchronous satellites to meet communications demands. Both systems require a new generation of high-capacity, high-performance data links. Free space optical communication links are a key enabling technology for these constellations.

This year, Ball Aerospace announced a collaboration with Honeywell to develop a line of affordable, high-performance optical communication terminals for the commercial market. Boasting a combined 60 years of experience in optical communications, Ball and Honeywell will work together to establish volume production of optical terminals for high-speed communications from ground to space, spacecraft to spacecraft and spacecraft to aircraft. Together, Ball and Honeywell will optimize volume production, enhancing technical designs for low-cost repeatability and leveraging a proven, robust supply chain. The team's proven capabilities in developing and manufacturing precision space-based optical systems will ensure that cost, volume and technical requirements of tomorrow's LEO and GEO communications satellites are met.

For customers who need data at the speed of light, optical communications technologies deliver. Ball's partnership with Honeywell is enabling this innovative technology area to expand into the commercial marketplace.

Phased Array Antennas

Another encouraging technology trend over the past year has been the development and recognition of the potential of commercial phased array antennas. Phased arrays deliver the critical 'last mile' connection, the gap between the data source and the end user. Wireless last mile solutions enable global network infrastructures and a whole new class of mobility applications.

Ball Aerospace has five decades of experience developing phased array antennas for the U.S. military, enabling mission-critical communications. Now, Ball is leveraging that expertise to transition phased array technology to commercial communications markets, including SATCOM and in-flight connectivity.

The benefits of phased arrays are numerous and exhibit why this technology area, though not new, has exciting commercial applications. Ball phased arrays are electronically steerable, with no moving parts, meaning customers enjoy higher reliability and lower maintenance costs. The fast, agile and accurate steering of electronically steered phased arrays enables quick and seamless tracking between satellites — key for today's in-flight connectivity and tomorrow's large LEO constellations.

The low profile of phased arrays reduces drag on mobile platforms, which is most notable on aeronautical platforms, reducing overall operating costs. Electronically scanned phased arrays provide a significant size and weight advantage over mechanically steered antennas. Much like many electronic devices today, these arrays are 'smart,' configured by software and aligned automatically, a major step up from parabolic dish antennas that require manual calibration and alignment. Ball is actively developing and selling modular, scalable antennas in the X-, Ku-, and Ka-band spectrums.

Phased array technology is enabling the future of 5G wireless, the next generation of wireless technology for the smartphone and smart device market. The 5G architectures of the future will use millimeter wave radio frequencies. Ball has a wealth of experience manufacturing phased arrays that transmit and receive data in millimeter wave radio frequencies, delivering the speed and data throughput of fiber optics without the price — a must in the 5G marketplace.

To demonstrate the capabilities of Ball's commercial 5G phased arrays, Ball is working with **Anokiwave** and recently enabled the world's first 5G commercially available 256-element phased array at 28GHz and 26GHz. The San Diego-based Anokiwave is a cutting-edge provider of highly-integrated circuit solutions that enable emerging mm-Wave markets and active antenna-based solutions.

While commercial phased array technologies are promising, their commercial viability depends on the ability to drive down costs by manufacturing at scale. Ball has already delivered phased array systems with all the key components to government markets. In 2018, our focus remained ramping production into high gear with designs that can be manufactured in high volumes — a key solution for LEO communications constellations.

Looking Ahead

For Ball Aerospace and the company's transformational communications technologies, 2018 was a banner year. What's next in 2019? More key tests to demonstrate the potential of the firm's technology are on the horizon and Ball Aerospace will continue to leverage industry partnerships to deliver the best products for our customers.

Cost continues to be a limiting factor in the viability of commercial communications constellations. Transforming an industry means manufacturing for scale. That's where Ball is translating our high volume commercial packaging heritage to quickly and efficiently deliver ground and space products directly to the customer for immediate use. In 2019, the company will continue our work to scale manufacturing for commercial needs.

In today's world, a company's success is directly related to its ability to connect with the people, technologies and markets that it depends on. As the need for data grows and the number of smart devices increases, customers staying connected depends on innovative adaptations for proven technologies like optical communications and phased arrays.

Ball is transforming the communications architecture, delivering reliable, high-speed, high-bandwidth connectivity — between satellites and to and from space. The company's innovative, high-bandwidth inter-satellite links and Earth-to-space links meet customer needs for data at the speed of light and connect the world faster and more securely. With low-cost phased array SATCOM antennas, innovative 5G Rapid Prototype Phased Arrays and advanced optical communications terminals, Ball Aerospace is helping the world meet today's data demand.

www.ball.com/aerospace

Brad Tousley is responsible for the company's strategic technology roadmap and investing in innovative technologies and capital that is aligned with the firm's customer needs and growth strategies. He brings more than 25 years of experience that spans government agencies, the private sector and the U.S. military. Prior to joining Ball, Brad led the Tactical Technology Office (TTO) at DARPA and was responsible for high-payoff/high-risk, efforts in space, air, maritime and ground systems, focused on capabilities for national security.



Boeing Space and Launch

By Dr. Bruce Chesley, Senior Director of Strategy

Boeing's customers for commercial and government satellites have made their needs clear: bring us flexible high-value solutions, and do it faster.

Given those mandates, Boeing has taken key strategic steps to bolster its space and satellites capabilities and reduce the time it takes to field them.

These customers are operating in market environments that are going through major changes of their own. The expected growth in new satellite applications supporting machine-to-machine communications and the Internet of Things (IoT) has them asking which new capabilities they will need to have on orbit.

The tantalizing possibilities associated with proposed new Low Earth Orbit (LEO) constellations are many, but questions persist: how many will be built, how long will they take and will they succeed? These uncertainties have, until recently, held most major commercial satellite operators back from buying more satellites to replenish their Geosynchronous Orbit (GEO) fleets, despite a great need to do so.

A similar pause in satellites acquisition on the government side also now seems to be ending, with new programs of record emerging that would acquire protected satellite communications capabilities and, for some, possible earth-to-space and inter-satellite laser links.

A number of recent investments are advancing Boeing's ability to provide such world-changing, mission critical satellite capabilities to customers in both of these markets.

In 2018 Boeing acquired El Segundo, California-based **Millennium Space Systems**, a leading provider of small satellite solutions. Boeing's **HorizonX Ventures** also made strategic investments in **BridgeSat Inc.**, a Denver-based optical communications solutions company, and in **Accion Systems Inc.**, a Boston-based startup pioneering scalable electric propulsion technology for space vehicles.

All three moves will give Boeing an infusion of valuable leading-edge technologies and talent:

- *Millennium's small refrigerator-sized satellites can pack multiple space mission solutions into a much smaller package that is more affordable and easier to launch. These Millennium platforms, and the company's expertise in avionics, structures, electronics and antennas, will complement Boeing capabilities and ultimately enhance our product offerings.*
- *BridgeSat has developed a global network of optical ground stations that will allow satellite networks to more securely and reliably transmit large amounts of data to and from space. By investing in companies with advanced optical communication technologies, we aim to accelerate space-qualified optical communication around the world.*
- *Accion's expertise in innovative space vehicle engine technology featuring non-toxic, ionic liquid propellant and dime-size thrusters will increase the lifespan and maneuverability of satellites and other vehicles in space. Accion's technology is smaller, lighter, and more cost-effective than traditional ion engines and can serve as an efficient way to keep constellations of satellites in orbit and propel spacecraft designed for interplanetary exploration.*

Clearly, Boeing sees that satellites — and technologies such as these that make them go — are an exciting and important part of its current and future space portfolio. It's a portfolio that already included advanced space and communications satellite systems for military, commercial and scientific uses, with advanced digital payloads, all-electric propulsion and 3D manufacturing capabilities for spacecraft that can operate in the LEO, MEO (Medium Earth Orbit) or GEO planes.

We are also expanding our product portfolio in support of human space exploration. The Boeing **Starliner CST-100** capsule will soon take astronauts and cargo to and from the International Space Station (which Boeing also operates).

Looking deeper into space, **NASA's Space Launch System** will provide a critical heavy-lift capability powering people and cargo to farther-off destinations such as the moon or Mars. Boeing is the prime contractor for the design, development, test and production of the SLS launch vehicle cryogenic stages, as well as development of the flight avionics suite.

Meanwhile, Boeing has been transforming its satellites manufacturing capabilities and evolving designs to allow faster development and testing of satellites whether they are built as one-offs or in multiples for entire constellations.

This latter group includes the seven MEO satellites that Boeing is building now for **SES Networks' O3b mPOWER system**. Boeing is developing cutting-edge technologies for mPOWER that will be incorporated into future spacecraft supporting a potentially wide range of programs and customer needs.

As the year drew to its close, Boeing shipped **WGS-10** to prepare for its upcoming launch. We also submitted a proposal for NASA's lunar orbital gateway.

Both designs drew heavily on advanced satellites capabilities, such as flexible digital payloads and solar electric propulsion. By coupling proven technology from Boeing's previous programs with next-generation technologies and processes, we will continue to offer innovative design solutions to meet customer needs.

Today, people around the world are excited about space exploration again. The many developmental efforts aimed at less expensive, easier access to space should lead to interesting new options for spacecraft owners and operators wanting to get payloads on-station or facilitate space tourism.

As Boeing moves ahead into 2019, although a lot of uncertainty remains, I know two things for certain. First, the next wave of content and data delivery systems will require satellites that are lighter, easier to maneuver and maintain, more capable and more affordable to develop, manufacture, launch and connect. And secondly, Boeing will continue to build the future of this satellites revolution and advance space-vehicle and satellite capabilities to generate value for all customers, accelerate space travel, and improve the lives of people around the world.

www.boeing.com

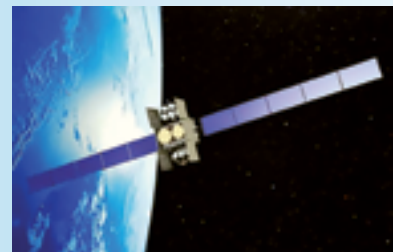
Dr. Bruce Chesley is Senior Director of Strategy for Boeing Space and Launch, where he leads a team charged with analyzing the marketplace, establishing a growth strategy and helping shape the future direction of the Boeing Space and Launch division, which includes the International Space Station; government and commercial satellite systems; and Boeing's work on its CST-100 Starliner Crew Capsule and the NASA Space Launch System.

Chesley joined Boeing in 2000 after serving in the U.S. Air Force. His Air Force assignments included positions at Air Force Space Command, the National Reconnaissance Office and the Department of Astronautics at the U.S. Air Force Academy. He holds a doctorate in aerospace engineering at the University of Colorado, Boulder; a Master of Science in aerospace engineering from the University of Texas at Austin, and a Bachelor of Science in aerospace engineering from the University of Notre Dame

An author of more than 20 technical articles and book chapters on space systems engineering and satellite design, Chesley is a vice president of the International Astronautical Federation Bureau, a senior member of the American Institute of Aeronautics and Astronautics and a member of the American Astronautical Society.



Artistic rendition of Boeing's MEO satellites being manufactured for SES Networks O3b mPOWER system.



Artistic rendition of the Boeing WGS satellite on orbit.



Artistic rendition of the Boeing Starliner CST-100 capsule..

Bridge Technologies

By Simen K. Frostad, Chairman

From the west coast of the U.S., you can see the future... sometimes, you look back over a year and a number of things are recalled that seemed important or influential for your business, items that would shape the coming years.

And then, sometimes, you look back and realize that there was just one event that really made a difference as to how you see your future.

For several years now, a good friend of mine had been trying to induce me to attend the **Satellite Innovation Symposium**. For one reason or another, I'd always declined.

This year, though, he was particularly persuasive — and so it was that I found myself in Mountain View, California, during the first half of October of this year.

Before I continue, though, I should point out that satellite operators have, historically, been great customers of Bridge Technologies. Our monitoring and analysis solutions are widely deployed within their networks, in headends. However, over time, as headends have become larger and fewer, we've seen a shift in the amount of business from those operators. Inevitably, we at Bridge lost track to a certain extent of what was going on in the satellite industry.

To say that the Satellite Innovation Symposium was a revelation would perhaps be something of an understatement — this event was pretty much an epiphany. There I was, among the good and the great of the satellite industry. The majority of those present were C-level executives, from all parts of the satellite ecosystem — and the excitement and enthusiasm in the room were almost tangible.

Sheer Size

One of the things that particularly caught my attention was the sheer size of the industry, which is worth approximately \$300 billion a year. By any standards, that's huge.

No less interesting was that, of that \$300 billion, only around \$6 billion/year is spent on launches — which, to the outsider, is the most visible part of what the industry does. Approximately \$130 billion is spent each year on the ground infrastructure that supports what's orbiting the Earth.

The other thing that particularly caught my attention is that this is an industry that is clearly in investment mode. Why the investment? Because this is an industry that sees itself as fulfilling a new role in the future.

I was reminded that, at **IBC 2017**, I'd been somewhat aware of these stirrings in the industry. At **IBC 2018**, those stirrings had become even more visible, with at least one major operator talking about his company's need to re-invent itself — not thinking of itself as a satellite company, but as a communications company. Another talked about their ambition to become the Swiss Army knife of transmission.

I also heard one of those acronyms that the industry loves: **ATAWADAC** - **anytime, anywhere, any device, any content**. That's defining the direction in which we're heading. Not only will OTT consumption overtake traditional content consumption within a couple of years but, because content is now more readily available, we're

consuming more of it — and that's especially true for live events, with their unique demands in terms of peak loading, minimal latency and so on.

Innate Strengths

Judging by the mood at the symposium, that's music to the ears of satellite operators. It seemed clear to me that being instrumental — the preferred choice, in fact — in delivering media is where the industry sees itself.

The future will leverage the innate strength and competitive advantage that satellite networks enjoy in that they can truly offer wide area distribution in a way that traditional telcos cannot accomplish. I also sensed a real appetite among those I spoke to for a future where satellite is only part of a solution that will deliver the content and the data to where it's needed — but a vital part of that scenario is the use of whatever network technology is appropriate to accomplish the task at hand. The concept of a "space-based network distribution company" springs to mind.

If you add content distribution to the explosion in demand for network capacity when the IoT moves from its current nascent stage to becoming part of the fabric of everyday life, it's hard to be anything other than hugely positive about the future of the satellite industry.

The reason that the Satellite Innovation Symposium left me as enthused and excited as the delegates obviously were is that, if I'm reading the runes correctly, the satellite industry has become extremely significant to us at Bridge Technologies — again. I'm sensing there will be a huge expansion in their networks, and with that expansion will come the need for the in-depth monitoring and analysis capabilities on which Bridge Technologies has built the business.

Enthused

Our satellite and IP probes are being widely deployed by customers around the world, with many broadcasters enthused by their unique capabilities that help them ensure optimum deliver of content from source to destination. We have even had opportunities to specifically target other niche areas such as the offshore maritime segment with VSAT carrier quality monitoring.

So: not so much a look backward at 2018, but more of a look forward to 2019 — a year wherein we're going to be fascinated in observing the satellite industry position itself as the network provider of choice for pretty much any organization looking to move any kind of data. **And:** we at Bridge look forward to becoming their monitoring and analytics provider of choice.

With hindsight, I think that being at the Satellite Innovation Symposium was one of the most significant events of 2018 for me. The event was a real eye-opener so far as the future of our industry is concerned. I'm glad I finally accepted that important invitation.

bridgetech.tv

Simen K. Frostad is Chairman and Co-Founder of Bridge Technologies. With 22 years of industry experience, Simen founded Bridge Technologies in 2004 after creating the world's first IP/MPLS contribution network for Scandinavian sports coverage. Simen had previously built the first multi-camera hard disk recording system for episodic drama production in 1998 and the first nonlinear sports editing facility during the 1994 Winter Olympics.



Bye Aerospace

By George E. Bye, Company Founder and CEO

In reflection, 2018 was, without question, a breakout year for Bye Aerospace.

The company flew two ground-breaking prototype aircraft for the first time — our two-seat, all electric, flight trainer called “*Sun Flyer 2*” and a demonstrator prototype for our solar-electric “*StratoAirNet*” and “*SOLESA*” families of medium-altitude solar-electric aircraft systems.

Bye Aerospace was also the winner of the Small Business category at the *Denver Business Journal's* 2018 Small Business awards.

Bye Aerospace, a privately-held company I founded in 2007, is an innovator of sophisticated aerospace technology that is applying innovative solar-electric propulsion, advanced aerodynamics and mechanical systems to design, build and market aerospace products that offer significant increases in performance.

The company's roots run deep in the broad spectrum of advanced technologies based around the core benefits of clean electric and solar-electric propulsion.

StratoAirNet and SOLESA are intended to provide support for long-endurance, commercial, geospatial and communications requirements, including patrol, observation, utility, mapping, precision agriculture, search and rescue and surveillance missions.

SOLESA will be piloted, performing similar patrol and survey missions for shorter flight durations. SOLESA will also provide a research and development test platform for new customer payloads. StratoAirNet will be a longer-endurance UAV.

Both will offer unique advantages over traditional systems, including lower unit cost, lower heat and noise signatures, lower operating costs and enhanced utility. **SolAero (SolAeroTech.com)** is collaborating with Bye Aerospace, integrating their advanced high-efficiency solar cell technologies on the advanced graphite composite wings.

Given the advantages of SolAero's solar cells (more than 30 percent average minimum efficiency) and the broad spectrum of advanced technologies based upon the core benefits of clean, electric propulsion, StratoAirNet has the potential for weeks, and eventually months, of flight endurance.

This provides new communications, geospatial and ISR market opportunities at a small fraction of the cost of conventional UAVs, with ops flexibility, hardware access (50 lbs. payload capability) and low latency that is impossible for traditional commercial satellites to accomplish.

LEO satellites are capable platforms, but they are expensive and lack the persistence and flexibility of UAV aircraft. They are also limited by slant ranges and repositioning; a problem that can be mitigated by altering flight plans. In terms of cost efficiencies, we anticipate the StratoAirNet UAV's aircraft cost will be 1 to 10 percent of traditional space launch and small satellite costs.



*The StratoAirNet aircraft in flight.
Photo is courtesy of Bye Aerospace.*

Our progress with StratoAirNet and SOLESA is notable; however, the company must continue to grow our human capital and financial capital resources to reach our ultimate goal of commercializing our programs. Fortunately, we have had success recruiting individuals with electric propulsion and design engineering experience from a variety of industries, ranging from ground transportation to traffic control to nuclear submarines to aircraft of all sizes.

Across our industry, we see 2019 as an ambitious growth year. Space is unquestionably a key domain asset and Bye Aerospace is in a transitory evolution to the next phase of “*big data*” or what some are calling the “*5G digital revolution*.”

At Bye Aerospace, we see this evolution as an opportunity to challenge the traditional ways of moving data quickly and efficiently. We believe a whole new awareness of what is possible will be realized in both the transfer of data and in global communications.

This awareness of possibilities will be enabled by innovations in air, ground and space technical devices. As a result, Bye Aerospace will continue to look at the realm of possibilities at all levels of the atmosphere and near-space.

One area of potential efficiency improvement is to replace rocket-launched satellites of all sizes with low-latency, capable atmospheric aircraft that can be recalled, refurbished, upgraded and re-deployed.

The fusion of advanced concepts and technologies, both in the public domain and developed by Bye Aerospace, have resulted in our piloted SOLESA and StratoAirNet UAV designs. Both use long “*glider-like*” low drag laminar flow wings and highly efficient solar-electric cell technologies, which combine to provide extreme flight endurance and a satellite-like capability at a multi-fold cost benefit and without satellite limitations.

Several short test flights for the StratoAirNet technology demonstrator prototype for the StratoAirNet family of aircraft systems have taken place in northern Colorado, with a focus on data collection for take-off and landing performance, climb rate, aero-efficiency and motor and battery operations.

Future tests will focus on airborne motor cruise efficiency and solar cell energy collection data. Early performance data is encouraging, exceeding each parameter in the test flight plans.

In closing, Bye Aerospace acknowledges that other projects similar to StratoAirNet and SOLESA are being developed by other companies, and we applaud their efforts. Why? Because we not only encourage innovation, we demand it.

Quite simply, we believe our company and our industry must innovate and achieve new efficiencies to survive and to thrive.

www.byeaerospace.com/

George Bye is the Founder and CEO of Bye Aerospace, named the “Small Business of the Year” for 2018 by the *Denver Business Journal* and one of the “Top 50 Colorado Companies to Watch” in 2017. Among his aircraft designs are a small solar-electric unmanned aerial vehicle (UAV) called *Silent Falcon*. George is an ATP rated pilot with over 4,000 flying hours. More info at www.GeorgeBye.com.



*Bye Aerospace' StratoAir Net prototype craft.
Photo is courtesy of the company.*

C-COM Satellite Systems

By Drew Klein, Director of Business Development

Pricing pressures from tariffs and global uncertainty reigned supreme in the company's niche marketplace this year; nevertheless, after multiple years of flat antenna sales, 2018 now appears to have been the year that the corner has officially and positively turned for C-COM Satellite Systems.

A resurgence in several different markets, regional and vertical, created novel, unexpected growth. Major sales into Africa, Asia and North America, in a vast array of different segments, drove C-COM to achieve a near record sales quarter in Q3 and pushed the firm toward a strong finish for the fiscal year, which closes in November.

C-COM began the year with some positive momentum — the company received new operator approvals from Optus Satellite Networks in Australia and Hughes Network Systems in the USA.

The latter certification has significant long-term appeal as a result of the planned, global Jupiter constellation that expects to offer significant Ka-band throughput across the globe for a multitude of enterprise/government and commercial customers. As of this writing, C-COM is the only mobile antenna approved for use over the Hughes' Jupiter service and the expectation is to experience incremental sales over this broadband service during the coming quarters.

C-COM continues to innovate, with new and improved auto-acquire antennas hitting the market throughout the year.

Most notably, the iNetVu 980, the classic Ku-band system, sold several thousand units in dozens of countries and was retired to be replaced by the company's next generation iNetVu 980+.



C-COM's iNetVu 980+.

The newest model of the 98 cm. motorized driveway antenna offers users a lower stow height, finer pointing accuracy, 24V motors, no actuator, zero maintenance, and a near zero backlash experience.

The new systems are also Ka-band upgradeable (to most services) and come with the first-class sales and technical support that C-COM partners know and appreciate.

Another new model of antenna introduced in 2018 was the first iNetVu backpack (manpack) antenna system: The iNetVu MP-80 and MP-100.

These 80 or 100 cm. systems, which are highly portable and fit into a single case, are available either with manual pointing or as fully motorized and automatic solutions.



C-COM's iNetVu MP-100..

The global premier of the first motorized manpack occurred at AfricaCom in Cape Town in November of 2018 — the feedback was exceptional. C-COM expects to see incremental sales of this system into broadcast, military, and government markets in 2019.

C-COM's most exciting developments in 2018 came in the form of the firm's long-term research and development into an electronically steerable phased array antenna system.

In June, the company announced the successful testing of the 16x16 subarray phased array antenna using 4x4 Transmit and Receive building block modules.

This is a key step forward in the progress toward a Comms-On-The-Move (COTM), wafer thin, modular and conforming, Ka-band antenna.

C-COM and partners at CIARS at the University of Waterloo are developing the next size antenna, a 32x32 subarray comprised of 1,000 elements for initial testing over a LEO constellation. The results are expected early next year.

The company also received, in late November, the firm's first patent for the invention of a low cost, low power and low insertion loss tunable phase shifter technology.

The developed antenna system uses a unique technique to adaptively control the antenna polarization in such a way that a prescribed quality of polarization can be guaranteed over the entire scan range.

Furthermore, the beam-processing unit and the antenna intelligent module can generate more than one radiation beam simultaneously and support multi-beam-tracking, a highly desired functionality in emerging LEO mobile networks.

By using a unique blend of low-cost but flexible/reconfigurable hardware components and highly intelligent software, the modular technology platform developed at CIARS provides the most cost-effective evolutionary path toward any antenna system configuration with a wide performance range of low-to high-end applications.

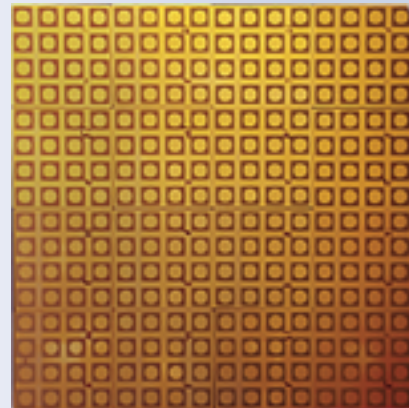
The developed technology platform can be easily extended to the rapidly emerging millimeter-wave 5G markets as well as for complex radar systems.

2019 is looking to be an exciting year. C-COM expects to continue to uncover new markets and to add to the 100+ countries that already use the first-in-class iNetVu solution.

The company is also aiming to sell the firm's 10,000th unit soon— with any luck and with further improvements in sales, perhaps this can be accomplished before the deadline for the SatMagazine 2019 YEAR IN REVIEW.

www.c-comsat.com

This article contains forward looking information about C-COM and its products, including information about possible future events or C-COM's expectations for its industry and its products. Such statements reflect C-COM's current expectations and assumptions regarding future events but, as with all assumptions, they remain subject to certain risks. For more information please see the Forward Looking Statements section of C-COM's most recent Management Discussion and Analysis available at www.SEDAR.com.



Ka-Band Phased Array Panel.



Cobham SATCOM

By Matthew Galston, Sr. Director, Global Market Strategy & Development

With demand for continuous connectivity driven by digitalization, using a single satellite service and antenna is not always the most optimal approach.

Cobham SATCOM continues to develop the most extensive portfolio of antenna systems to address the changing demands coming from digital transformation for users on land and at sea, with focus on enabling multi-band services with seamlessly integrated antennas, and 2018 has seen several key developments across the company's portfolio of products...

L-Band

2018 was the year that Cobham SATCOM's position as an **Iridium CertusSM** terminal manufacturing partner — since 2015 — came to fruition. After receiving certification for the new **SAILOR 4300 L-band** terminal in August, Cobham SATCOM's first Iridium CertusSM terminal started shipping, ensuring that maritime early adopters of Iridium's next generation multi-service platform are ready for commercial service introduction.



Innovations, such as integrating the **Iridium BCX** module within the antenna itself, introduced significant benefits, including lower installation costs, more flexible antenna placement and optimized link performance.

SAILOR 4300 L-band enables users to optimize diverse operational applications including; multi-user Internet/VPN, IoT and telemedicine, alongside regular usage including email, electronic forms/reporting and crew communication. Game-changing as a standalone, fully global communications platform, the deep integration between SAILOR 4300 and **SAILOR VSAT** will also enable service providers to upgrade their multi-band network services, enjoying a partnership with Cobham SATCOM as a single source of proven technology for all frequencies.

Ku- and Ka-band VSAT

Building upon the proven success of the market-leading **SAILOR 100 GX** system, the new SAILOR 100 GX High Power Fleet Xpress user terminal arrived in September. The compact 1 meter, 3-axis stabilized Ka-band system is specifically designed to enable Inmarsat's newly launched high data rate plans packaged for bandwidth-hungry segments, such as Offshore Support Vessels (OSV), Global Cruise, and Superyachts.

Delivering twice the RF power of standard GX terminals, SAILOR 100 GX High Power dramatically improves the economics of pushing large amounts of data from ship to shore, while also improving overall service quality and availability around the globe. The significant power boost comes courtesy of a fully-integrated, military-grade 10W GaN amplifier, which in addition to increasing upload speeds, facilitates a more reliable link to the GX satellites in all conditions to ensure continuity in the flow of mission critical data.

As an additional enhancement to stability and Quality of Service, the SAILOR 100 GX HP system is compatible with Cobham SATCOM's **GX Antenna Diversity Solution**, enabling two Ka-band antennas to be connected on a single GX modem unit, with **SAILOR FleetBroadband**, all on a single Fleet Xpress subscription. Only SAILOR GX series terminals enable dual antenna operation through embedded intelligent software, which eliminates thousands of dollars in costly rack devices and maintains the SAILOR emphasis on streamlined installation and activation.



On land, Cobham SATCOM's **EXPLORER VSAT** systems have been involved in several, high profile deployments this year. The **EXPLORER 8100 Auto-Acquire, Drive-Away Antenna System**, with its unique *Dynamic Pointing Correction* technology, has been installed on the UK's leading-edge broadcast solutions provider Timeline TV's new 4K-uplink RF2 broadcast truck. RF2's first major project was the royal wedding of Prince Harry and Meghan Markle in May. Timeline TV's crews used the system for operational communication over a high bandwidth, always-on Ka-band VSAT link, supporting the broadcast of what was one of the UK's most watched events in years.

The Government of South Australia's Department of Planning, Transport and Infrastructure (DPTI) selected the 1.2 meter version of the same VSAT antenna — **EXPLORER 8120** — to enable broadband data connectivity for workers delivering essential services to communities in remote areas.



The EXPLORER 8120 VSAT systems feature the same Dynamic Pointing Correction technology, which ensures a reliable link to the satellite, even if the antenna is being buffeted by winds or people are moving around inside the accommodation unit. The EXPLORER 8120 systems were selected due to their easy installation and proven ability to deliver high uptime and were delivered in May 2018.

Multi-Band and Multi-Channel

In March of this year, Cobham SATCOM unveiled the unique **Sea Tel 9711 Triband maritime antenna system**, the world's first and only 2.4 meter maritime stabilized antenna capable of delivering full gain performance across any C-, Ku-, or Ka-band network to maximize high-speed, high-quality broadband connectivity for demanding maritime segments such as Cruise, Energy and Government.

The triband antenna system offers seamless, automated electronic switching between bands, providing unmatched operational continuity for vessels demanding the most bandwidth, reliability and coverage. **Viasat** has partnered with Cobham SATCOM to create a version of the Triband system capable of operating on their **Viasat-2** satellite. The system will also support all other Ka-band networks in the future, including those operating in NGSO.

Staying with 'hybrid' technology but on a smaller scale, it's notable that Cobham SATCOM's **EXPLORER Push-to-Talk** system, featuring unique PRISM (Private Routing & Intelligent System Management) technology, gained considerable traction this year. The system combines highly reliable global L-band satellite technology and least cost routing for automatic switching between SATCOM, LTE and Land Mobile Radio without user intervention. By seamlessly combining all available channels, the system significantly extends communications reach, providing high quality voice and data coverage even in radio blackspots. The migration by users of the first generation **EXPLORER PTT** to the second generation with PRISM technology after more than six years is testament to the significant safety and efficiency improvements possible for diverse users, from utilities field engineers to blue light emergency services.

Gateways and LEO

In November, Cobham SATCOM reported that the company's advanced Ka-band **TRACKER** antennas deployed at **Telesat's** Allan Park teleport near Toronto, Canada, are successfully demonstrating live, over-the air broadband connectivity on Telesat's first LEO satellite. The Phase 1 LEO satellite launched in January of 2018 and is currently testing ground equipment and validating performance in an operational LEO environment.

Cobham SATCOM provided 3.7 meter and 1.1 meter TRACKER antennas to test the satellite's Ka-band payload, evaluate the capabilities of modems and other communications hardware in different service scenarios and to provide satellite tracking, telemetry and control (TT&C) services. The speed and stability of network traffic supporting latency sensitive applications revealed that Telesat's satellite and Cobham's antennas can deliver high performance, high quality data communications.

2019 and Beyond

With positive results at Allan Park, Cobham antennas could become part of a larger group of globally distributed landing stations as well as user terminals required to support Telesat's fully deployed global LEO constellation, expected to enter service in 2022, especially as they offer such a powerful business case. Tangible CAPEX and OPEX savings including up to 90 percent reduction in energy consumption and better than 50 percent savings on installation time and costs are all possible with Cobham TRACKER antennas.

For now, Cobham SATCOM's diverse partners and users have plenty to look forward to from established Geostationary satellite services using L-, Ka-, Ku- and C-band frequencies. Antenna reliability and performance contributes significantly to Quality of Service, but delivering always available connectivity, especially at sea, requires integration of different platforms. It's here that Cobham SATCOM will continue to forge its leading position as a single supplier for digital transformation enabling technology, with an extensive antenna systems portfolio covering all needs and offering easy integration for complete connectivity.

www.cobham.com/communications-and-connectivity/satcom/

Comtech EF Data

By Richard Swardh, Senior Vice President for MNO

2018 will go down in the history books as the year 3GPP Release 15 was agreed upon — the first 5G standard is now a fact and equipment vendors and Mobile Network Operators (MNO) are scrambling to be first to market. Additionally, many adjacent industries are quick to chime in and want a piece of the action.

Everyone seems to seek an association with 5G, and even technologies that are developed or standardized outside of 3GPP get a 5G label put on it such as NFV (*Network Function Virtualization*), SDN (*Software Defined Networking*) and ONAP (*Open Networking Automation Platform*) to offer a few examples.

To fully understand and leverage 5G, it is important to understand and separate what outside forces are the enablers and the influencers to the standard, from what is included and currently standardized within **3GPP Release 15** and subsequent Releases.

Thankfully, the satellite industry is actively participating in many important discussions around the development of future Releases.

It may also be prudent to take a step back from the media frenzy that is already way ahead of the current capabilities of the technology and look at how 5G may influence your business through different lenses. Perhaps one view that takes a two to three year horizon and another that is more futuristic and considers use cases that may happen five to ten years from now.

It is easy to get carried away by all the hype surrounding the new use cases that 5G may enable one day; however, we should not lose sight that things usually take longer than originally planned and sometimes the journey is more important than the end goal.

For those of us who have lived and worked through previous standards being ratified, we may remember what ITU's IMT-Advanced vision for wireless said about LTE back in 2008. For instance, the system should be able to provide 1 Gbps of throughput and there were plenty of exotic use cases being presented as key drivers for LTE and many of them never saw the light of day.

However, if it hadn't been for the introduction of the Apple iPhone combined with the new ecosystem and business models smartphones brought to market by destroying the walled gardens of the MNOs and allowing for applications and **Over-The-Top (OTT)** services to proliferate and be monetized through App stores, LTE would surely not have been the commercial success it is today.

Innovation coming from adjacent industries is something that, many times, is needed to disrupt status quo and make a new mobile technology a success.

And what about that 1 Gbps throughput? Well, we are 10 years past ITU's original vision for LTE published in 2008 and now there is finally a model of the iPhone supporting 1 Gbps of throughput. Yes, you read that correctly — LTE is fully living up to its name, **Long Term Evolution**. Ten years in and iPhone XS (this year's new model) is the first Category 16 LTE (3GPP term for 1 Gbps capable user equipment) phone ever in Apple's portfolio.

Sometimes things take time to fully develop and mature and that is fine. This is about the journey as much as anything else, so try to rise above the noise and look for the path that is correct for your business when it comes to 5G.

In mobile backhaul over satellite, the industry saw more growth in throughput than ever before and **Comtech EF Data** managed to accomplish a few world firsts.

For instance, a GEO-based trunking solution for Internet and LTE backhaul surpassing 3 Gbps per link is now in service. That's a number no one would have believed being possible to accomplish over satellite just a few years ago.

Traffic continued to grow around the world as customers demand more 3G and LTE data services. This was particularly evident in Latin America where one MNO is now operating the world's largest combined 2G/3G/LTE network over satellite backhaul supporting many Gbps of traffic over an HTS satellite supporting millions of happy customers and Internet of Things (IoT) devices.

There is also another interesting trend in our industry that is happening around connecting the unconnected. With the reduction in price for satellite transmission, along with less expensive satellite modems, base stations, solar panels and towers, many companies are now successfully embarking on providing connectivity to the most remote and poorest parts of the world.

It is quite difficult to deploy a mobile network over satellite and make a decent return on investment when *Average Revenue Per User (ARPU)* are in the low single digits, but we are now witnessing that happening for good commercial reasons.

This is something, as an industry, that we should be proud of accomplishing, as it is truly changing the world for the better. The United Nations published 17 Sustainable Development Goals for social and economic development and basically all of them can be accelerated and improved upon with the help of basic connectivity. **Well done to all satellite companies out there for making this happen.**

Lastly, as we look back over 2018, it was a year where the second wave of non-GEO satellite constellations commenced with innovative new entrants such as Kepler joining the longer standing providers in the LEO and MEO market.

Comtech EF Data has active projects for high-speed, real-time and low-latency communications and exciting projects on the horizon. Non-GEO has the potential to change the satellite communications landscape, and Comtech EF Data is proud to be at the forefront of this revolution.

www.comtechefdata.com

Richard Swardh is Senior Vice President, MNO, for Comtech EF Data. In this role, he leads the market development and direction for the 2G/3G/LTE mobile backhaul market, directing long-term strategic initiatives and defining solution suites and feature sets. A mobile network backhaul veteran, Swardh's background includes strategic and operational positions at Ericsson with business development, partnership management and strategy execution responsibilities. He holds a Bachelor of Science degree in Mechanical Engineering and a Bachelor of Business degree in Administration and Logistics from Vaxjo University in Sweden.



CPI Antenna Systems Division

By Tony Russell, President

How do you prepare for a market where LEO and MEO SATCOM markets will not only flourish, but place new types of services and capabilities in the hands of a new generation of users? If you are **Communications & Power Industries (CPI), you grow bigger, make strategic consolidations and acquisitions and focus on streamlined production and delivery systems.**

The past year has been a highly successful one for the new **Antenna Systems Division (ASD)** of CPI on several fronts. This was the company's first year as the newly consolidated Antenna Systems Division, which was formed by integrating the activities of CPI's two antenna divisions — the former **Malibu Division**

in 2007 and **ASC Signal Division** in 2015 — under a single operating division. This effort was a significant undertaking and the synergies harnessed from operating as a single division have been substantial. Of particular note is that this consolidation better enabled us to unite the technological strengths of each organization in one, comprehensive offering for customers.

For example, as ASD, the advanced millimeter-wave SATCOM positioner technology from Malibu Division was combined with ASC Signal Division technology to generate a new class of full motion tracking antennas for LEO/MEO SATCOM applications. The integrated Antenna Systems Division then used the large-scale manufacturing capabilities of the firm's Whitby, Ontario, Canada, facility to move into full-rate production of these antennas for a prominent LEO customer. Involving all aspects of the newly consolidated division, this large program brought major benefits to production flow and overall logistics, thereby enhancing our time to deliver products to market. The experience gained through the development and deployment of the 3.5 meter satellite communications antenna enables CPI ASD to offer a rare, field-proven product of this size to address the growing LEO/MEO SATCOM market.

In an effort to better serve the company's customers in the GEO SATCOM space, CPI made a strategic decision to extend ASD's product line with a range of new, large-aperture, Earth station antennas. In March of 2018, we acquired technology in March of 2018 from **ViaSat, Inc.** that allows ASD to offer customers new, larger antennas for the first time. These antennas range in diameter from 7.2 to 18 meters, can be configured for C-, K-, Ku-, X- and DBS-band operation and feature high-efficiency optics and precision high-rigidity mounts. ASD is in the process of integrating these larger aperture antennas into the firm's existing product line, while making them compatible with industry-leading technologies.

The new antennas may now be configured with ASD's **Next-Generation Controller (NGC)**; this controller receives a great deal of attention — and rightly so. This is a powerful, modular platform for controlling every aspect of antenna operation. The NGC can interface with a full suite of tracking technologies and also offers a wide range of features and options, such as an integral spectrum analyzer, a beacon receiver, transmit and receive chain-switching capabilities, system redundancy management, and carrier monitoring.

Two Key Areas of Growth

In 2018, CPI ASD was strategically focused on growth in two areas: the company's technology base and the expansion and strength of the expansive product portfolio. We continue to offer a complete range of products for any type of satellite, irrespective of that satellite's orbit, and for any type of line-of-sight telemetry and common data link (CDL) application. This makes CPI one of the few antenna manufacturers to support such a wide array of applications. CPI completed several acquisitions that have furthered this goal over the years, as mentioned earlier in this article.

In August of 2018, CPI grew the firm's antenna technology and expertise for various space and satellite communication markets, strengthening the product portfolio with the simultaneous acquisition of **Orbital Systems** and **Quorum Communications**. These two related companies design and manufacture antenna positioners, as well as complete front-end systems that meet the high performance, accuracy and reliability needs of Earth Observation Satellites (EOS), direct broadcast

(DB), telemetry and control (TT&C), UAV/RPV tracking, radar, search & rescue (SARSAT), and general satellite uplink and downlink applications. CPI's acquisition of Orbital and Quorum brought the firm the designs for cost effective, high-quality full-motion antenna solutions for the satellite remote-sensing market, including microwave receivers, demodulators, downconverters and feeds. CPI ASD anticipates strong growth in these vertical markets over the next decade. With this acquisition, ASD offers a best-of-class antenna portfolio to address the demands of a growing customer base.

In addition to the acquisition of key technologies in 2018, valued expertise and talent were attracted to ASD, as well. In March, **Andre Jones** joined CPI ASD as the company's new Vice President of Business Development, bringing a wealth of knowledge in SATCOM systems engineering and sales and previous experiences in key senior executive roles at industry leading firms in the satellite antenna business. Andre is responsible for leading global business development efforts while addressing the needs of the company's strategic customer base.

A Record Year for ATC Radar

In 2018, in spite of a softer commercial SATCOM market, ASD's business grew and had several key areas of success, particularly within the government and military MILSATCOM market segments, which remained strong during the year, and industry interest in our transportable, multi-band, SATCOM **Trifold®** systems is expected to continue. CPI ASD's line-of-sight (LOS) telemetry systems and other unique products for MILSATCOM applications were also strong sellers. In addition, the firm's air traffic control (ATC) radar antenna business saw a record number of systems being manufactured and the near-term outlook for these systems is rosy heading into 2019.



ASD's **Data Link** product line serves an important specialty market and business in this market remained vibrant in 2018. Our expertise in high-precision pointing/tracking has made ASD a recognized leader in this segment for advanced antenna systems for LOS applications in the global unmanned aerial systems (UAS) market, including some of the most sophisticated UAS platforms. These platforms include **NATO's Global Hawk AGS, Fire Scout, Shadow, Gray Eagle, Watchkeeper** and **ANKA**. CPI ASD is extremely excited about ongoing opportunities in this market.

Although the teleport industry is currently undergoing major changes with the advancement of LEO/MEO technologies, ASD believes that the teleport remains the most important link of any satellite communications network. CPI's focus on innovation in our SATCOM business is critical to the firm's, and our customers, future successes. The company will continue to develop technologies and products to support this strategy. For the satellite communications industry to remain relevant, it is imperative that CPI develop cost effective space and ground systems that operate efficiently and at the desired frequency bands to meet the growing demand for bandwidth. ASD is investing heavily in R&D, with a focus on technologies and products that permit efficient operation at higher frequency bands, including Q/V-band and higher.

In 2018, CPI ASD prepared for the future of a dynamic market that will touch more and more vertical industries, with new fleets emerging to play a key role in areas as diverse as agriculture, broadband connectivity, and military and government applications. The company worked to develop the scale and technological depth that we believe will be needed as traditional GEO satellite operators, broadcasters and telecommunications companies adjust their business models to a hyper-connected world, including LEO/MEO and hybrid systems. In order to meet the demands of these complex architectures and business propositions, the company will continue to invest in the talent, the time and the capital to evolve our technologies and systems to ensure that CPI ASD customers can count on us across the board.

www.cpii.com/asd

Tony Russell possesses 35 years of experience in the RF industry, primarily within the airborne and maritime radar, ground and airborne communications and millimeter-wave science segments. Mr. Russell has been with Communications & Power Industries (and the firm's predecessor) for more than 25 years, serving in technical and management roles in the firm's electron device solid-state HPA and antenna businesses. Currently, Tony serves as the President of the CPI Antenna Systems Division. He has an Honors degree in Physics from the University of York (UK) and an MBA from York University (Canada).

DEV Systemtechnik

By Tom Keim, Business Development Manager



DEV can look back on an eventful and successful 2018 in terms of leadership and personnel changes, as well as expanded product lines, trade-fair exhibitions, international projects and alliances, and quality management progress.

Leadership and Personnel

February 2018 began with a change of company executives. **Manfred Mettendorff** replaced **Jörg Schmidt** as Managing Director of the company that designs and manufactures a complete range of devices for optical and electrical signal transmission. Personnel advances at DEV included ramping up the firm's its sales, marketing and customer service departments.

Product Portfolio



The DEV Systemtechnik 1975.

DEV Systemtechnik's new 16x16 combining matrix – the **DEV 1975**. This new, fan-out matrix for uplink applications, together with the new 16x16 distributing matrix **DEV 1985**, completes DEV's range of matrices for arrays up to 2048x2048 channels, well beyond the firm's popular 64x64 **Archimedes** matrix and smaller versions.

The largest product innovation was featured at the IBC exhibition in Amsterdam: **Alpha** — the world's densest RF-over-Fiber solution in one rack unit (RU) to emerge



as the most cost-effective RFOF product line from DEV. Alpha consolidates an unprecedented 32 connections into one RU with function modules installed within a single 19-inch indoor or outdoor waterproof enclosure. Alpha supports fiber optic connections up to three kilometers in length and also offers redundancy options. For more distant and extensive functions, DEV Systemtechnik continues to offer its **Optribution** product line.

Trade Shows

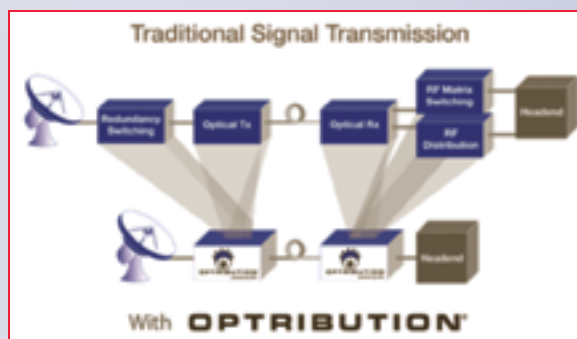
The release of new products and solutions fueled further reasons why DEV could reflect on a highly successful trade-fair season. Complementing the company's major presence at the **CABSAT** in Dubai, **CommunicAsia** in Singapore, **ANGA COM** in Cologne and **IBC** in Amsterdam, DEV also attended additional venues in Germany, the United States, China, Thailand and Japan to further expand international business opportunities. Notably, DEV has secured **Optimum Viking Satcom India** as its latest representative partner to promote and expand the burgeoning Indian market with the complete range of DEV's RF equipment. Both firms will exhibit in January at **Convergence India** their products for SATCOM and broadcasting applications.

International Projects



Owing to DEV's diverse portfolio of state-of-the-art technology, there were a number of major international flagship projects launched by the company in 2018. For example, DEV supplied two headends served by Austria's largest cable network operator, with nine Distribution Amplifier Chassis (**DEV 2190**). These devices ensure that TV signals are reliably fed into the cable network.

At the onset of 2018, DEV also activated a TV signal feed for a Television Receive-Only (TVRO) application in Germany using the firm's **Optribution RF-over-Fiber** solution. This client also benefits from a 160 km. site diversity solution that boosts the reliability of its satellite network, despite atmospheric or weather-related effects.



A customer in Hungary benefited from DEV Systemtechnik's **Archimedes Matrix Switch** that offers unrivaled functionality. Beyond the integrated spectrum analyzer and **Secure Lock Operation** mode, redundant controllers ensure extremely high reliability in signal management and transmission. This Archimedes Switch serving 32 input and 40 output channels can be upgraded anytime in-field by the customer up to a 64x64 configuration.

The Archimedes RF Matrix also found favor in Asia, particularly in asymmetric configurations where it offers attractive cost savings. One large telecommunications company in Southeast Asia ordered a 32x80 matrix from DEV — the "**Archimedes Cluster**" — which can be upgraded in-field to handle 128x128 channels.

An upgrade of an existing Asian Direct-to-Home (DTH) system introduced in 2006 was also on the "to-do" list for 2018. Through the extension and use of several Distribution Amplifier Chassis (**DEV 2190**), customer's headend capacity has expanded to feed 200 additional channels into the TV distribution network.

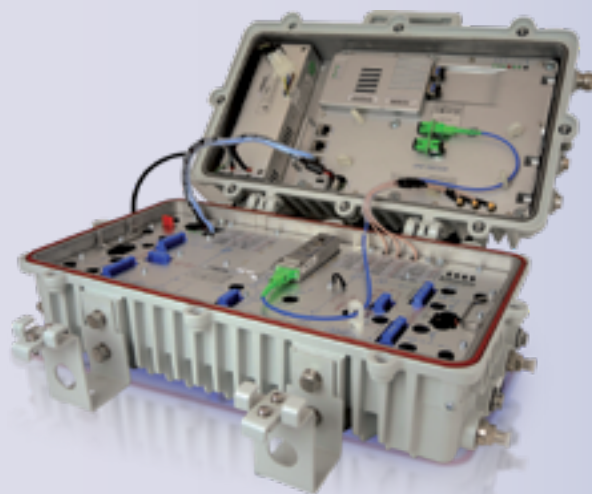
Quality Management

Capping DEV Systemtechnik's 2018 success was the announcement that the company now offers a seven year warranty on all products, meriting industry attention for once again setting the bar in product durability and sustainability for transmitting high-frequency signals over coax and fiber.

DEV's quality management system was also officially certified to ISO 9001 standards by **TÜV SÜD** in February of 2018. This credential certifies that DEV applies an established quality management system for the development, production and sales of equipment and systems for signal transmission.

In close cooperation with the company's majority shareholder, **Axing AG**, DEV Systemtechnik will support the signal chain from teleport to end user.

To serve the European-wide rollout of **Remote MAC-PHY**, the company supplies farsighted "state-of-the-art" technology for cable network operators.



The extensive product portfolio of Axing AG with their optical nodes well complements DEV systems using the DOCSIS 3.1 standard. DEV will also showcase at 2019 conferences and trade fairs worldwide new product launches and solutions.

www.dev-systemtechnik.com

Tom Keim studied economics in Germany with a master's degree and has been Business Development Manager of DEV Systemtechnik GmbH since 2017.

Elara Comunicaciones

By Gonzalo Flores, Business Development, and Michel San German, Project Management

2018 has been a significant year for Elara Comunicaciones' growth. Elara's Mexico City facility has become the 21st teleport to be fully certified by WTA and the first teleport in Latin America to gain full certification. As one of the big players integrating telco turnkey solutions through satellite, Elara Comunicaciones has cemented into place a privileged seat in the twists and turns occurring recently in the satellite service chain.

It's important to understand the circumstances that the industry is being subjected to across the globe to focus on Elara's milestones. On one hand, satellite operators are experiencing a mayor ARPU (Average Revenue Per Unit) decrease due to the accelerated growth of HTS capacity. For Mexico, ARPU had increased about 2000 percent over the last four years — last year's launches are offering 10 times the previously existing throughput for NAM. Combining this with technological developments that allow satellites to be launched together on recoverable and reusable rockets (which lowers the cost of the investment), the result is virtual oversupply.

These symptoms are responsible for strategic adaptations from satellite operators, actors who are aggressively moving up the satellite value chain, horizontally and vertically. The end of

2018 is marked with a broader presence of satellite capacity, pushed by the opening of frontiers and a changing political climate. This leads Elara to expect an offer contraction wherein the capacity providers would migrate from leasing their assets to an as-a-service model and that move brings important changes to their partnerships.

The transformation journey requires a highly adaptive DNA as well as flexible but well defined procedures and a strong customer service culture. All of the above are met by companies such as Elara, which are in constant pursuit of development and innovative solutions to add value to customers and business associates.

As a consequence, telco integrators must diversify their revenue sources by complementing current services with initiatives that take advantage of their operational capacity and structure, as well as leveraging their market position and vendor partnerships. However, most business development initiatives are facing a rough, go-to-market process, due to immature demand of such services. Therefore, the efficient assignment of organic and financial resources is key in order to achieve a healthy, cost-benefit ratio. A better understanding of that ratio would allow the players in the satellite industry to monetize their business efforts outside their core. This would also minimize the risks and pain of leaving a well-known comfort zone reached by their wide experience as critical link providers and ISPs.

Elara has been working in the satellite industry in Mexico for more than 14 years and has become a pioneer in Latin America through the usage and implementation of innovative technologies, such as **Service Over HTS** satellites, quota based remote access and FAP, among others. Recently, the industry in Mexico has been quickly evolving and adapting itself to the continuous, changing needs of customers. This has been



reflected in ongoing price reductions and a far more competitive market strategy.

There are various influences that continue to affect the market's behavior. For instance, the introduction of Ka-band and HTS to provide higher throughput and lower costs has been of major consequence. Also, the challenges to enter the market as a network operator and integrator have been significantly reduced; selling prices are sliding lower and that has pushed satellite operators to rethink their go-to market strategy and has resulted in them attempting to reach down the supply chain to the end user.

Business models and types of solutions have changed, as well. For example, services provided on HTS and Ka-band have lower availability, higher throughput and lower costs; however, as a business model, these services come with a new consideration to take into account for the communication services market — the **Fair Access Policy (FAP)**. FAP is used to measure and restrict the amount of information that is transferred through the satellite link. This information is no longer only restricted by the transfer ratio or throughput, but also by the FAP determined by the service provider — or even by the satellite operator.

Technology is one of fastest evolving industries in the history of mankind. During the last 20 years, this pace has significantly accelerated. This technological evolution has a direct impact on the needs and requirements of people, companies and entire industries. This is also why communication services have become commoditized — the availability of immediate information is a "must have" consumer demand that encompasses every genre of productive activity.

Elara's increasing coverage and availability, through the use of various satellites, and innovative services in order to guarantee competitive prices and adequate solutions for each client, has allowed the company to be part of the technological evolution in the world of telecommunications — Elara is well prepared for the changes bound to arrive during 2019.

www.elara.com.mx

Gonzalo Flores has a Bachelor of electrical, electronic and communications engineering from Universidad Autonoma Metropolitana. He has extensive experience in the telecommunications industry, having worked in the world's third largest satellite operator in terms of revenues. Currently, he serves as Elara's business development coordinator, among his duties are to continuously generate new clients or new sales leads and to maintain good relationships with existing clients.

Michel San German has a Bachelor of Science Industrial Engineering and an MBA from Universidad Iberoamericana. He has served as Elara's Head of the Project Management Team and then created and managed the After-sales and Sales Support department, as well as Market and Business Intelligence operations which evolved into the Planning and Control Department in support of the company's business strategy. Michel monitors the efficiency of Elara's commercial strategies and evaluates the best course of action, according to the market's needs.



ETL Systems

By Andrew Bond, Sales Director

At the start of 2018, there was an air of uncertainty surrounding the satellite industry... many were worried that huge change was on the horizon due to the ongoing pressure from competing connections. From talk of 'the death of satellite' to concerns surrounding a congested space, there is actually a lot more positivity to be derived from this year and much to look forward to in 2019 as satellite reinvents itself.

The So-Called Demise of Satellite

First, I think it's important to quash the rumors that satellite has lost its relevance. Many had predicted the demise of satellite, but this year we have seen satellite retain its importance. In truth,

although fiber, OTT (Over-The-Top) and other internet-based distribution methods have caused the satellite industry to lose some of its market share, satellite remains highly important for video.

In many cases, especially for sports, live events and news, there is no other reliable method of ensuring quality coverage. Ampere analyst, **Toby Holleran**, recently said that "if 10 million people wanted to tune into a World Cup game in 4K, even with IP delivery costs decreasing, [satellite] would still be the most cost-effective method, as additional viewers incur no additional cost." Interestingly, 3.4 billion people watched part of this year's World Cup, according to **IBC365** who, in the same article, confirmed that "satellite is still at the heart of the broadcast industry."

Growing demand for 4K content will further play into the hands of the satellite industry as other connections continue to struggle to provide 4K reliably (thanks to the rather sluggish roll out of super-fast broadband). According to **Futuresource Consulting**, ultra-high definition (UHD) 4K devices **will account for nearly 50 percent** of all TVs shipped worldwide by the end of the year, and that number is expected to grow.

On top of this, SNG (Satellite News Gathering) trucks are no less important in today's broadcast ecosystem than they were five years ago. The demand for live sports and news is unlikely to subside, so the mobile nature of SNG trucks and their fast setup times will ensure they remain highly relevant to the broadcast industry. Whether used for uplink traffic from a network of live cameras, or in larger trucks for local fiber inputs, satellite is the fastest and most affordable way to distribute signals.

Looking ahead, what we do need to do is ensure that satellite remains attractive in the face of pressure from internet-based streaming. In short, this means ensuring viewers at home get a high-quality feed that is resilient to outages on a 24/7 basis. After all, when a consumer experiences a poor-quality broadcast, it not only encourages that consumer to move away from satellite services, it can also cast doubt over satellite broadcasting as a whole.

In this highly competitive environment, having redundancy measures in place becomes increasingly important. Those operators that do invest in the correct equipment can minimize errors as well as lower the expenditure of resources, keeping the cost of services low and reliability high.

At **NAB Las Vegas** in April, we demoed several of solutions that ensure reliable, satellite broadcasts. This included the firm's **Griffin Redundancy Switch**, a solution used to provide redundancy for downlink and uplink RF or ASI feeds and enabling switching to a standby path in the case of an error. Not only can this be triggered automatically upon detection of signal loss, but also manually from the front panel upon RF level detection or alarm contacts, or by a Network Monitoring Solution, which can trigger switching when required.

Meeting the Demand for Constant Connectivity

One of the most prominent trends this year has been the growth of High-Throughput Satellites (HTS). HTS has really grown exponentially over recent months, opening up a wealth of opportunities within the SATCOM industry. At present, much of this growth is focused mainly on supplying the data services market, in other words, services that require constant connectivity. HTS is also helping ETL Systems to connect otherwise isolated, rural communities, thanks to low-cost and relative ease of deployment.

Excitingly, HTS could be an enabler of new technologies, such as the Internet of Things (IoT) and connected cars. For the wider industry, HTS increases demand for satellite connectivity in general, and that is a boon that should excite all involved in this industry.

At the same time, to maximize the potential of HTS, it's important to have the correct tools in place. HTS is spot beam driven, which means VSATs are commonly used. It is widely reported that VSATs are a prominent cause of errors in SATCOM, mainly as a result of poor equipment and incorrect installation. This can be solved by proper type approval processes and by ensuring users only buy from manufacturers that rigorously test their equipment.

However, another common cause of errors in VSATs is the sensitivity to weather conditions. This can be a significant problem when terminals are in remote or unmanned sites and can prove costly if engineers need to be sent onsite to resolve them. One solution is to house equipment in weatherproof chassis — another protective measure is to always ensure there is a backup site in case operations are severely affected. In this manner, operations can continue even while the issue at the site is being resolved.

Ideally, a diverse range of sites in separate locations should be used — in some locations, weather is so localized that 40 kilometres may be enough of a separation between sites. In most scenarios, that's more likely talking between 70 to 100 kilometres to offset different weather patterns. A fiber connection is then run from the satellite dish to the control center via **Dense Wavelength Division Multiplexing (DWDM)**. Rain fade is combated, meaning signal loss is minimal and the end-user receives a good quality feed.

At IBC 2018, we launched the new **StingRay** DWDM solution that enables high-quality distribution between a satellite antenna and a remote control room. It is capable of transmitting multiple signals over distances of 50 to 500 km through a dedicated fiber cable. We also added pre-amp and post-amp **Erbium Doped Fiber Amplifiers (EDFA)** to reduce the potential for signal loss over these distances.



While it is more important than ever that satellite remains cost-effective, adding extra redundancies such as the Stingray DWDM bolsters the all-important reliability of a service. As the industry faces an uncertain future, these factors will be even more essential.

Facing the LEO Constellations of the Future

This year there has been a great deal of talk of the impending Low Earth Orbit (LEO) launches and mega constellations. There have been a few such launches during 2018; however, there haven't been as many as expected and I am doubtful whether we will see as many as promised over the coming years.

A maximum of one to three LEO constellations will probably be more likely by the mid 2020s. Although the launch of LEO smallsats will definitely mean faster and better connectivity, I see a more gradual introduction as a positive thing, for that will allow us to evaluate the effect of LEO constellations on the wider industry and will give us the time necessary to alter business models when needed.

We will still need to manage LEO effectively to avoid causing problems. Part of this will involve having measures in place to closely monitor LEO operations so all are aware of where and when problems arise. Also, if we want to make sure we lessen the chances of interference from LEO, one action operators and manufacturers can undertake now is to invest in reliable, quality equipment. We already know this is a major cause of errors in SATCOM, particularly for VSATs — this is easily solvable today with effective training and planning.

What is clear from 2018 is that innovation is still very much alive in the satellite sector, whether it is long distance fiber links or fast redundancy switching. I am certain that whatever challenges the industry faces over the coming decade, innovative solutions will overcome these challenges. To that end, ETL Systems will continue to bring to market solutions that will maintain the reliability of satellite for the foreseeable future — and beyond.

www.etlsystems.com



Exos Aerospace

By John Quinn, Co-Founder and Chief Operating Officer



A tiny, Texas-based rocket manufacturer is about to make a huge impact on the aerospace industry. With the goal and company slogan of making “SPACEavailable...,” Exos Aerospace has developed some of the world’s most commercially-viable, reusable rockets to drive down space access costs and reduce lengthy launch wait times.

“Our rockets are reusable, and we already have the capability to provide multiple launches per week,” said Exos COO and front-man, John Quinn. “Our upcoming launch on January 5th, 2019 has SPACEavailable... and, with just a few days of work, we could integrate your payload and add it to the launch manifest.”

The Beginning...

With a military background as a submariner in the U.S. Navy, Quinn has been involved with engineering most of his adult life. He and his close friend/business mentor, David Mitchell, co-founded **Exos Aerospace Systems & Technologies, Inc.** in 2015. David worked on funding the operation, while John focused on the day-to-day tasks of developing the technology and the processes to mimic how commercial spacecraft are flown and “reused.” On August 25th, 2018, the Exos team successfully test-launched and recovered their **Suborbital Autonomous Rocket w/Guidance, (SARGE)** vehicle from **Spaceport America**, providing a glimpse into a future of increased space flight opportunity via reusable vehicles.

The Launch...

The rocket was “light loaded with propellant,” reached an altitude of 32 km. and was recovered less than 30 minutes later with 99 percent of the vehicle ready for reuse, validating the vehicle’s robust design. The test also demonstrated the capability of the autonomous control system, validated the preflight vehicle integration process and proved accuracy of the models that will be used for fine-tuning the vehicle for a NASA IDIQ qualification flight planned for January 5th, 2019.

Once Exos qualifies for NASA’s IDIQ program for suborbital launches, Exos will continue to use SARGE to provide cost effective commercial launch services as the company develops the predictive and prognostic data models required to support development of the firm’s next vehicle, a mobile Low Earth Orbit (LEO) launcher the company calls “Jaguar.” Jaguar is being designed to loft 100 to 200 kg. to a 200 to 400 km. orbit.

The Impact...

Commercial Space Flight

This reduced-cost, fly-now focus will offer increased availability of space-flight for corporations, medical research firms, schools, and anyone with a few thousand dollars and a desire to send product into the cold vacuum and microgravity of space. The recent Exos test-flight carried payloads from **Purdue University, CAST (for the Mayo Clinic), Arete’, Space Kidz India,** and a few individuals who just wanted to fly space memorabilia.

Education

Pioneering the world of space education, Exos has developed a school assistance program for educators around the world to help their young scientists send real cubesat experiments to space. The “SPACEdu...” program has already gained some footing with major universities, high schools and even some grade schools. Exos is looking for additional sponsors and partners to cubesat research competition part of the national science fair.

BioMedical Research

Unlike flying on traditional solid fuel spin stabilized rockets (such as missiles), Exos rockets are stabilized using fins and gimbal capabilities to keep the vehicle from rolling. The gimbal used for controlling and directing SARGE is controlled by **Morpheus** flight software that was acquired through a Space Act Agreement with NASA. The drogue recovery system brings the rocket back from space and the Wamore GPS guided canopy system flies the rocket back to its launch site within minutes of launch. All this results in a very smooth (~5G) and efficient rocket ride that is friendly to even the most delicate of payloads, giving medical researchers hope for new space tests and data acquisition.

Environment

Perhaps the only thing not feeling the impact of the Exos rockets is the environment. Compared to the solid rocket boosters of the past, the exhaust from the Lox/Ethanol fuel burn doesn’t leave a smoke trail, but does leave a bit of water vapor. Their Lox/Ethanol technology is one approach that Exos will use to support the industry in an environmentally responsible way.



The successful Exos Aerospace SARGE launch.

Government/Military

The implications of these reusable rockets will be pivotal in the industry. The SARGE rocket is designed to support up to 200 flights, but Exos plans to use the Lox/Ethanol vehicle as long as it’s “safe” and ultimately desires to sell the liquid-fired rockets to **Missile Defense Agency (MDA)** as “hard-to-acquire” targets when they near the end of their economically viable life. Meanwhile, plans for Jaguar to provide low-cost, fast turn-around solutions for satellite deployment could place Exos in the forefront of military and commercial space needs.

“The main concern here is the long wait times to get something launched and deployed,” said Quinn, “There are payloads on two-year or more waiting lists and we intend to fix that.”

Looking back at Sputnik, the satellite weighed 83 kg. yet, today, its replacement would weigh only a few ounces. Exos intends to leverage what the firm calls the “miniaturization of space” as they initially develop their small-scale launchers to serve the sub-1000 kg. reusable (first stage) launcher market.

The Future...

Exos is in the process of launching their first National Charter Enterprise in the Basilicata Region of Italy. David Mitchell and John Quinn signed the first Charter LOI with **Roberto Cifarelli**, Regional Director of the Basilicata Region, Southern Italy, on November 6, 2018, to bring an Exos presence to Italy. **Mario Mauro** (former Italy Minister of Defense and member of the European Parliament) aided in the negotiations and directed Exos in its development efforts.

While working through the process of bringing Suborbital Capabilities to Italy with the Italian government and **PricewaterhouseCoopers**, Exos realized the many benefits and resources that are available in the region. In addition to the benefits afforded companies that come to support development in the SEZ (Special Economic Zones), it is also well positioned with Aerospace University pipelines and the broad base of expertise available across the EU. When developing the business plan for Italy, the team said they could not deny the logistically enviable position they found possible if they expanded their plans for Italy to include development of the **Exos Mobile Reusable** (first stage) LEO Launch Vehicle. Based on this realization, this expansion will include additional facilities to support the added scope of LEO launcher development in Italy. Exos intends to commence construction of their Italy facilities in the second quarter of 2019.

With Exos taking their vision abroad, the world will take notice of the tiny rocket company from Greenville, Texas, and for the space industry to realize the monumental shifts that the reusable rocket maker is causing in their realm of space. Exos is excited to discuss establishment of National Charter Enterprises with other NATO countries looking to bring space development to their nations.

“Our next flight is slated for January 5th, 2019” said Quinn, “We will have a NASA REDDI payload for UCF, a NASA Tech Transfer payload, an FAA payload, several educational payloads, several memorabilia payloads, and... We will still have SPACEavailable... for your payload.”

exosaero.com

At 18 years old, John enlisted in the U.S. Navy-serving in the Silent-Service on fast-attack and Trident submarines for a total of 14.5 years (including his reserve duty). In 1992, he started his civilian career as a power plant instrument technician and operator. In 2002, he completed his degree getting a Bachelor of Science in Electrical Engineering with a Controls Specialty. John’s love of business drove him to develop the opportunity he recognized while working on an MST Project (with the brilliant Scientists at Blink Design and Manufacturing) in what we now officially call EXOS Aerospace Systems & Technologies, INC. (E.A.S.T.) In Feb of 2015 John became was promoted to Chief Operating Officer for E.A.S.T., and is driven to help make this company a guaranteed winner in the private commercial space race.



2018 marked 25 years since the founding of Foxcom, one of the pioneers of RF over Fiber technology. Needless to say, the telecom market, which has undergone profound changes during this period, has given birth to new technologies and solutions that were unthinkable back in the early 90's.

The traditional SATCOM business has been the mainstay of our business over the years, as the need for high performance RF over Fiber solutions has remained firmly in place in the world market.

Satellite and teleport operators look to Foxcom as a market leader for innovative, resilient and reliable solutions. As High Throughput Satellite (HTS) technology took root worldwide, more and more operators began deploying Ka-Band Earth stations. This created a need for site diversity to help mitigate the problem of rain fade.

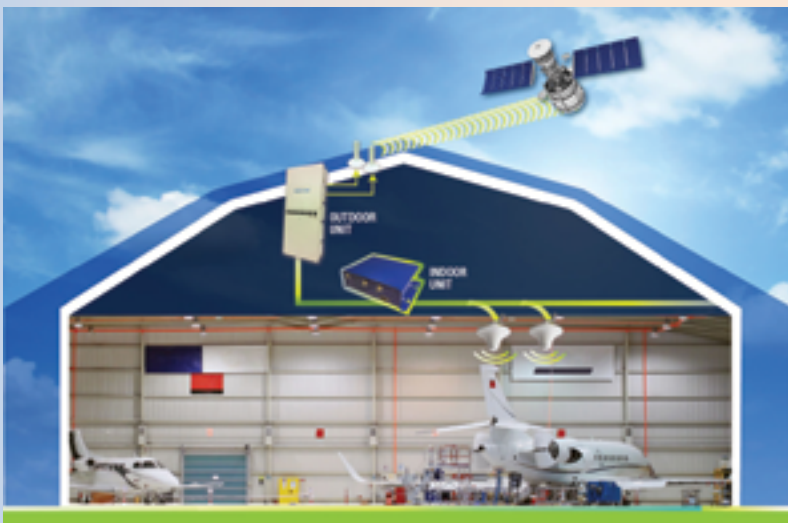
Foxcom met the challenge by providing long-distance connectivity over a single fiber using DWDM (Dense Wavelength Division Multiplexing), which reaches distances that were unprecedented in the industry. This was achieved using the company's advanced **Platinum** series of links, along with high-power optical amplifiers (EDFA's), DWDMs and an all-encompassing **Simple Network Management Protocol** (SNMP)-based Monitoring and Control (M&C) platform.

Foxcom has always been a market driven company. The company's greatest asset lies in the firm's ability to learn from customers, to leverage that intelligence and to seize opportunities well ahead of the competition. Foxcom's close relationship with the military has been a great source of inspiration for developing new technologies.

No challenge is too great for the company's R&D team. Thanks to their dedication, creativity and perseverance, Foxcom has rolled out a new range of products that are unique — if not revolutionary — in the industry.

Iridium, Inmarsat and GPS Repeaters

This year marked the release of Foxcom's new SATCOM and GPS hangar repeater solution, which enables engineers involved in **Maintenance, Repair and Overhaul** (MRO) of aircraft to undertake testing 24/7, regardless of weather conditions, without having to move aircraft in and out of a hangar, as is the current practice.



While **Inmarsat** and **Iridium** satellite equipment has been deployed worldwide, its use was limited to the outdoors, as building structures' block satellite signals. Foxcom's unique and all-inclusive repeater solution provides communication inside buildings or underground without the need for a direct line of sight to the sky.

The dedicated repeater, which now includes GPS, Inmarsat and Iridium, greatly reduces aircraft-on-ground time, man-hours and overall maintenance costs, thereby providing an immediate Return on Investment (ROI). This is our latest solution in the highly successful range of repeaters launched by Foxcom in 2014.

Beyond the aviation sector, GPS, Inmarsat and Iridium repeaters can be deployed across a range of locations and industries, such as underground civil defense and military bunkers, oil rigs and ships, and large buildings.

Military Radio Links

Military radios are equipped with encryption and hopping mechanism making their operation mode classified. This means that transmit or relay sites need be manned in order to guard these devices in the battlefield. Close proximity to the antenna makes the soldier an easy target.

The Foxcom fiber solution provides a cost-effective alternative to coax cable deployments and allows military personnel to place their antenna far away from the military radio. The equipment consists of two ruggedized units, one for the Radio-side (RSU) and another for the Antenna-side (ASU). The system supports two simultaneous radio channels and is equipped with a programmable microcontroller providing universal adaptive hopping frequency support and a Dust-Proof mechanism for maintaining constant RF performance levels.

FiberGo — Low Cost VSAT Fiber Link

Foxcom's innovative **FiberGO** solution uses a single fiber optic cable, rather than coax, to connect VSAT dishes to the indoor modems over long distances. This solution is sold as a compact and weatherproof kit with compact indoor (IDU) and outdoor units (ODU).

The IDU interfaces with the satellite modem, while the ODU connects to the block upconverter (BUC) and LNB at the antenna-site. The solution has generated much interest in the region due to the product's low cost, ease of installation and performance boost that the product line provides over traditional coaxial infrastructure.



Outlook for 2019

It is still not clear to me how HTS will affect the satellite industry as an ecosystem in the long term, and how much it will impact on the traditional satellite business model once it is fully operational.

Regardless of the outcome, Foxcom is committed to bringing solutions to new horizontal markets that leverage the company's 25 years of RF over fiber expertise. This will be an integral part of the firm's growth strategy for 2019. Our entry into the MRO market with our latest repeater solutions is a perfect example of how we plan to achieve this goal.

Being part of the **Global Invacom Group** has facilitated this growth by leveraging the vast amount resources that the group has to offer, such as their global marketing reach, integrated manufacturing footprint and strong research and development capabilities.

With seven manufacturing plants across China, Israel, Malaysia, the United Kingdom and the USA, I am more confident than ever that Foxcom will continue to position itself as the leading provider of RF over Fiber solutions to the satellite, military and aerospace industries.

www.foxcom.com



Gilat Satellite Networks

By Doreet Oren, Director of Product Marketing and Corporate Communications

During 2018, Gilat helped the world move closer toward closing the digital divide by providing solutions that enable abundant broadband connectivity to unserved and underserved areas on the land, sea and air.

HTS — Broadband

Early in the year, Gilat was selected to deliver the satellite platform for Australia's National Broadband Network, **NBN Co**. Gilat's **X-Architecture** platform is now being integrated into NBN's ten satellite gateway infrastructure, allowing NBN to address Australia's broadband demand for businesses and government customers.

During 2018, Gilat signed a partnership agreement with Russian satellite operator **Gazprom Space Systems (GSS)** to provide broadband coverage over a new Ka-band satellite, **Yamal 601**. This satellite will be launched in 2019 and is planned to serve the European and Asian regions of Russia. Already having a longstanding partnership with **Eutelsat**, Gilat has become the dominant player in the Russian Ka-band satellite broadband market.

Similarly, in China, Gilat became the sole provider of the ground network for HTS Ka-band capacity across the entire country. Gilat's network will operate with the soon to be launched **ChinaSat-18 (CS-18)** and the existing **CS-16** satellites. The deployments with Gazprom, Eutelsat and **China Satcom** create a unique ground network that stretches from Asia to Europe and enables continuous Ka-band coverage. This "**Space Silk Road**" covers two billion people, 23 million square kilometers and 30 countries.

Gilat further strengthened its leadership position with additional collaborations worldwide. In Latin America, Gilat partnered with **Hispasat** to provide the ground segment for the **Amazonas 3** and **Amazonas 5** satellites over Mexico and Brazil. In Japan, Gilat partnered with **SKY Perfect JSAT**, Asia's largest satellite operator, to support its solutions for Mobility and Fixed broadband services.

Gilat's single platform for multiple applications is the basis for expanding its offering worldwide from enterprise and consumer broadband services to applications such as **In-Flight Connectivity (IFC)** and cellular backhaul. For example, Gilat is seeing further development of IFC in China and Russia.

In-Flight Connectivity (IFC)

At the start of 2018, a live demonstration of Gilat's Ku-/Ka dual-band aero terminal, **AeroEdge 6000**, took place at a customer's site in China. The terminal demonstrated unprecedented speeds of more than 130 Mbps while maintaining application continuity with automatic beam/gateway and satellite switchover. This terminal is the only dual-band complete aero terminal that can operate and provide service over any satellite and any network, as well as having the flexibility to interwork with other modems, antennas and power amplifiers. This distinct advantage accommodates the diverse requirements of airlines and service providers.



The year ended with the achievement of a major milestone with promising business opportunities worldwide. Gilat's AeroEdge 6000 passed the standard for environmental testing of avionics hardware, receiving the DO-160 certification and qualifying for installation on commercial aircrafts.

Cellular Backhaul (CBH)

As the quest for data communication over mobile devices continues to grow, Gilat is seeing a major expansion of satellite-backhauled LTE sites, as well as ongoing growth of the capacity required for current sites. A wide variety of use

cases are being deployed, such as coverage for islands, metro-edge and tourists visiting national parks and mountainous areas, as well as using satellite-based CBH to support disaster recovery. The growing number of Gilat customers and sites indicates that the industry is overcoming the myths that were associated with cellular backhauling over satellite and is embracing satellite backhaul as a mainstream solution. Today satellite backhauling is being used to complement terrestrial solutions with an uncompromised user experience, competitive bandwidth costs and significant reduction of complexity.

Gilat was selected for major new projects this year by **KDDI Corporation** in Japan and by **Telstra** in Australia. Global deployments also included reduced complexity with Layer-2 and Layer-3 integration of the satellite backhaul with the terrestrial network. All of the projects mentioned above take advantage of Gilat's multi-application, multi-beam, and multi-satellite X-Architecture that is optimized for HTS. The underlying multi-service **SkyEdge II-c** platform supports applications such as: enterprise, cellular backhaul and mobility services over a single platform. The platform delivers high spectral efficiency and optimized space segment via advanced DVB-S2X waveform and Gilat's innovative LDPC-based fast adaptive return access scheme.

What's Coming Next?

NGSO

In addition to its ongoing business, Gilat is heavily engaged in the next wave of satellite constellations — i.e., **Non-Geostationary Orbit (NGSO)** — and this will continue to be a major focus in 2019. One of the high points in this area during 2018 was Gilat's collaboration with **Global Eagle** and Telesat in the first-ever live in-flight broadband testing with an LEO satellite. The testing, carried out on Global Eagle's **Albatross** test aircraft, has yielded continuous uninterrupted broadband connectivity, while also performing switchovers between Telesat's GEO and LEO satellites. Multiple broadband services were demonstrated and tested, including secure real-time video chat using **Skype** and **Whatsapp** in parallel, as well as secure Internet browsing. This milestone underscored the technological advantages of Gilat's solution, which supports multiple applications, satellites, bands and beams and is also the first in the industry to demonstrate multi-orbit connectivity.

5G

Satellite communications is an integral enabler of the 5G connectivity vision and has an inherent advantage when facilitating ubiquitous connectivity while driving network efficiencies forward. Gilat is active in the SaT5G European project which aims to introduce satellite communication-related standards into future releases of 5G standards.

As a leading global provider of 4G satellite backhaul services, Gilat sees the transition to 5G service enablement as a natural evolution of its current service offering, centered on its cloud-based X-Architecture. Gilat is working closely with customers and partners to enable effective extension of 5G service and use cases, as well as developing next generation high performance terminals. Leveraging its SkyEdge II-c platform, Gilat is developing efficient interfaces to 5G network functions and implementation of full network orchestration, network slicing, service slicing, QoS, acceleration and security.

Electronically Steered Array (ESA)

With the growing importance of mobility applications and the emergence of NGSO constellations, **Electronically Steered Array (ESA)** antennas are another key focus area for Gilat. Major progress is being made on Gilat's joint development with **Airbus** of an ESA antenna for in-flight connectivity, as part of the **European Commission's Horizon 2020** program. This Ka-band ESA terminal is based on Gilat's chipset for its **Phased Array Antenna (PAA)**. Gilat is investing in ESA antennas for the aero market to address the expected efficiency challenges of the upcoming market transformations. The characteristics of ESA antennas such as flat panel, instantaneous bandwidth, beam agility, multi-beam connectivity, scalability/modularity and longevity — are imperative for unlocking new business opportunities and for maximizing performance of satellite networks.

In 2019, Gilat expects to continue to demonstrate technological innovation in key industry segments for the benefit of its extensive customer base worldwide. Moving forward, Gilat is committed to the ongoing development of cutting-edge technologies and products that improve the quality of lives through enhanced broadband connectivity all the time and everywhere.

www.gilat.com

Doreet Oren (doreeto@gilat.com) is Director of Product Marketing & Corporate Communications for Gilat Satellite Networks. Doreet Oren has been in this role since 2012 and has been responsible for defining product positioning, messaging, go-to-market strategies, market research, and analyst relations. Oren has more than 20 years of industry experience, and has held management positions in R&D, product management and product marketing, for international high-tech companies. In this capacity she contributed to next generation product definition and was responsible for delivering the company's vision to the media and analyst community. Oren has published thought leadership articles in renowned international journals, and has spoken at numerous industry conferences worldwide.

Gilmour Space Technologies

By Adam Gilmour, Chief Executive Officer and Founder

2018 was a year of 'fire and fury' for new Australian rocket company, Gilmour Space Technologies, which is targeting to launch a range of low-cost, hybrid rockets for the global small satellite market starting in 2020.

"We started the year with a 45-kilonewton hybrid engine test fire in January, scaled it up to a record 80 kN in August and are now two months from a suborbital flight test of this orbital-class rocket engine," said the company's CEO and Founder, **Adam Gilmour**. This will be the company's second launch since a successful sounding rocket test in mid-2016 (see the image at the bottom of this page).

More Rockets, More Business

Despite being half a world away from most of today's space launch activities, this small company based in Queensland, Australia, has joined the race to provide smaller and less expensive launch vehicles for the next generation of smallsats heading into Low Earth Orbits (LEO). Gilmour Space plans to launch **Eris-100** in 2020, a three-stage commercial vehicle capable of carrying 100 kg. into LEO, to be followed by **Eris-400** in 2021, a clustered-engine vehicle for payloads up to 400 kg.

"The small satellite revolution is gaining momentum globally, with thousands of small satellites slated to launch in the next five years," said Mr. Gilmour. "However, these new players will be challenged by high launch costs and limited launch opportunities."

To address this global bottleneck, Gilmour Space is working to deliver dedicated and ride-share launches for smallsats weighing up to 400 kg., at prices that will enable more business and growth in this exciting new market.

In September, the company secured A\$19 million (US\$13.5 million) in a second round of funding from Australian and international investors, including **Blackbird Ventures**, **Main Sequence Ventures** and **500 Startups**, bringing their total investment to date to A\$26 million.

"I believe our progress so far puts us at a Technology Readiness Level (TRL) of six, well ahead of most small launch competitors globally. The fact that we've come this far on relatively little funding is also a testament to our innovative engineering and low cost manufacturing capability," said Mr. Gilmour. "This latest round will help us build our team, and give us the safe runway we need to launch our first commercial hybrid rocket to orbit in 2020."

Additional Highlights

In 2018, Gilmour Space signed a *Space Act Agreement* with NASA to collaborate on potential space research and technology development initiatives; two space veterans were appointed to the firm's board of advisors — former NASA deputy administrator, Professor **Dava Newman**, and former NASA astronaut and shuttle commander, Colonel (Retired) **Pamela Melroy**.

According to Professor Newman, who is currently *Apollo Program Professor of Astronautics* at **Massachusetts Institute of Technology** (MIT), "We are at the crossroads in commercial space with new small launch vehicles, and it's great to see Gilmour Space becoming a serious new player in this global market."

To support their launch efforts, the company also began work on a mobile launch platform for their rockets this year.

"Australia is a new entrant into the global space scene, and we don't have a launch site yet. As such, we've had to build one of our own, which took more time than expected with our small team; however, we're at the final assembly stages right now," said Mr. Gilmour. "Interestingly, this capability for remote and responsive launch is one that other countries like the US, Europe and UK are also trying to develop."

The Road Ahead

Looking forward into 2019, Mr. Gilmour believes that the New Space industry will need to see more small launchers coming online from 2019, as well as higher cadences from existing launch companies.

"More rockets means more business, and that will drive the small sat market to new heights," he noted. "I'm also encouraged to see continual venture capital investments into the New Space industry for both launch vehicles and satellite services. We think 2019 will be a year in which space agencies (including those in the U.S., Europe and Japan) will start to ramp up their efforts to work with small private space companies. There will likely be a record number of payloads heading to the moon surface in 2019, which would be a great sign of things to come."

"Australia, too, is seeing the dawn of a New Space Age, with a newly established space agency and key amendments in legislation that will enable domestic launches," the company's CEO noted. "Ultimately, however, what customers want are reliable, timely and affordable launches that get their payloads to where they need them to be. There are a lot of eyes on us at the moment, but that's fine... because we plan to deliver," Mr. Gilmour concluded.

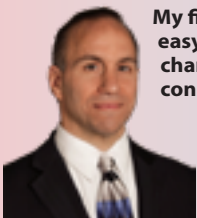
Bookings for launch will open in 2019.

www.gspacetechnologies.com

Adam Gilmour is the CEO and Founder of Gilmour Space Technologies, a venture-funded, hybrid, propulsion company that is pioneering low-cost rocket development and launch for small satellites up to 400 kg. Considered one of the leading space startups in Australia, Gilmour Space is scaling up to launch its first commercial hybrid rocket to LEO in 2020.



By Paul Scardino, Senior Vice President, Sales Engineering, Operations and Marketing



My first day of work out of college as a systems engineer is easy to remember. It was 8-8-88: August 8, 1988 — much has changed since that date,; however, one element has been constant — *Innovation*.

Globecomm started life as a systems integration company building satellite Earth stations. Today the firm integrates complete satellite networks and provides sophisticated terminals to high-demand users in the commercial and commercial markets.

However, that is just the tip of the iceberg. The company also develops and operates data and media centers, cellular and maritime networks, software platforms, global fiber-satellite networks, and much more. Technology innovation across multiple markets has become Globecomm's business, and the end of the year provides a chance to assess where those technologies have, and will, take us in the future.

Maritime Transition from L-Band to VSAT

Mobility is the great growth driver for wireless telecom — and wireless most definitely includes satellite. The maritime market has been slow to accept what the rest of the business world knows: expectations for connectivity everywhere are high and online services can substantially boost productivity and improve performance. During the past year or two, that has begun to change in a big way. Reflecting that is a growing preference for higher-capacity VSAT over L-band for maritime networks. Once costly and complex to install and operate, VSAT has become simpler, more automated, more affordable and flexible. Cost-sensitive ship owners are taking note, and Globecomm is helping them find the correct solutions for their needs.

5G and Mobile

The next generation of mobility promises a drastic multiplication of growth in capacity demand. The upcoming rollout of 5G and IoT will provide individual 5G and IoT devices on the network with between 1 and 10 Gbps of speed with practically unlimited capacity. That translates into a requirement for backhaul that is 100 times greater than today, particularly as the rise of IoT applications adds to total demand. Compared with previous generations, 5G service will depend on a much greater density of cell sites to support the high-bandwidth, low-latency service required by the 5G specification. Since the firm's inception, Globecomm has provided cellular backhaul solutions and managed services by delivering SCPC and TDMA VSAT solutions in developing countries, where fiber and microwave are either impractical or too costly. In the U.S., we've provided cellular backhaul for GSM, UMTS and LTE networks for years and — unique among teleport operator — the company owns and operates Tier-1 cellular switches. That technology allows us to provide hosted switching for rural operators, who act as roaming partners for the large MNOs but also want to provide cellular services to their general population.

Satellite has the capability to support the rollout of 5G meeting the fronthaul and backhaul capacity demands of 5G and IoT growth. Furthermore, using techniques such as data offload and optimization, satellite offers a cost-effective solution to increase the effective capacity of lower-generation cellular networks. The same holds true for video. It is estimated that more than three-fourths of the world's mobile data traffic will be video by 2021. Globecomm is already involved in the content delivery business for broadcasting, OTT and IPTV, and we expect that experience to be valuable in video delivery across 5G. As each viewer requires a separate stream in an internet environment, we are talking about billions of individual streams, especially for high-demand programming. The most cost-efficient way to provide that is by using satellite to deliver content close to the edge, leveraging the one-to-many competitive advantage of the technology.

For any of this to be achieved, satellite must aggressively engage with the standards' committees to have a voice in the development of specifications. Recently, we've seen the **C-Band Alliance** (CBA) announcement that the organization is talking with the FCC regarding proposals to use satellite's C-band frequencies to help boost take-up and deployment of 5G cellular. However, the satellite industry also needs to take an approach to ensure multi-technology connectivity — inclusive of satellite — is considered to truly provide continuity of connection.

LEO Constellations and a Flat World — Iridium NEXT Constellation

The new LEO satellite constellations promise low-latency broadband connectivity with global coverage, narrowband connectivity with partial coverage or some variation of the two. However, one thing they all promise is a much greater amount of satellite bandwidth with lower price points, depending on how many of the 40-odd applications actually make it through the licensing process. One thing is certain: the success of the non-GEO constellation will depend on development of low-cost, electronically-scanned flat panel antennas. The past year has seen an acceleration of manufacturing advances, commercial pilots and strategic partnerships, and more are certainly on the way. Growth in both the antenna and LEO services markets

requires antennas that can get to market quickly, are continuously interoperable among satellite configurations and frequencies, and come in a single, easy-to-install unit at a successful price point. **The challenge is huge, but so is the opportunity.**

Software-Defined Networks and Edge Computing

Of all the trends of the past year, the most interesting is the battle to manage the increasing complexity of applications and the networks they run on. More and more, we're noting the need for instantaneous, automated decision-making, supported by network resources — whether for autonomous vehicles, security applications, entertainment or e-commerce. This screams for computing at the edge, which in turn demands a mix of transmission technologies, of which satellite will always be one. The success of future satellite communications will require cooperation and interoperability between GEO, MEO, LEO.

The Internet of Things (IoT) and AI

IoT may be the ultimate example of SDN. Sensors and actuators connect to local computing capacity, and then to more centralized and powerful capacity that manages the entire network of sensors, actuators and edge computers. The only way to create the robust, continuous connectivity needed for IoT is with a technology infrastructure that offers a fluid and dynamic portfolio of internal and external services.

The number of connected IoT devices worldwide will grow from nearly 27 billion in 2017 to 125 billion in 2030, according to **IHS**. Satellite will play an important role in providing global IoT connectivity, as only 10 percent of Earth is covered by terrestrial communications (cellular, WiFi) — so will terrestrial wireless, and terrestrial fixed networks will provide the backbone that connects it all — and so will the people who know how to integrate these technologies and make the network optimize itself for cost and performance from moment to moment.

Globecomm won the **Top IOT Mobility Satcom Innovation** award from the **Mobile Satellite Users Association** for just this mix of technology, networks and management expertise.

I can't mention IoT without including *Analytics* and *Artificial Intelligence* (AI). As businesses look to show measurable return on their IoT investments, AI will help to make sense of the data generated from an ever-increasing number of devices and sensors. In manufacturing IoT and beyond — oil and gas operations, robotics, smart buildings, home automation, supply chains, and so on — companies are slowly taking steps to add AI to automation to achieve smarter autonomy. The sooner companies start cultivating intelligent data from a wide range of interconnected devices by using AI-based applications, the sooner they will reach greater levels of financial and operational proficiency and realize better returns on their IoT investments.

The more services connected to the internet, the greater the threat to end-point operations, and from potentially degraded speed and service quality. Think of it as pollution. The world rushed to industrialize, and then it discovered that unchecked industry leads to unbreathable air, undrinkable water and ruined farmland. Globecomm is designing cybersecurity into every network and the configuration of every end-point device, and we help our customers develop the plans and management systems needed to adapt to the changing threat environment.

Consolidation

In August, 2018, **Speedcast International** announced agreement to acquire Globecomm, with the deal expected to close by the end of 2018. Globecomm complements Speedcast's global network of satellite and fiber connectivity, and the company brings our trusted technological expertise and diversification of markets that make the combination of the two companies tough to beat. More important than technology, however, are relationships old and new. Our missions converge in the importance that customers receive. Ultimately, when we know and understand the customers, it allows us to fully grasp their goals and expectations and provide the solutions that exceed those expectations.

Earlier in my career, I was nervous for the industry. There was talk of fiber reaching every populated area on the planet and cellular technology filling in the rest. Surely the demise of satellite communications was at hand. Today I'm upbeat, as I see the industry evolving and expanding to meet new opportunities. With the ever-increasing demand for broadband connectivity, linked to the cost-performance benefits expected from the next generation, high-throughput GEO and non-GEO satellites, we can expect wider deployments of satellite as a communication medium. I'm looking forward to the new future of our industry as it continues to evolve and grow and, of course, deploy continuous innovation.

I wish you all a blessed holiday season and all the best in 2019.

www.globecomm.com

Paul Scardino is the Senior Vice President, Sales Engineering and Marketing and is responsible for Globecomm's technical solutions, products, sales operations and marketing. Previously, he was Vice President, Corporate Sales and Marketing as well as Senior Director EMEA Region responsible for the P/L within Europe, the Middle East and Africa as well as customer specific global accounts.

Goonhilly Earth Station

By Ian Jones, Founder and Chief Executive Officer



The stars were definitely aligned for Goonhilly in 2018. We kicked off the year with an £8.4 million contract from the European Space Agency (ESA) to upgrade one of our antennas to become one of ESA's deep space nodes in what will be the world's first, commercial, deep-space communications station, capable of tracking missions to the Moon and Mars.

This was quickly followed by a collaboration agreement between **ESA**, **Goonhilly** and **Surrey Satellite Technology (SSTL)** for **Commercial Lunar Mission Support Services**. Together we plan to develop a European lunar telecommunications and navigation infrastructure that will support lunar scientific and economic

development. Uniquely, these missions will be funded by payload customers wanting to take a piggy-back ride to the Moon on the Lunar Pathfinder spacecraft. Payload commitments have already been secured from some customers for the first flight and the expectation is further commitments will be obtained to fulfill the payload quota during 2019.

The Moon also lies at the heart of the company's formal collaboration with **SSTL** and **Astrobotic**. Next year, Astrobotic plans to start delivering uncrewed payload flights for organizations carrying out operations in particularly challenging destinations on the Moon, including the far side. The three partners are working together to deploy sophisticated commercial lunar communication relay services that will support these endeavors and expand the commercial lunar economy.

In May, the company welcomed UK businessman Peter Hargreaves, founder of the FTSE 100 financial services firm **Hargreaves Lansdown**, as an investor. Sharing our bold vision of becoming a new space disruptor and leader, Peter has given us the financial resources needed to embark on the firm's ambitious plans to build a truly global business spanning commercial space communications, space exploration, data services and leading edge engineering design.

Following this investment, with one eye on the future in 2018, our other eye has been focused firmly on the continued growth of our established and profitable spacecraft support and services business offering telemetry, tracking and control (TT&C), deep space communications and LEO tracking and monitoring services. Goonhilly is proud to have retrieved or renewed contracts with most of the world's major satellite operators to provide the vital communications required to fly and guide their satellites.

Achieving the goal of building a global business that will shape the next wave of satellite communications requires Goonhilly to quickly grow. Last year, we roughly doubled headcount and expect to do the same in 2019. A star appointment was the respected space and satellite industry veteran **Bob Gough**, who joined in July as Head of Business Development, Australia and Asia-Pacific to spearhead our growth in this important region of the world.

As well as the new Australian office run by Bob, we opened a second office in the UK in October. The new Farnborough site complements our base in Cornwall and supports the company's plans to expand the firm's consultancy, design engineering and small-scale manufacturing capabilities. A particular highlight is the work on the development of Software-Defined Radio (SDR) and smart antenna systems for supporting ground terminals.

Blasting off into 2019

2019 is poised to be another ground-breaking year for the entire industry as well as for Goonhilly. With so much going on, it is difficult to call out just a few areas to watch, but the shortlist:

Building a commercial economy on the Moon (and ultimately Mars)

With a renewed interest in the Moon as a destination for prospecting and exploration - and ultimately as a stepping stone to Mars - deep space is definitely back in favor. In 2019 we will see more commercial and government-backed missions being planned and executed as the deep space economy lifts off.

At Goonhilly, we will continue to work closely with our partners on the design and deployment of commercial deep space communications systems. We will progress our plans to build a private global network of deep space antennas, including identifying suitable ground station sites in Australia and North America, and continuing our work on upgrading our existing antennas at Goonhilly, readying them to meet the short, medium and long term requirements of space agencies and a wide range of commercial users

Lift off for new-space LEO tracking systems

The LEO satellite market in particular will be one to watch in 2019. Supporting a constellation of LEO satellites with a collection of tracking



antennas on the ground is complex. In our view the sector has so far struggled to find the right satellite tracking business model that will open the floodgates for massive growth. We're already hosting tracking antennas for a few customers, and we are firming up partnerships in this space. We see a real gap in the market for a disruptor like Goonhilly to make waves here. To support the constellations of orbiting satellites starting to come into play, we are starting work on designing, and ultimately manufacturing, new kinds of advanced phased array systems for LEO satellite tracking. Plus a little further out we plan to design and manufacture user terminals to house and enable these arrays.

Applying radio astronomy techniques to new space communications

For some reason, radio astronomy has never been considered a part of the space sector. But this is about to change. This year we'll see a ramping up of interest in applying radio astronomy techniques to solve some of the new space communications challenges. Working closely with the UK's academic radio astronomy community our engineers are already applying the latest radio astronomy techniques to innovative commercial projects, for example, the development of whole-sky antenna arrays for detecting and tracking satellites. These arrays will in turn enable other services including: IoT-centric satellite terminals; 5G satellite systems; aeronautical terminals; and highly efficient and high-throughput modulation designs for constellation communications.

Data Centre and Internet Exchange

We are investing over £1m in upgrading the power, cooling, monitoring and fire-suppression facilities in our state-of-the-art data center. Goonhilly sits at a unique geographical location on the world stage where sub-sea fiber-optic cables from all continents converge at landing sites nearby. We plan to make our facilities freely available to carriers wishing to participate in our Internet Exchange and committing to minimum service level agreements.

UK spaceport developments

Last but not least, we are a key partner in the UK's plans for spaceports. We can expect updates from Spaceport Cornwall on their plans to provide **Virgin Orbit** with a strategic location at Newquay for the UK's first horizontal rocket launches using a 747 plane. This exciting venture is one that is particularly close to my heart as it will see Goonhilly providing the all-important tracking services.

As we round off a year that was packed with major developments for Goonhilly, a source of huge pride is the company's collaboration with **Development in Africa with Radio Astronomy (DARA)** project which won a **Better Satellite World Award**. DARA is an amazing project led by Professor **Melvin Hoare** of the **University of Leeds' School of Physics and Astronomy**, with Goonhilly as an industry partner, that uses radio astronomy to develop high-tech and business skills in eight sub-Saharan African countries. The DARA partners train African students in radio astronomy. The goal is to share technical and commercial expertise that inspires the students to boost economic growth by setting up their own businesses and passing on their knowledge and skills to the next generation of students. For **Space and Satellite Professionals International (SSPI)** to acknowledge DARA with a Better Satellite World Award is an honor and a real testament to how radio astronomy and related space sciences can play a key role in transforming economies, businesses, and the day-to-day lives of people, everywhere.

www.goonhilly.org/

Ian Jones is founder and CEO of Goonhilly Earth Station Ltd. A talented satellite communications engineer and successful entrepreneur with over 30 years' experience, Ian has led the rejuvenation of the renowned Goonhilly satellite teleport, building a profitable business offering commercial satellite communications, deep space communication, radio astronomy, and data center services, training, and business co-location services. Prior to running Goonhilly, Ian was Managing Director of Orbit Research Ltd., a company he co-founded in 1994.

By Pekka Laurila, Co-Founder and Chief Strategy Officer



2018 has been an unprecedented year for the space industry — from spawning an exorbitant number of launches by companies such as SpaceX and Rocket Lab, to hundreds of millions of dollars being invested in emerging startups, the industry is growing at a massive rate and everyone is taking notice.

New Space has been on the rise for several years now, as traditional companies have recognized the inherent need for collaboration to drive innovation and move the industry forward.

This last year, however, has been critical for securing a fruitful future for companies like ICEYE, who have successfully demonstrated the potential of their technology.

Seraphim Space Capital reported that the Space Tech industry received \$3.312 billion in venture capital (VC) investment between June 30, 2017 and June 30, 2018, with the launch sector corresponding to the majority of transactions.

ICEYE was fortunate enough to receive funding this past year and also successfully launch the world's first synthetic-aperture radar (SAR) satellite under 100 kg. in January of 2018.

While the expectation is that all should expect remarkable innovations in the year to come, 2018 certainly proved to be an exceptional year when noting the technology that is transforming the industry.

SAR Success

Until this past year, SAR technology was a phrase heard, but not all that often. Not because the technology didn't exist, but because the success rate for launching the miniature SAR radar on a satellite into orbit was at zero percent and tantamount to a myth — would anyone be able to prove that a SAR satellite can work?

At ICEYE, we took it upon ourselves to challenge the industry's preconceived notions about SAR and to prove that it could be accomplished. ICEYE miniaturized the SAR instrument by building our own technology from scratch and fitting it on a satellite with a mass of under 100 kg. — bearing in mind that the earliest versions of these satellites could weigh upwards of thousands of kilograms.

In January of 2018, ICEYE garnered success: the company launched a smallsat (under 100 kg.) into Low Earth Orbit (LEO) on board **ISRO's PSLV-C40** rocket. Further underlining the success, ICEYE established communications with the satellite while the spacecraft was on orbit and subsequently captured more than 600 images from around the world during the breakthrough **ICEYE-X1** mission.

SAR radars have a wide range of benefits compared to optical radars. SAR radar technology can see through inclement weather and cloud cover without sunlight. The capabilities of SAR data range from the prevention of illegal fishing to monitoring crops and detecting icebergs, and the applications for SAR continue to grow. 2018 saw only the beginning in demonstrating these use cases.

Increase in Funding

Adequate funding was and is a critical factor in the success of companies such as ICEYE who rely on private investments to further R&D and fund launches that are strategic in demonstrating to customers and VCs the viability of a satellite's technology.

Notwithstanding the risk, of course, ICEYE's recent Series B funding of \$34 million was raised to accelerate the company's launch plans, supported by ICEYE partners' belief in the company, largely due to the success of the first satellite launch, ICEYE-X1.

This level of funding is expected to increase throughout the industry in 2019, as more New Space companies from around the world continue to break ground.

One of ICEYE's lead investors, **Space Angels**, predicted in one of their quarterly reports that 2018 would be the 'Year of Small Launch'. And with launch investments exceeding \$1 billion, we have to agree with that statement. With the recent surge in launches and funding, launches will continue to 'take off' during 2019.

Beneficial Partnerships

Partnerships with traditional and New Space companies were also solidified in 2018 and will continue to increase in 2019.

ICEYE entered into partnerships with the **European Space Agency**, **Aker Arctic** and **KSAT (Kongsberg Satellite Services)** to change the future of Earth Observation (EO) and improve access to satellite imaging data.

It's no longer about one company achieving the impossible; it's about companies joining forces to combine their respective advancements in technology and move the industry forward as a result.

The benefits of partnerships doesn't end there, however. ICEYE's relationships with investors such as **Seraphim Capital** and Space Angels are intended to last far beyond the signings on the dotted line and these relationships will extend into the generation of new opportunities in the future.

2019 and Beyond

While 2018 was certainly a milestone year for ICEYE, such doesn't mean that the firm won't be facing additional challenges in the coming year, just as other New Space companies will face.

The industry is constantly in flux; however, ICEYE is eager to see additional satellites being launched in 2019 and the company will truly move the needle by reaching the goal of launching a full SAR constellation by 2020.

ICEYE is excited to launch as many as nine additional ICEYE satellites before the close of next year, further showcasing the capabilities of SAR technology and helping the company move one step closer to changing the future — for the better.

As ICEYE continues to see growth, it's undeniable that the future of space is also transforming. While new players are entering the market, costs are going down and new technologies are being developed, all of which can enable further expansion in various industries.

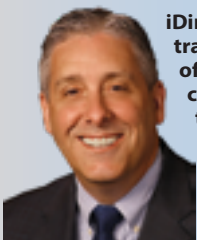
Even more of a telltale sign that the industry is seeing rapid growth is the rise in interest from VCs. With more successes being delivered through the pipeline, investor interest will likely skyrocket in the next year, particularly for more niche sectors such as EO. This further demonstrates the abilities and the transformative capabilities the New Space industry offers for the future.

www.iceye.com

An artist's depiction of ICEYE-X2 SAR satellite in orbit.

As CSO, Laurila has been instrumental in establishing and directing the company's strategy — previously, as CFO, he raised the initial \$20 million in funding for ICEYE. Laurila joined forces with ICEYE Co-founder Rafal Modrzewski to create synthetic-aperture radar (SAR) smallsats to solve the various large scale issues the world faces, including those related to the melting ice caps, ice monitoring, agricultural issues, and analytics focused on Earth Observation.

Prior to co-founding ICEYE, Laurila played an instrumental role in Finland's Aalto University Nanosatellite Program Aalto-1, where he studied as a student of the Engineering and Geoinformation Systems program.



iDirect can look back at 2018 as a year of continued transformation. We're experiencing a thrilling mixture of innovation, optimism and anxiety. Currently, satellite connectivity advances are merging with an even bigger transformation across mainstream telcom networks.

On the satellite front, we continue to be dazzled by the revolution in the sky — new satellite designs and constellations across GEO, MEO and LEO orbits that are projected to drive down the overall cost of satellite capacity to spur new growth. Satellite ground infrastructure leaders are, in turn, focusing on service roaming, sourcing bandwidth from multi-orbit constellations, software-defined terminal architectures, flat-panel antennas and new designs for both hub infrastructure and network operations that reduce the cost to scale and manage networks.

On the broader telecom front, mobile operators are re-architecting wireless networks to support exploding demand for connectivity around the world. Along with terrestrial and satellite network leaders, they are co-developing new standards for network speed, reach and operating efficiency.

A key tenet of the 5G standard is the convergence of access technologies into a unified force. If the satellite industry leverages this opportunity, we can accelerate the integration of satellite and mainstream networks to connect the world in bold new ways. iDirect's 2018 is a story in how we are taking measured steps in this combined direction so that our customers can grow their businesses to new levels.

Expanding DVB-S2X Networks

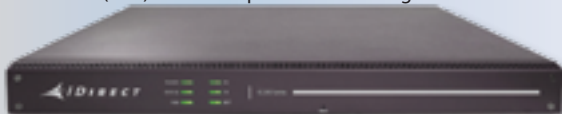
In 2018, iDirect saw many of our customers in price-sensitive enterprise markets launch new DVB-S2X networks to gain greater efficiency and meet growing bandwidth demands.

- **Bentley Walker**, a major operator of VSAT Networks, launched an iDirect-based DVB-S2X service in Afghanistan, following highly successful deployments in Iraq and Libya.
- Chilean satellite service provider, **Andesat**, leveraged our iQ remotes and Intelligent Gateway to introduce powerful new DVB-S2X networking capabilities. Their initial target is the commercial fishing market, which has long needed the right blend of features and affordability.
- **MEASAT Satellite Systems** deployed the first iDirect DVB-S2X network in Malaysia to bring its customers scalable and affordable satellite broadband services and tap into new markets.
- **Internet Solutions**, a leading Pan-African service provider, launched the first iDirect DVB-S2X network in Africa to expand into new markets, such as finance and energy, delivering greater satellite throughput efficiencies to its customers.

Expanding the iQ Portfolio

iDirect is leading the development of software-defined remote architectures. We believe that terminals should be engineered to support multiple waveforms and access technologies; integrate into 4G/5G wireless networks; be upgradeable over the air without service disruption; and leverage innovation at the edge device.

The firm's iQ remote portfolio is a step in this direction, delivering greater performance and efficiency to leverage the benefits of today's High Throughput Satellites (HTS) and the capabilities of next-generation U-HTS.



iDirect has addressed the low-end price sensitive markets with the **iQ Desktop** remote. This year, we addressed the low-end to mid-level mobility and cellular backhaul markets with the launch of the **iQ 200** rackmount and board-level remotes. Early adopter testing has been extremely positive.

For the cellular backhaul market, the company is combining the iQ 200 with our **SatHaul-XE** solution to provide a cost-effective, high performance solution for 2G/3G/4G with an enhanced end-user experience.

Strong Growth in Government and Military

This year saw continued expansion of defense spending and demand from government and military markets around the world.

With the launch of our defense software release, **Evolution 4.2**, which enabled the full capabilities of the **9-Series** satellite routers and **Defense Line Cards**, many of our customers refreshed their networks for the enhanced capabilities that came with our 9-series portfolio.

iDirect also launched the **9050 OM** for U.S. customers, the firm's first, fully-ruggedized terminal designed to withstand harsh environments and survive a High Altitude Low Opening (HALO) parachute jump.

In May, the **Tactical Removable Airborne Satellite Communications (TRASC)** became available — TRASC is an FAA-approved design for the C-130 to deliver cutting-edge SATCOM technology to the warfighter. TRASC was designed in partnership with **UltiSat**, **SelectTech GeoSpatial** and **R4 Integration** as an ideal solution for the C-130 aircraft.

Greater Ecosystem Collaboration to Open New Apps and Markets

As an industry, we need to collaborate across a much wider array of players from satellite operators, ground infrastructure developers, and terminal integrators to mobile operators, aero integrators and auto manufacturers.

In 2018, iDirect expanded its partnership with **Kymeta** in an agreement to become an official reseller of the **KyWay Terminal** to the company's global base of mobility-focused partners. The KyWay Terminal integrates with the **iDirect X7 modem**, uniting performance with a sleek, cost-effective form factor. The partnership will drive growth across key mobility markets, specifically for land mobility, such as first response vehicles, trains and buses.



This year, iDirect and Kymeta showcased our solutions at Verizon's exhibition of the world's latest emergency response innovation. An All-Terrain Vehicle was rolled out that enabled first responders to communicate with their existing communications devices back to the command center to send crucial data.

The company also expanded our strategic relationship with **Inmarsat** who, this year, awarded iDirect with the ground infrastructure contract for the fifth **Global Xpress (GX-5)** satellite. The contract is a critical advancement in mobility, enabling commercial airlines, maritime operators and mobility service providers to gain a performance advantage while meeting escalating customer demands.

Driving Satellite and Mainstream Connectivity Integration

In 2018, iDirect joined forces with two consortiums to drive research, development and validation of key principles for satellite integration with future terrestrial architectures. This first of these is the EU-sponsored **SaT5G Consortium**. The second is ESA's **SATis5**, through which iDirect is leading research and development to support multi-orbit (Geo and non-Geo) satellite integration into 5G.

iDirect is teaming with consortium members on solutions for telco providers so they can accelerate 5G deployment over satellite across all geographies and support multiple use cases, such as massive IoT and enhanced broadband (eMBB), as efficient, edge delivery of multimedia content. 2018 marked the year where iDirect showcased two, first-of-its kind live demonstration at 5G industry events.

Accelerating in 2019

Turning into 2019, iDirect is focused more than ever on driving innovation across the satellite industry. The iQ remote portfolio will be expanded with the introduction of the **iQ 800** and **iQ 500**, and further return channel enhancements in terms of efficiencies and throughput. The iQ 800 is an aero solution designed for high-throughput capabilities, featuring wideband support and seamless satellite beam switching. The iQ 800 will also be the industry's first multi-provider roaming solution. The iQ 500 will serve high-end mobility and telecommunications markets with high-throughput capabilities and wideband support.

The company will continue to improve performance and efficiency in waveforms, with the development of alternate return channels for aero and maritime networks. We'll integrate further with wireless and terrestrial networks through 5G collaboration efforts and the company will move more aggressively toward delivering remotes as software solutions that can be embedded in new form factors.

For 2018 and into 2019, the iDirect goal is to drive down cost and drive up performance for customers — all the while equipping them with the technology to participate and drive new revenue within the end-to-end network.

IMT Vislink

By David Edwards, Product Manager

People on the edge of the SATCOM world have often viewed the industry as static and slow to change; however, when you are at the heart of the action, you can see the evolution and transformation that is occurring at an ever increasing pace.

For an industry that relies on RF technology, there is a lot happening to integrate with the IP connected world. The rapid growth in High Throughput Satellite (HTS) capacity and the rise of Ka-band capacity is a testament to that, with some predictions suggesting a doubling of leasing revenues by the early 2020's. There are major innovations going on in what has been termed New Space — Low earth Orbit (LEO) constellations that promise connectivity for locations that have always been a challenge for any form of reliable communication. This includes dependable, high bandwidth infrastructure for developing nations, polar regions and marine services.

IMT Vislink is seeing transition and growth driven by humankind's desire to experience more and better visual communication systems. 4K UHD resolution video is having an impact on TV broadcast services. Forward-looking statements of intent from many top-tier providers and high-end live events indicate that 2019 is likely to bring an increased demand for payload capacity and demand for antenna systems that fulfill the link budget requirements of higher bandwidth transmissions.

News programming is changing as well. News channels were once marketed and funded as halo services that stood clear as the identity of a broadcasting brand. Budget priorities have changed and operations leaders are investing in new ways to be more efficient in delivering on the insatiable appetite for news. Pre-recorded pieces to camera delivered as video files are becoming more common than live two-way interviews. There is a drive to procure more integrated and automated technology in a move to lessen the need for multiple highly skilled, highly specialized technical staff. Operational simplicity is most certainly the order of the day going forward.

Live TV broadcasting over satellite and other forms of connectivity continues to be driven by cost per bit economics. Uplink operators are keen to reduce their OPEX costs by investing in greater transmission efficiency — the company has been actively innovating this year to deliver that next step change.



IMT Vislink has recently been showcasing a suite of new **Advent** products in the form of the **DVE 6100** satellite encoder and **IRD 6200** satellite decoder (pictured to the left), that together provide end-to-end video connectivity and use new HEVC compression and

DVB-S2X satellite modulation.

These two technologies combined offer up to a 50 percent reduction in satellite bandwidth compared to older technology, while maintaining equivalent quality video. For HD resolutions, the reduction in satellite bandwidth leasing and satellite bandwidth costs can result in a payback on investment in new equipment in just a few months. For operations that are dealing in 4K quality video, the new technology is the key that makes a service launch a practical reality.

It is not just the search for OPEX cost reduction where the new HEVC and DVB-S2X technology finds a home. By being more efficient in use of valuable bandwidth, broadcasters now have access to more payload data rate without transmission cost increases. This new space enables the broadcasters to satisfy the demand for additional content, like companion device content, commentary tailored to highlight a particular team and backstage interviews that all become affordable and deliver a more engaging production.

The Advent DVE encoder and IRD decoder products have developed a strong following in the SATCOM world by mixing high-quality video compression with low latency processing, which is extremely valuable when communication channels inevitably incorporate a geostationary round-trip. The small form-factor and integrated HPA control capability delivers valuable space-savings in increasingly sophisticated uplink vehicles or for fly-away applications that have to comply with airline baggage regulations.

Where does the IP world come in? In short, everywhere — IP internet connectivity between equipment is preferred as it leads to common interfacing, lower cost installations and for mobile operations, a valuable reduction in weight. New standards for video interconnection are now here and 2018 saw the beginning of SMPTE 2110 as a mechanism to transport baseband video over IP with the first all-IP video production trucks being brought into service. 2019 looks like it will be the year that many operators follow suit and finally transition to all-IP internal connectivity.

IP is increasingly critical on the external communication side too. In today's hyper-connected world, it is unrealistic to expect remote and mobile teams to be beyond reach of IT network connectivity. For newsgathering and outside broadcast satellite transmission operations, if there is go-anywhere satellite connectivity, why not simplify operations by providing go-anywhere satellite connectivity to the corporate network?

This year, IMT Vislink has been responding to this need with a brand new Advent satellite terminal with IP at its heart. The **AirPro75Ka** antenna offers high rate IP connectivity that allows ad-hoc connection to the **Eutelsat Konnect** (formerly **Tooway**) network.

The Advent AirPro75Ka terminal is a single-click device that automatically finds the satellite and provides users on-air connectivity in a matter of minutes. The antenna system uses pay-as-you-go data bundles for general connectivity and file transfer in conjunction with the ability to book uncontended satellite time to enable live and reliable broadcasts.



The Advent AirPro75Ka antenna has been finding many fans in the SATCOM industry by addressing the need of operators to work in newer and smarter ways with better use of budgets. The Ka-band IP connectivity provides better flexibility, better price per bit and a physically smaller antenna package than traditional Ku-band terminals, which allows it to be installed as a companion antenna on existing DSN trucks or as a sole transmission device on new smaller vehicles.

Having tested the market response to the device this year, conducting data transmission trials, including on environmentally friendly electric vehicles, not only are customers liking the robust affordable construction, they are also liking that IMT Vislink is selling the antenna and air-time as a combined package. Selling both the antenna and air-time in a package is enabling a quick and easy transition to the IP connected world. This is something IMT Vislink will be taking to the mass-market in the coming year.

With such a heavy investment and commitment to the SATCOMs industry, IMT Vislink is reaffirming the long-standing Advent satellite brand. Users taking delivery of new satellite products in 2019 will notice improved user interfaces and a fresh modern logo that reflects the dawning of a new IP-centric satellite world.

www.vislink.com

David Edwards started his career as a design engineer working on the first generation of Direct Conversion satellite demodulators for Digital TV - realizing an all-silicon solution that enabled a shift in technology price points and reduction in complexity. With a background in designing link budgets for many of the world's leading broadcaster's satellite networks, Edwards understands the balance and trade-off of video quality, network reliability and operational cost that operators need to create a financially successful satellite-based business. Acting as a Product Manager at IMT Vislink, Edwards spends a good deal of his time monitoring industry trends, listening to equipment operators to understand what matters most to them and translating these desires into bringing to market many familiar, leading-edge satellite broadcasting products.

Integrasys

By Alvaro Sanchez, Chief Executive Officer and Marquess of Antella

2018 has proven to be an exciting year for Integrasys, with important changes occurring — there's a new CEO for the firm, and with that change, new business units and positions have been acquired.

The company bases its success in innovative products that make satellite technology simpler to use — the company launched multiple new technologies during 2018 and developed highly effective new partnerships.

Following the company's strategy of "Win-Win" with our partners and to never compete with them, Integrasys has accomplished several superlative achievements. In 2018, we obtained partnerships with **SpaceBridge** and **UHP** with new projects and numerous opportunities afforded the firm.

Integrasys' **Alusat** was awarded the most *Innovative Technology* at a trade show by the **World Teleport Association**; thanks to the product's massive OPEX savings that predictive maintenance delivers to the satellite networks. Additionally, the industry recognized Integrasys as one of today's most innovative companies with four awards over the last four years

This year, we grew our staff by 180 percent and gained far more traction with **Integrasys LLC** within the USA through the hiring of new employees. Additionally, significant staff was added in Madrid and then, following closely, the company's Seville, Spain, unit added a new Customer Success Business Unit. Currently, the company is expanding into Asia.

Last year, company profits grew 300 percent and this year appears to also experience strong growth in profitability, thanks to the industry trusting the firm's technologies and the great support across the globe. This year, before the end of Q3, Integrasys will have exceeded the 2017 revenue.

After 28 years of being a very stable business, it is a pleasure to experience how a dynamic company can strengthen their product lines through innovation and then, subsequently, win significant market share by differentiating their technology from competitors.

Satellite operators today need to consider the acquisition of tools that add value to support the increased capacity needs of customers and to provide a better value proposition to their VNOs. Integrasys offerings are ideal for this proposition, allowing service providers and telcos to save significant OPEX.

Integrasys is fully engaged with our customers. The firm's support team is staffed by the same engineers who develop the product, which helps with instant connectivity resolution, providing support anytime, anywhere — Integrasys has received a 99 percent Customer Support Satisfaction via customer support surveys.

Integrasys is global company with partners ranging from New Zealand to Alaska and is opening new offices across the globe. The company is providing new solutions day by day, with the goal being to facilitate the needs of our customers.

Integrasys would not be the success that it is today without the dedication of our partners. The company is proud to be working with most of the leading Satellite Operators and Service Providers in the industry. For us, a total commitment to quality and service is an absolute must.

The company's R&D team has more than 25 years of experience and the Integrasys engineering team in Seville has been developing ad-hoc projects to solve a variety of customer challenges to ensure their success.

We strongly believe that product innovation and understanding the needs of customers and the market are the keys to success.

In 2019, Integrasys expects to experience important growth in various regions across the world, with new offices to support a growing customer base. The company commits to provide them with simpler and faster solutions for monitoring their carriers, as well as designing, deploying and maintaining their networks.

www.integrasys-space.com

Alvaro (pictured to the right in the photo below) is the CEO of the Integrasys Group (Integrasys S.A. and Integrasys LLC), and focuses on developing and commercializing the best Carrier Monitoring Systems and VSAT Network tools for designing, deploying and maintaining networks. In the past years, Alvaro has experience in the Sales & Marketing Departments at Integrasys — prior to joining the company, Alvaro was an RF Engineer at CERN in Switzerland.



KenCast, Inc.

By William Steele, Chairman and Chief Executive Officer

The potential of Non Geo-Synchronous Orbiting Satellite constellations is well recognized. This has drawn unprecedented investment from major entities with over two dozen NGOS constellations preparing to launch in the next two years.

There are a vast number of applications, many potentially global, enabled by these new LEO and MEO constellations. Teleports, application owners and integrators can take advantage of them — in many cases, with hybrid networks combining GEO constellations, 5G, and 5G LTE-Broadcast (aka, eMBMS) networks.

However, there will be inevitable failures and consolidation going forward. Because of shifting technical and price leadership among constellations, antennas and Earth station vendors, it behooves early application builder teams to implement with flexibility to take advantage of, or recover from, these shifts — that is, to launch and go forward with Open Architecture where feasible.

Constellations

These pending satellite constellations bring much higher throughput than the current generation. In addition, speeds on satellite can now match or even exceed fiber by using laser. Several constellations intend to offer laser interconnectivity between satellites. Combined with laser uplink at the source and downlink to local sites or local broadband networks, which effectively provides fiber-speeds end-to-end globally.

Fiber offers great speed but has limits: laser has a serious vulnerability to atmospheric disturbances; and, unlike RF, laser is not suitable for multicast of the same large content directly to a multitude of sites or vehicles, even when in line-of-sight. This also argues for RF/laser hybrid networks and error correction capabilities.

Antennas

Delivery of files and live streams from orbiting satellites to moving vehicles is an enticing possibility with these global markets in the offing. However, early testing has exposed the difficulties of transmitting from orbiting satellites to vehicles on the move. Vehicles may intermittently lose signal because they are randomly visible to satellites, on a difficult incline when in sight, traversing tunnels, under overpasses, in urban building canyons, or turned on/off.

Success requires an antenna with a flat profile, low power consumption and reliability in delivery, often of encrypted/DRM content, as well as strategies for dealing with the inevitable, intermittent, lost signal issue.

Open Architecture strategies — that include forward error correction algorithms and availability simultaneously of multiple wireless network paths via MEO, LEO, LTE, with 1 or more antennas — provide approaches to achieve reliable delivery.

The best offerings on the market will likely change over time and between market applications. Applications built with open architecture will better migrate between networks and antenna and terminal offerings, as reliability and price bestow new opportunities over time.

Strategies for Establishing Smallsat Open Architecture

Content for smallsat applications will, in many cases, come from Cloud storage, where Open Architecture is more established by the archival community. For example, in the reference model for cloud storage, *Open Archival Information System (OAIS)*¹. Strategies from OAIS (Refreshing, Migration, Replication, Emulation, and more) can be adapted to smallsat network delivery also.

Some of the weaknesses of laser networking can be overcome by routing around bad weather, employing forward error correction schemes and/or switching to terrestrial wire/wireless network alternatives whenever necessary. Satellite carriers are currently experimenting with lasers and LTE and other RF networks for these reasons.

Hybrid network offers the immediate alternative path option as well as the opportunity to more quickly take advantage of breakthroughs that will certainly occur from time to time with flat plate antennas, laser terminals, next generation LTE, satellite modems, and the satellites themselves.

Elements in an Open Architecture

KenCast's *Fazzt* platform for content delivery is designed to provide the tools content owners, teleports, and integrators need to realize Open Architecture on new HTS Smallsat and GEO constellations.

To achieve flexibility in technically and economically shifting markets, the foundation software & hardware delivery platform for operation may usefully include:

- **Hybrid use of GEO, MEO, LEO, LTE, WiFi, Fiber, and/or other networking**
- **Dynamic alternate network routing — alternate routing to avoid weather, network congestion/network-outages**
- **Replicating and Refreshing content in diverse cloud storage locations to shorten delivery time, provide content backup, and alternate sources for network path disruption**
- **Hybrid use of diverse antennas — FPA, parabolic, laser terminals, LTE-B, WiFi.....**
- **Multicast, unicast — on wire and wireless media**
- **Multiple, diverse Forward Error Correction schemes/algorithms to ensure recovery**
- **Application & Network-specific security for delivery of encrypted/DRM content (files & streams)**
- **Migration-Prepared — be able to readily move to newer/better/less-expensive networks, antennas, clouds, CDNs..... as technology and pricing shift**

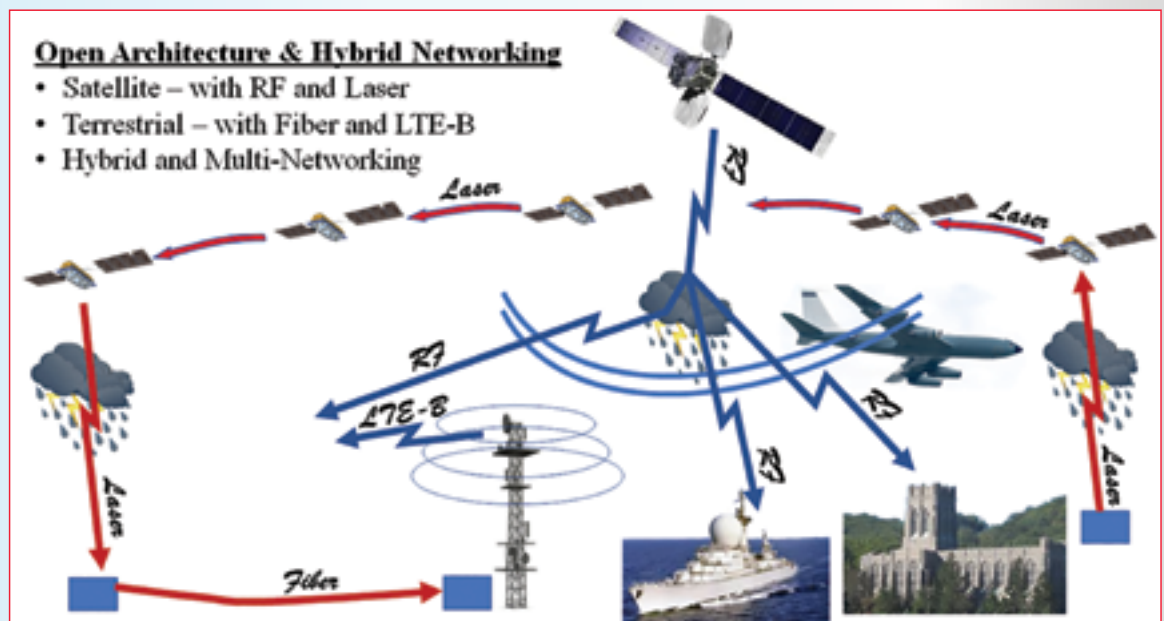
The KenCast *Fazzt* platform for content delivery supports hybrid networking and Open Architecture.

www.kencast.com

Reference

¹ Digital Preservations: see en.wikipedia.org/wiki/Digital_preservation#Migration

William Steele is Chairman & CEO of KenCast, Inc. Prior to founding the company, he spent 14 years with GTE Corporation; five of those years as General Manager of the GTE ImageSpan company within GTE Spacenet. His experience in the satellite and telecommunications industry includes a position as Vice President of Marketing at the Microband subsidiary of McDonnell-Douglas and Sales Manager at the American Satellite Corporation division of Fairchild. He was an Assistant Professor of Economics at Villanova University and holds a Ph.D. in Economics from New York University.



Kepler

By Jeffrey Osborne, Vice President of Strategy and Business Development

Kepler was founded in 2015 with the mission to build in-space telecommunications infrastructure. By providing connectivity to spaceborne assets, this infrastructure will enable the space economy and allow society to expand into space.

After the first three years of operations, the Canadian company has already broken a few records including the launch of the first commercial Ku-band Low Earth Orbit (LEO) satellite and demonstrating the highest data rates ever achieved with a nanosatellite.

All along, Kepler's strategy has been to develop best-in-class satellite communications technologies that can simultaneously serve the needs of near-term existing markets, and progressively build capacity to deliver upon its ultimate mission; to become the backbone network for space data relay.

In January of this year, Kepler launched its first satellite, nicknamed **KIPP**. Joined on orbit in November by the firm's second satellite, **CASE**, these sister satellites are tasked as technology demonstrators for the company's pole-to-pole wideband store-and-forward data service. In addition to the firm's wideband connectivity service, Kepler plans to address the Internet of Things (IoT) market with cellular-like, narrowband, bi-directional communications through an ultra-small, low-power, low-cost satellite transceiver.

Take-Off into Headwinds

Major tectonic shift are occurring as new capabilities are brought into the satellite broadband market. High-throughput satellites (HTS) systems have completely changed the game.

With a single HTS now capable of delivering 10 to 100x the capacity of a broadband satellite, the market for bandwidth is exceptionally competitive. As supply dwarfs demand, bandwidth pricing has plummeted around 50 percent across the board. The days of \$3,000/MHz are long forgotten and empowered customers are driving prices below \$1,000/MHz.

Double-digit revenue drops for satellite operators are the norm as they reduce prices to stay competitive and maintain acceptable fill rates. The unwavering laws of supply and demand appear to be holding steady.

All the while, far on the horizon, are the audacious plans of non-geostationary HTS (NGSO-HTS) systems. Regardless of the many controversies around the economic viability of these systems, their deployment could profoundly impact the market.

The recent increase in global satellite bandwidth supply via HTS systems from around 500 Gbps to 1 Tbps has led to a 50 percent drop in prices. A sudden increase of 10s of Tbps as promised by these NGSO-HTS systems will have a profound impact on bandwidth prices and the business model of all satellite operators.

Rather than attempt to play in these contentious markets, Kepler has placed its initial focus on providing a wideband connectivity to niche and underserved markets. For instance, there are gaps in connectivity for organizations that operate predominantly at the poles. At extreme latitudes, mountains, trees, rolling sea waves, and ultimately the curvature of the Earth, cause intermittent or permanent blockage of GEO satellites. Due to poor GEO coverage at the poles, there does not exist the same race-to-the-bottom for bandwidth pricing.

Determining the Ground Challenges

The bulk of Kepler's early pilots have been maritime operators — icebreakers, scientific vessels, and cruise ships — that seek a wideband data service that they otherwise cannot get for their polar operations. For vessels, a key challenge has been a lack of available deck space for new antennas. To solve this challenge, as well as to reduce the cost of hardware, Kepler developed its connectivity service to be backwards compatible with off-the-shelf Ku-band VSATs.

In addition, as most modern ships have two or even three VSATs on board to provide redundancy from antenna shadowing, Kepler's service is able to leverage the secondary or tertiary antennas. Effectively, this gives ship operators the ability to add

a wideband store-and-forward service while maintaining real-time connectivity on GEO satellites.

This past year also brought Kepler a number of new collaborations with antenna manufacturers, including a demonstration with **Phasor's** flat panel antenna technology communicating with our smallsat.

Widely believed to be a necessary technology to fully leverage NGSO-HTS systems, there are also some early use cases for operations in very extreme environments where lack of mechanical actuation on high-gain VSATs is an important value-add. Through the demonstration, Kepler and Phasor demonstrated 10 Mbps uplink, 20 Mbps downlink to a nanosatellite.

Advancements Toward Narrowband Connectivity

In parallel to the offered wideband data services, Kepler continues to make strides toward developing a cellular-like narrowband connectivity service for Internet of Things (IoT) devices. Although terrestrial infrastructure for connecting IoT devices is widespread, a key challenge is connecting a single device across borders and regions because of disparities in frequency and network technology.

More specifically, there are around 50 LTE frequency bands used globally, with no single wireless module capable of connecting across all networks. Network technology is also inconsistent between countries. 2G (GSM) networks are being shut down across a number of countries despite the technology's benefits for low-bandwidth IoT connectivity.

The recent **LTE Cat-M1** and **Cat-NB1** standards are intended to replace the loss of 2G for IoT devices; however, telecom operators remain inconsistent in their roll-outs. U.S. network operators have shown a clear preference for LTE Cat-M1, whereas Europe and China are beginning their rollouts with Cat-NB1. Solution providers building IoT devices and networks are, therefore, unable to ensure that their products will have seamless, globally available connectivity.

A satellite-enabled solution is required to deliver seamless IoT connectivity, but considerable engineering challenges in delivering a compelling service are present. User equipment must consume very lower power, be low-size as well as have bi-directional and MB/month performance capabilities. Of course, this must be delivered for below \$50 in hardware costs and around \$1 to \$2 per month in airtime fees.

To tackle these hurdles, this year Kepler partnered with the UK's **Satellite Applications Catapult** to collaborate on a narrowband technology demonstration satellite — **TARS**. This spacecraft will deliver S-band connectivity to user devices and make use of their wideband Ku-band link as the gateway backhaul. The backhaul capability is critical, as this allows to drastically increase how many user devices can be served by a single satellite.

What Lies Ahead

In the latter portion of 2018, Kepler announced a successful completion of a \$16 million Series A round of financing. This round was led by **Costanoa Ventures** and included participation from **Deutsche Bahn's (DB) Digital Ventures** as a strategic investor. DB's investment came because of a need within their business units for IoT connectivity services which can be served through Kepler.

With 2019 on the horizon, Kepler aims to enhance the value proposition of their store-and-forward service as well as moving towards early trials of an IoT connectivity solution. Kepler plans to develop the capabilities for a wideband LEO-GEO hybrid offering, giving customers the ability to dynamically optimize bandwidth and save cost by routing data through either a store-and-forward LEO or a real-time GEO link.

In the second half of 2019, Kepler will be launching TARS, the firm's first satellite dedicated to providing trials of its narrowband connectivity service. This upcoming year will also begin development of the company's **GEN1** constellation, which will begin launching closer to 2020 and will be dedicated to wideband data services.

www.kepler.space

Jeffrey Osborne is Kepler Communications' co-founder and VP of Business Development. He is responsible for the company's various market segments and services, including its two initial Satcom offerings for wideband and narrowband communications. Jeffrey's creative thinking and pragmatic approach to business strategy has helped Kepler secure some of the most important partnerships and early customers.



Kongsberg Satellite Services

By Katherine Monson, Head of KSAT USA

As small satellite constellation missions require flexible and scalable capabilities, there are clear advantages of using an existing ground station network transformed into a globally integrated “ground station cloud” as opposed to the traditional ground station networks primarily designed to support the needs of one or few satellites with consistent contact needs.

Cloud Computing in Space

Cloud computing is defined as “ubiquitous, on-demand access to a shared pool of configurable computing resources.” Applying this paradigm to existing ground station network architecture improves applicability, effectiveness, and user-friendliness for small satellite constellations.

The use of existing multi-mission antennas in established ground station networks has been the first step in this direction, and has overcome initial challenges inhibiting satellite-agnostic operations such as configuration and compatibility concerns. Fortunately, recent advances in low-cost TT&C and payload reception architectures (e.g., *Software Defined Radio* – SDR, etc.) have now made it possible to provide a true multi-mission ground station network as a cloud — enabling support of any satellite at any time from any ground station for the first time in history.

The ability to support many satellites from such an integrated network enhances the user abstraction level, allowing satellite operators to request data coverage (in addition to specific ground station passes), in turn leaving detailed mission planning to the **Ground Station Cloud**.

The “Ground Station Cloud” Today

Applying the NewSpace constellation data-centric approach, the “Ground Station Cloud” (realized through the existing **KSAT Lite** network) provides a global, easy-to-use and omnipresent ground station solution enabling Big Data applications.

KSAT has built the world’s largest NewSpace ground station network through a lean innovation process, with input from satellite owners and operators. Now satellite owners can access their satellites from any world continent through the integrated KSAT global ground station network. KSAT’s ground network is designed so that the customer can schedule all needed satellite contacts over the Internet, via Machine-to-Machine (M2M) or human-to-machine (via web portal).

Once scheduled, KSAT downlinks and brings the data to storage on-site and then immediately to any cloud service such as **AWS, Google Cloud** or the users’ own service installation from anywhere in the world. This network also supports different levels of processing — through any combination of cloud-based equipment, or KSAT-provided or customer-provided equipment on site. KSAT has continued innovating our ground station technology, giving a truly global satellite coverage accessible through the cloud, with data delivered through various processing options to the storage location of choice.

Global Hardware

KSAT has in just over a decade taken the position as the world’s leading ground station provider in the LEO satellite market. KSAT currently has more than 20 ground station sites around the globe and has apertures on all world continents. KSAT owns and operates uniquely positioned ground stations spanning from 78 degrees north in Svalbard to 72 degrees south in Antarctica. Between five different sites in the Arctic and the one in Antarctica, KSAT has 14 additional sites located in the more mid-latitude regions.

Competitive Advantage Focus

The KSAT goal is that customers can access their satellite from anywhere, anytime. KSAT’s core business is the ground segment, and KSAT delivers ground station as a service so that the satellite owners and operators can focus on their core business — data, data analytics, and providing information to their customers. KSAT has therefore approached the market designing solutions that enables a “plug and play” approach for the satellite operators, which at the same time enables flexibility of technical design for the end user.

Due to the company’s experience in this sector, KSAT has been able to implement customer-centric business models at attractive prices, which for new companies is often just as important as the technical solution. From the beginning, KSAT understood that optimizing solutions for constellation support was crucial to meet a new mindset in the industry.

As many companies first considered COTS and DIY approaches, the challenges around high investment costs, securing international laws and license, little or no onsite support, and unreliable hardware quickly reinforced the value of having an integrated ground network commercially available for the industry.

With our expertise, we were able to meet the industry need by integrating our capabilities in procuring validated hardware through capital-intensive investments, securing international communications licenses, and maintaining a highly-skilled engineering support team at all of our sites.

Customer-Centric Solutions

Given the trend of technology, KSAT approached building the company’s global ground network with the goal of enabling the customer to buy ground station services in the same fashion as they buy any other cloud service. Now that the firm’s network is in place and constantly expanding, customers can acquire cost-efficient services, while still expanding the data volume passing from spacecraft to the cloud, and experiencing lower latency.

Integrated Solutions

The KSAT system comes with an “out of the box” **Interface Control Document (ICD)** on how to interconnect to KSAT antenna systems. The ICD also list several options to customize the systems to accommodate a certain degree of flexibility — but just enough to keep it cost efficient. The KSAT system was designed to standardize ground support, while at the same time allowing a high degree of flexibility — balancing requirements to achieve a plug-and-play and one-size-fits-most solution.

The KSAT system includes fully integrated baseband units, which support a variety of the most used modulation types and protocols. As an alternative, KSAT does allow users to “bring their own devices” to interconnect to the KSAT network, if that architecture better fits the operational needs and technical design. Whichever solution the user chooses to implement, it is all accessible over the cloud. With the ease of set-up and scheduling, KSAT is able quickly to respond to customer needs to provide the needed satellite access time from a global network in just a matter of days.

The Success of Open Platforms

With now dozens of constellations of smallsats, the value of open, standardized platforms is clear. In a capital-intensive industry, it is crucial to leverage benefits of economy of scale in both hardware and expertise.

The KSAT Lite network, in establishing a cloud-based service for satellite communications, allows satellite operators to seamlessly transfer data from space through processing algorithms and on to the end-customer in record time. By offering an advanced capability on a scalable platform, KSAT has further opened access to space, enabling new missions to succeed in a fast-growing industry.

www.ksat.no



KSAT's High-Arctic Svalbard Satellite Station. Photo is courtesy of Reuben Wu.

By Mark Rigolle, Chief Executive Officer



Big Data is clearly driving the need for new communications infrastructure and data volumes are exploding. Global networks are already carrying more than 1 Zeta Byte of traffic globally and this is forecast to grow exponentially. This is having a significant effect on the communications industry, with the need to invest in and deploy appropriate infrastructure, particularly as current satellite solutions remain suboptimal for data and are generally seen as a last resort.

The company believes that fast, reliable and ubiquitous data connectivity will fuel growth for businesses worldwide. The LeoSat solution is to take data networking into space, and in doing so, set a new bar for ultra-secure, high-speed connectivity.

2018 has been a key year for LeoSat, having achieved a number of significant milestones for the company that have included securing investment from **Hispasat** and **SKY Perfect JSAT** and gaining approval from the **FCC** to operate our constellation in the U.S., commitments for the company from customers and resellers total more than \$1 billion. Significant progress on the journey to deliver the world's first business backbone in space, to open new markets for data networking for enterprise, telecoms and government communications across the globe, all is well underway.

The Hispasat Commitment

Hispasat, the Spanish national satellite operator, invested in LeoSat. Hispasat is one of the only global satellite operators to have achieved continuous growth over the past years, thanks to a strong focus on innovation and smart long term investments. With this investment, Hispasat has found a perfect complement for their geostationary fleet with the ability to expand its scope significantly toward new verticals that will define the data market over the coming years. This investment underlines Hispasat's firm belief in the unique attributes of LeoSat's new Low Earth Orbit (LEO) network architecture to ensure further growth in the future.

Combining advanced on-board routers with inter-satellite laser links, LeoSat is creating an optical backbone in space, providing fiber-like low-latency and gigabit per second data delivery which is ultra-secure and extremely resilient, thanks to its gateway independent meshed-network data-connectivity from transmitter to receiver. This solution will provide valuable new business opportunities in the growing data and mobility markets in sectors such as telecommunications, multinational enterprise, maritime and government services by ensuring previously unavailable levels of network performance combined with worldwide reach.

Carlos Espinós, CEO of Hispasat, said, "With the current and future growth of data traffic, we see the strategic importance of investing in new infrastructure to enable our existing and future customers to substantially increase their communications capabilities. LeoSat has distinguishing features from the other constellations that makes it especially interesting: high capacity, low latency, high security and a meshed network that simplifies its architecture. LeoSat's system design, combining satellite and networking technology to provide a network in space, is a departure from existing solutions today and we see this as a key opportunity for us to open-up new markets and deliver business growth. This investment in LeoSat demonstrates our belief that there will be very strong demand for LeoSat as it is the best solution to address the Enterprise market. It will allow Hispasat to strengthen and expand our existing GEO satellite services and position the company at the forefront of the new digital infrastructure. In addition, Hispasat and SKY Perfect JSAT have a relationship of complementarity, understanding and mutual trust that will ease our joint leadership in this initiative."



Concept image of LeoSat's backbone in space.

FCC Grants LeoSat U.S. Market Access

LeoSat was recently awarded the authority by the U.S. Federal Communications Commission (FCC) to provide **NGSO (Non-Geostationary Satellite Orbit)** services in the United States. The FCC market access grant will allow the company to address currently unmet demand for high-bandwidth, low-latency, high-security data transmissions from large commercial and government customers in the United States. Designed as a backbone in space for global business, the data network will enable new opportunities for sectors such as enterprise-to-enterprise communications, telecommunications, oil & gas operations and maritime services, delivering premise-to-premise high-speed data (greater than 1 Gbps) with unmatched security to any location in the world. Moreover, while our core focus is solving essential business communications challenges, the unique design of LeoSat's constellation means capacity will also be available to enable a new level of connectivity services for internet and cellular backhaul for remote and underserved communities. Getting approval from the U.S. Federal Communications Commission – among the world's most sophisticated radio frequency regulators – is an important milestone for LeoSat and recognizes that we have a unique solution for high-speed and ultra-secure enterprise connectivity.

Game Changing Connectivity for Enterprise Networks

Earlier this year, LeoSat entered into an agreement with **Phasor**, the developer of leading, enterprise-grade electronically-steered antenna (ESA) systems, to develop a powerful Ka-band, NGSO-ready version of their breakthrough low-profile ESA, scalable to virtually any use-case requirement to provide high-speed, low-latency, ultra-secure, Ka connectivity infrastructure to corporate, government and commercial markets, offering speeds about 1.5 times faster than terrestrial fiber. Phasor's very low profile, electronically steerable antenna enables the reliable, robust delivery of high-bandwidth services. The antenna is solid-state, with no moving parts, allowing satellite signals to be tracked electronically. The ESA can be flat or conformal in design and can be fitted seamlessly to moving vehicles, enabling a number of applications for maritime and mobility markets.

David Helfgott, Phasor's CEO, said, "This landmark agreement between LeoSat and Phasor opens the door to a whole new level of high-powered communications networks capable of unleashing unprecedented connectivity for enterprise network markets around the world. Phasor's electronically-steered antenna technology is incredibly versatile and scalable – a perfect match for LeoSat's constellation in meeting diverse demands for big data and high-speed connectivity."

NexGen Data Networks

This year, pre-launch commitments that span a wide range of fast-growing data and mobility sectors have been received by LeoSat from customers and resellers for more than \$1 billion. With the ever-growing demands of managing Big Data and Cybersecurity, global enterprises now — more than ever — need instant infrastructure from anywhere to everywhere that is fast, secure and reliable. For companies such as **DCS Telecom**, **Globecom** and **Signalhorn**, who will provide innovative connectivity solutions, LeoSat is helping these firms to open-up new markets and deliver business growth.

While the perception of satellite for data communications has been seen as a last resort, LeoSat will change that belief by pairing the speed of fiber with the ubiquity of satellite and adding a new dimension of ultra-security, bringing a paradigm shift in expanding the existing satellite services market. LeoSat can fuel worldwide economic growth by offering customers the fastest, most reliable and secure global infrastructure for data communications. These commercial agreements demonstrate LeoSat's progression from a new networking concept to a unique solution which resonates with customers and has also attracted the aforementioned backing of leading satellite companies.

With capabilities beyond satellite and fiber, LeoSat's unique infrastructure is what data communications has been waiting for — a game-changing service which realizes the synergies of both worlds to re-define connectivity in terms of capacity, latency, security, efficiency and coverage. For 2018 and beyond, significant interest in the LeoSat constellation will continue to be seen. Resilient and future-proof networking to deliver connectivity and new services and the opportunity to tap into the broader data-communication market outside and beyond the traditional SATCOM market will be realized.

www.leosat.com

Mark Rigolle joined LeoSat as CEO in September of 2015. He has more than 22 years of experience in the telecom and satellite sectors. Between 2004 and 2009, he served as the CFO of SES. He was then appointed CEO of O3b Networks, successfully raising \$1.2 billion to fund the launch of a MEO constellation of satellites that provide affordable trunking and mobile backhaul capacity in developing countries. In addition, Mark has acted as advisor to satellite operators and private equity funds, as well as being a co-founder of Kacific, a promising satellite-broadband-to-the-home start-up. Mark has held various positions in Finance and Business Development at Belgacom and ABN AMRO. He holds a Master's Degree in Economics from the University of Leuven, Belgium.

ManSat

By Chris Stott, Chairman and CEO, and Katherine Gizinski, VP, Sales/Marketing



The defining characteristic of ManSat's satellite spectrum business in 2018 is growth fueled by agility and customer focus.

ManSat's History

With almost 20 years of experience, ManSat has a hard-earned reputation of bringing transparency, ease of use, and expertise to the ITU filing process for established global operators and start-ups alike.

"No spectrum, no satellite. Know spectrum, know satellite." The correct filing is a critical step toward bringing a new satellite or constellation into use.

ManSat presently leads the third largest filing jurisdiction in the world for commercial Geostationary satellites, according to independent studies conducted by **Northern Sky Research**, and is itself the world's largest commercial provider of satellite spectrum. ManSat has carefully preserved its start-up culture and willingness to flexibly respond to customer needs. This principal continued to bear fruit in 2018 with further growth.



Continued Growth in the Small Satellite Market

Tremendous technological advancements are bringing the same performance to smaller and lighter platforms, enabling significant growth in the small satellite market.

Northern Sky Research's **Small Satellite Markets Report** confirmed 211 smallsats already launched, and/or forecasted to launch, by the close of 2018 in their comprehensive survey of the industry. With launch rates reaching historic levels and expected to continue rising, it's clear why ManSat and many others in the industry spent 2018 implementing changes in response to this market growth. As a result, ManSat was able to welcome its first Non Geostationary constellations and Remote Sensing customers.

Customer-Driven Service Offerings

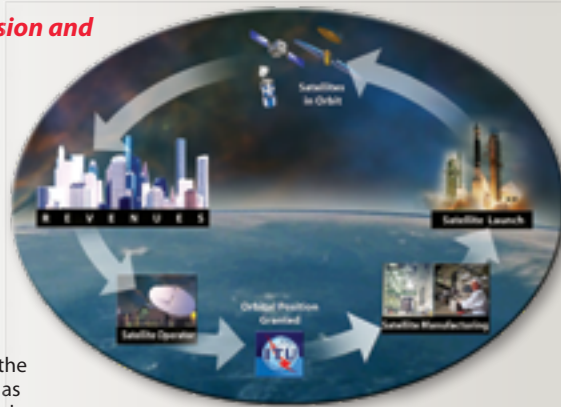
True to its customer-focused roots and with an eye to change, ManSat expanded its service offering with the goal of providing dynamic services tailored to each customer's varied needs. The result was growth in ManSat's consulting business that exceeded expectations and yielded significant reinvestment and expansion. New customers from Geostationary Communications to Non Geostationary Remote Sensing selected ManSat for ITU filing and an array of other services.

Investment, Expansion and Looking Ahead

ManSat expanded its U.S. footprint with the establishment of West Coast offices in San Diego, California, with **Katherine Gizinski** joining ManSat as a Vice President of Sales and Marketing to focus on end-to-end service solutions.

John Sheath also joined the ManSat leadership team as Chief Financial Officer and Finance Director, bringing a breadth of knowledge and experience to the team from a career in banking and insurance.

In 2019, the trend of growth will continue, with a new office slated to open in support of additional ITU filing service offerings.



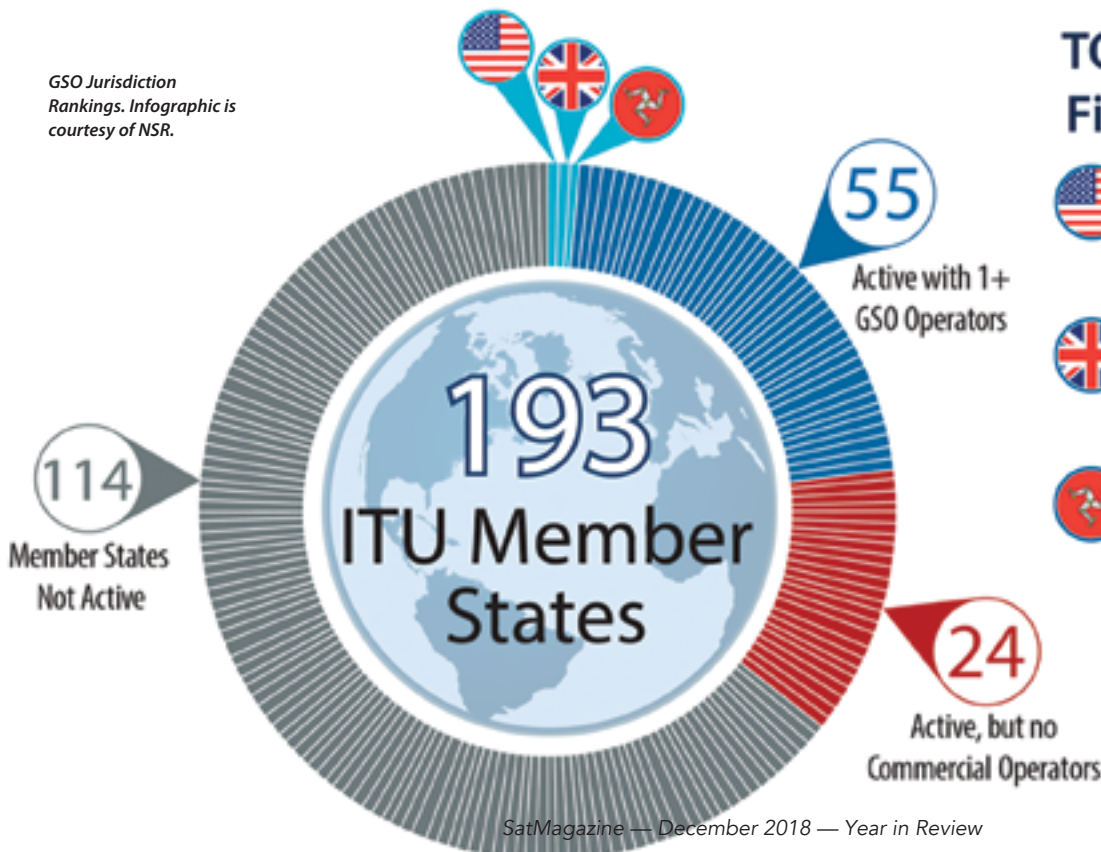
InfoGraphic: Satellite Operator Cycle is courtesy of ManSat.

mansat.com

Chris Stott is the Chairman and Chief Executive Officer of ManSat, the company he co-founded with his father, Bryan. In 2000, he left his position as Director of International Commercialization and Sales with Lockheed Martin Space Operations to become ManSat's President. Prior to his work with Lockheed Martin, Chris was an executive with McDonnell Douglas and the Boeing Company working in International Business Development on the Delta Launch Vehicle program.

Katherine Gizinski is the Vice President of Sales and Marketing for ManSat. Prior to joining ManSat, Katherine worked with U.S. defense contractors to bring cutting edge commercial satellite and terrestrial communication technologies to austere environments in support of military, diplomatic, first responder, and commercial initiatives.

GSO Jurisdiction Rankings. Infographic is courtesy of NSR.



TOP 3 Satellite Filing Countries

1. USA with 9 Satellite Users

 Federal Communications Commission
2. UK with 7 Satellite Users
3. IOM with 5 Satellite Users



As the largest maritime communications provider in the market, Marlink is in a position of responsibility. The company's diverse customer base want access to efficiency enhancing applications and Marlink's job is to deliver the communications infrastructure that enable them.

Marlink's response is to continue growing its highly resilient global network and, this year, such has strategically added new beams to cover the busiest areas and also regions where more demand is emerging, due to changing usage of the oceans.

Reflecting the former, the Marlink network serving Singapore had new, over-lapping beams added to meet demand in one of the world's busiest shipping regions. For the latter, the network expanded for various specific user-groups.

Furthering Capacity

First of all, new satellite capacity was added in the Indian Ocean and around the Falkland Islands with specific focus on delivering reliable, high bandwidth VSAT services to commercial fishing vessels. The new capacity is already enabling improved vessel and fleet operations and providing greater access to voice calling and internet for crews on a number of Spanish tuna vessels in the Indian Ocean that are serviced by Marlink partner **Nautical**, while the extra bandwidth around the Falkland Islands has been put in place to meet a predicted spike in demand as more companies look for new fishing grounds.

Also in response to changing market demands and usage patterns, new capacity was added in the North West passage to meet the high-end needs of Marlink's growing adventure cruising customer-base. The new satellites and beams provide flexible access to reliable, high-speed Internet connectivity, enabling operational, crew and guest communications in the fast-growing adventure cruising and bandwidth-hungry superyacht markets.

The coverage spans the east coast of Canada to the western tip of Alaska, helping to open the region further for cruise ships and superyachts looking for adventure off the beaten track. With sea ice receding, larger vessels are now able to further explore the Northwest Passage, which is generating significant extra demand for connectivity.

Selecting a provider with more sources of high throughput services enabled by redundant and overlapping satellite coverage ensures quality of service, resulting in more uptime even in the most remote regions. The Northwest Passage capacity was joined by a further boost for the Mediterranean and Caribbean, delivering even more potential for digital transformation in the adventure cruise and superyacht sectors.

French luxury cruise specialist **Ponant** uses Marlink's multi-band communication services to meet the increasing demand for fast, reliable and available connectivity driven by its unique and global expedition and luxury cruise offering. With its seven strong fleet (and two new builds on the way), Ponant offers exceptional itineraries and five-star hotel services, specializing in French-style cruises designed to offer

excellence across the board, from ship-board services to the quality and exclusivity of the itinerary destinations. These luxury vessels all promise high-end experiences, of which available communication even in tropical regions, the Arctic and Antarctic is a vital ingredient.

Marlink's satellite services for all Ponant vessels include class-leading internet access, premium quality telephone, GSM and data communications connectivity for on board guests, crew and business based on global coverage, including this year's extensions.

Marlink is able to deliver even higher QoS to Ponant through its unique global network of overlapping beams on all frequencies. Each vessel has access to global Ku- and C-band VSAT in addition to L-band solutions and GSM/LTE services, ensuring that the best available service is in use at any time and that IP and voice communication is always available. Marlink's sophisticated **SMARTConnect** service handles switching between alternate carriers to ensure seamless connectivity and class-leading uptime.

Leading the Way

While the firm's global network continues to grow, Marlink also stays committed to offering new technologies — in August, two new solutions for the **XChange** centralized communications management system were launched.

XChange Cloud helps ship owners and operators to streamline and automate their business, logistical and vessel operations by providing a secured, reliable and easy to manage platform to share files of any size or type across a fleet of vessels of any size. It has been designed to specifically support the business needs of maritime users who wish to effectively implement a more digital approach, including automation, to their fleet operations management.

Application scenarios include storing and sharing status reports from on board engine monitoring systems. Once transferred, the customer's on shore ERP system can access the reports and take the necessary actions, such as, ordering spare parts for the next port call or automatically warning the fleet manager about any technical issues without manual intervention. Should a 'pushed' status report (or any other file) become lost or damaged, it can easily be recalled due to the file redundancy feature, which stores a copy of each file on both sides as default.

XChange Cloud is designed to enable optimal file transfer and synchronization over a satellite link, ensuring data integrity at all times and best use of available bandwidth through advanced file compression. Shipping companies can be confident in the security of any data shared within the closed-ecosystem, which is segregated from the public Internet and accessible only with approved credentials.

XChange FX, also launched this August, is an advanced new hardware solution designed to maximize value for Marlink customers using **Inmarsat Fleet Xpress** voice and data services. **XChange FX** provides previously unavailable network and service information in real-time, enabling users to manage usage according to status and ensuring Marlink's global support network can react fast and effectively to any issues, based on the availability of precise, real-time network data. The system also future-proofs Fleet Xpress, by enabling over-the-air firmware and software updates.

While Marlink Fleet Xpress users already enjoy exclusive access to the most extensive portfolio of business critical solutions, **XChange FX** adds an extra layer of management functionality which empowers end-users to make the most effective use of Fleet Xpress. It provides unique visibility into on board network performance and statistics, ensuring users will always know if they are using Ka-band or L-band via a number of methods including a built in LCD screen, enabling usage patterns to be adjusted. More in-depth data will be available in a customer dashboard providing easy to understand bandwidth performance and traffic statistics, available on board and for Marlink support experts to streamline remote troubleshooting.

Future Focus

Looking forward, the demand for new satellite capacity and technologies to optimize it is not going to go away. The maritime industry is undergoing a transition as we speak, with digitalization offering the potential to transform the entire transport logistics value chain for the better. Satcom, especially VSAT, is a critical enabler of this. It can bring new ways of operating that will bring more sustainability to the industry as a whole — SATCOM can help the maritime industry to reduce its impact on the environment. With a global communications infrastructure for, i.e., reducing fuel consumption, the maritime industry can improve its green credentials significantly by focusing on advanced, new solutions, such as autonomous ships and smart ships — those would not be possible without SATCOM.



Marlink's XChange FX.



Marlink's Sealink.

MDA Commercial

By Michael Rack, President



This is an exciting time of transformation in the space industry, as new commercial markets open for satellites, communications, Earth Observation (EO), on orbit servicing, space exploration, space mining, space manufacturing and even space tourism.

All of these developments are particularly encouraging for MDA Commercial, which has a deep heritage delivering iconic solutions into many of these markets, and is recognized as a world leader across a range of technologies on which the next generation of space business will be built.

MDA Commercial's Space Robotics, Sensors, and Automation

It is difficult to believe that the first Canadarm flight on Space Shuttle Columbia took place in 1981. As the creator of Canadarm, MDA was a pioneer in space robotics, successfully operating and maintaining the arm on 90 Space Shuttle missions.

For more than a decade, MDA's real-time *Orbiter Space Vision System (OSVS)* was used to conduct on orbit measurements critical in the support of International Space Station assembly operations and the company's next-generation *Mobile Servicing System (Canadarm2 and Dextre)* has enabled the construction and maintenance of the ISS since 2001. Today, MDA's *Cygnus TriDAR* rendezvous and docking sensor flies as a manifest item on **Northrop Grumman** cargo resupply missions, and MDA robotics and sensor solutions developed for the **CSA, NASA, ESA and JAXA** continue to enable human spaceflight and space exploration as they have for more than 20 years.

At the same time, MDA has leveraged its Canadarm robotics and sensors heritage to derive new capabilities for unmanned, on orbit robotic satellite servicing for government and commercial customers, including some state-of-the-art flight demonstrations for NASA and the U.S. DoD and, in some cases, working together with our sister company, **SSL**, which is part of the Maxar family of companies.

It is interesting to note that unlike almost all critical infrastructure on Earth that are regularly repaired and maintained, the bulk of the current "space" infrastructure consisting of hundreds of costly orbiting satellites are all "one-time" deployment and not serviced at all. These satellites are in need of maintenance support, some needing inspection and repair, some needing "gas up" to extend their life, while others will require assistance to "get out of the way" and to de-orbit once their useful life is complete.

This has opened up a market for lowering overall lifecycle operating costs enabled by on-orbit robotic servicing. Allowing for only the satellites in orbit today, a 2018 market report has quantified on orbit servicing as a \$3 billion market opportunity. As MDA has been sensing, grabbing and maintaining a number of highly valuable government space assets in orbit for nearly 40 years, the company is very well-positioned to serve the vast number of commercial satellite, as well; and MDA is already marketing and supplying new robotic and sensors kits for companies wanting to develop their own on orbit servicing operations.

Today, MDA Commercial is revolutionizing on orbit satellite servicing and defining robotic and sensor solutions that will support the next generation of manned and unmanned space and planetary exploration missions, while redeploying those technologies to drive change in medicine, nuclear and aerospace industries with robotics automation here on Earth.

MDA Commercial's Satellite Antennas, Electronics, and Payloads

For more than 50 years, MDA's satellite payloads, antennas and electronics have enabled state-of-the-art communications and remote sensing solutions. Among the industry firsts achieved by MDA are the **Anik** satellites for **Telesat**, which were the first communications satellites for Canada, **MSAT**, short for **Mobile Satellite**, to support mobile communications, and the **Synthetic Aperture Radar (SAR)** antennas for **RADARSAT-1** and **-2** and the upcoming **RADARSAT Constellation Mission** for the **Canadian Space Agency**, which will further extend Canada's capabilities in global remote sensing.

The number of orders for new geostationary communication satellites has dropped substantially over the past three years, significantly impacting the satellite manufacturing industry. Globally, consumer behavior is shifting the demand from broadcast (linear TV) to broadband data (on-demand, internet-based entertainment), driving a new market emphasis on reducing the cost per bit through increased capacity and on-orbit payload flexibility. As a result, satellite operators are reticent to invest in traditional GEO satellites to maintain their fleet, a situation that is further exacerbated by the commercial market's diversification to non-geostationary (NGSO) constellations that include lower-latency MEO and/or LEO satellites.

As the world's largest independent supplier of satellite payloads, antennas and electronics this downturn could certainly have had an impact on our growth, but MDA's diversification strategies have mitigated the damage experienced by other dedicated GEO manufacturers. First, MDA successfully transitioned to a more balanced and wider customer base for its GEO solutions, as we are increasing our geographical footprint in emerging space countries and markets. Second, the company has been able to adapt and capture key sub-tier roles on institutional programs such as **Sierra Nevada Corp.'s Dream Chaser** communications system, the ISS communications subsystem refurbishment and the payload for the upcoming **Airbus Defense and Space EDRS-D** satellite. Third, MDA Commercial's investments in Industry 4.0 capabilities led to its selection to play a key role on the **O3b, INX and OneWeb** constellations.

An exciting time is ahead of us, as future years will be crucial for the LEO constellations business, with programs such as OneWeb and Telesat LEO reaching key investment and programmatic milestones.

MDA's Evolution

MDA will complete its integration within the **Maxar Technologies** family of companies in the coming year and realize the benefits of the new corporate structure through cost reduction, efficiencies and the ability to address bigger opportunities than it could as an independent entity. With 1,900 employees across Canada, MDA is the nation's largest space prime contractor and continues to grow its ecosystem of innovative Canadian partners and suppliers.

Additionally, the company is leveraging its core capabilities to explore new opportunities beyond space markets, into terrestrial markets that can benefit from its experience and technology. MDA expects those to materialize in 2019 or 2020, demonstrating once again the synergies between space, defense and other high-tech commercial markets. MDA's involvement in the space exploration, space infrastructure servicing and space-based communication markets presents a dynamic mix of opportunities and risks. New and proven robotic capabilities are allowing critical government and commercial space assets to be assembled, maintained and upgraded. As well, the space-based communications market is undergoing a sea change in approach, technology and purchasing trends.

Through leadership across multiple market areas, innovative engineering and the diversification of its customer base and targeted applications, MDA has achieved a very high level of competitiveness that enables continued growth and international success in the new space and terrestrial markets.

mdacorporation.com

Michael is responsible for strategy, global growth and operations of MDA's commercial product lines, which include commercial space robotics, space sensors, vision systems, antennas, electronics, payloads and non-space products. His career spans 25 years in aerospace, critical communications and defense and security executive positions. He previously served as Senior Vice President at Inmarsat and Vice President of International Sales at General Dynamics Mission Systems.



This image shows an area of MDA's automated antenna assembly and testing facility.



This image shows the wrist joint for the MDA-developed Canadarm, the robotic arm used on NASA's space shuttles.

Mission Microwave Technologies

By Steve Richeson, Vice President, Sales and Marketing

Mission Microwave completes 2018 with record revenues and an established industry position as manufacturer of RF products that raise the bar for innovation, performance and SWaP (Size, Weight and Power) in X-, Ku- and K-band BUCs.

Although Mission is now recognized as a top-tier industry competitor, it actually started 2018 still perceived by many in the industry as a newcomer to the BUC business. Fortunately for Mission, word of mouth spreads quickly. Positive experience from system integrators and terminal manufacturers gets around, and both integrators and manufacturers are keen to be offer

the best value and performance to their customers. By the end of 2018, that made Mission Microwave the obvious competitive choice for the leading integrators and manufacturers.

The year for Mission Microwave was marked by the successes of their customers in the tactical, public safety, mobile and maritime market sectors. Customers in all of these segments have relied on Mission Microwave to provide BUCs that differentiate their system designs and improve the positioning of their products in terms of portability, ease of use and reliability at a commercially competitive price point. Mission has excelled at leading the industry in the delivery of Ka-band BUCs at power levels from 10 to 200 Watts. With hundreds of Ka-band units shipped in 2018, the company continues to provide customers with smaller, lighter, more versatile solid state BUCs for Ka Band.

New Commercial Maritime Terminals Enabled By Mission BUCs

In the maritime sector, 2018 saw the approval and initial product announcements of new high performance maritime terminals based on Mission's high power BUC for **INMARSAT Global Xpress** networks. The **GX-XL** BUC provides 10 Watts of linear power to GX terminals for several major maritime terminal manufacturers. This significant power boost is delivered by Mission Microwave's fully-integrated, 10W GaN amplifier, which significantly increases upload speeds, and facilitates a more reliable link to the GX satellites with enhanced throughput and greater reliability, the newly launched terminals raise the bar for those operating in an increasingly data-centric environment, while improving the overall experience of shipboard crew communications.

Tactical and Flyaway Terminals Depend on Mission BUCs

In the tactical and flyaway terminal market, the top-tier manufacturers have designed Mission BUCs into their latest successful product offerings — 2018 saw the roll out of Mission BUCs on full-rate production of tactical terminals for a US DoD program of record. Several of the company's Ka-band BUCs have been included as part of certified terminals operating on the DoD's **WGS** platform. By bringing substantial power and weight savings to their mission critical platforms, Mission's customers have taken advantage of the well thought out designs of the company's product line. Examples are family-of-terminal solutions offered by SATCOM terminal integrators that use X, Ku and Ka Band "Stinger" BUCs to bring a common interchangeable housing design, and power and control interfaces to multi-band terminals

Mobility Needs Mission BUCs

On vehicular mounted antennas, Mission's BUCs offer reliable and compact performance. The small size and weight is such that redundant systems up to 400 Watts, in a 1:1 configuration, can be mounted on the boom of a moderately sized drive-away antenna. Also on mobile communications vehicles, Mission's 100 Watt Ku-band **Javelin** BUCs are deployed on emergency communications systems for a Nationwide Public Safety Network, operated by a major national American telecommunications carrier.

During 2018, other applications that have earned the loyalty of new customers in the wide ranging mobility markets include **SOTM (Satellite-On-The-Move)** terminals on

a variety of platforms, including maritime, unmanned, and ground mobile platforms integrated on flat panel or traditional parabolic antenna structures. Many of the Mission Microwave products are so highly integrated into their customers' designs that they are not visible — despite the signature "cylindrical" shape of these BUCs.

At a trade event earlier this year, Mission debuted products with a more traditional rectangular shape for both low power and high power applications. The **Flatpack** and **Cube** BUCs are designed for highly integrated terminals — at 1.75 lbs, the Flatpack offers 12 Watts at Ka-band or 25 Watts at Ku-band in under 35 cubic inches. The Ku-band Cube is the ideal bolt-on 25 Watt BUC weighing in at only 2.5 lbs. The high power **MOAB** Ku-band BUC brings 400 Watts of RF power in a 35 pound package; 33 percent lighter than products marketed as "the industry's lightest." The MOAB is also the most efficient BUC in its class, making it ideal for maritime applications within a radome or in other high reliability, high temperature environments.

Efficiency is the hallmark of Mission's products. Mission BUCs prime power to RF energy efficiency is higher than any other BUC in the industry. Mission's customers understand that higher efficiency leads to higher reliability. Less efficient BUCs generate more waste heat and heat is the primary enemy of reliability for high power RF power products. Mission has had several patents granted in 2018 and continues to expand its IP portfolio in regard to highly efficient RF designs.

Mission Microwave's BUCs in X-, Ku- and Ka-bands range in output power from 10 to 400 Watts. These BUCs have been incorporated in the leading on-the-move, tactical, and flyaway terminal in the industry. High-end users of SATCOM terminals insist on using Mission Microwave BUCs for performance and SWAP benefits. Mission's customers have requested several features in 2018, including some DC power variants of high power units and the incorporation of reference oscillators in some units.



Mission Microwave's 80 Watt X Band, 55 Watt Ku Band, and 25 Watt Ka Band "Stinger" BUCs with Common Electrical and Mechanical Interfaces

2019 and Beyond

Looking into 2019, Mission expects to bring additional compact products, as well as higher power products, to the market in X-, Ku- and Ka-bands and to expand the frequency range for more versatile Ka-band products. Several terminal manufacturers have announced their intent to develop flexible Ka-band terminals and Mission intends to offer products that can work on multiple satellite network architectures throughout the commercial Ka Band.

Thanks to an impressive list of top-tier customers, the industry has recognized Mission Microwave as a reliable, credible and preferred provider of X-, Ku- and Ka-band BUCs. Mission's customers expect Mission to maintain its market position through continued innovation, allowing them to provide the most competitive products. Mission leads the Satcom BUC industry in RF efficiency (the conversion of prime power to RF power) and offers products that are 30 percent more efficient than competing products.

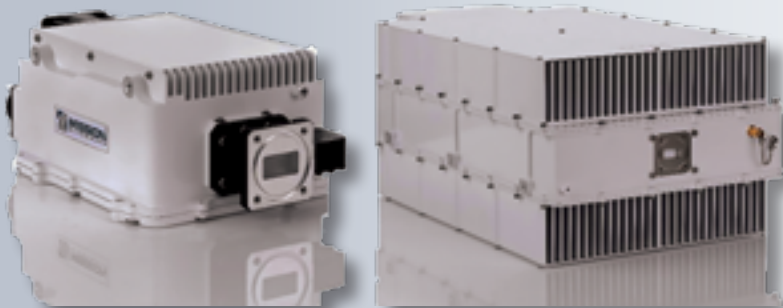
Mission's team has expanded significantly in 2018 and the company will continue to evolve its organization in support of its growing customer base. Throughout 2019, Mission will continue to invest in development of new technologies and lead the Satcom industry in the development and application of GaN devices for satellite communications.

2019 will be another banner year for this innovative leader in high power SATCOM BUCs. Both Mission Microwave and its customers are planning on more success and bringing new capabilities to end-users, as the satellite industry evolves beyond traditional architecture to mobile and non-GEO networks in 2020 and beyond.

www.missionmicrowave.com

Mr. Steve Richeson joined Mission Microwave in 2017 and is responsible for the company's sales and marketing organization. He has 30 years of satellite and Radio Frequency (RF) experience in engineering and sales leadership roles at Advantech Wireless, Exelis Inc., Harris Corporation, EchoStar, Scientific-Atlanta, GTE Spacenet International, RSI SATCOM Technologies and Schlumberger.

Mr. Richeson was the founding CEO of RF Solutions, Inc. a compound semiconductor design firm started by Georgia Tech faculty where he raised two rounds of venture investment. He is a Senior Member of the IEEE and a Registered Professional Engineer and earned his electrical engineering degree at Georgia Tech and an MBA at Georgia State University.



Mission Microwave's 25 Watt Ku Band "Cube" and 400 Watt Ku Band "MOAB".

Modular Devices, Inc.

By Chris Alfenito, Director of Sales and Marketing



Modular Devices Inc. (MDI), a small privately held U.S. Corporation, has established itself for 45 years as a global power engineering resource that design and manufacture high reliability power solutions for demanding applications. The company concentrates on DC power systems and subsystems and 2018 was an exciting year for the firm.

MDI measures success a bit differently than most companies. One of their most critical assessment factors is focused on how satisfied their clients are with MDI — not just the products, but across the spectra of the complete transaction. Their aim is to be responsive to their clients' needs before, during and after a sale. This is a collaborative approach with their client partners, from the initial contact through in-depth engineering discussions and throughout the length of the program. MDI offers lifetime support for their products. MDI has yet to obsolete a product that is still required or requested by their customers.

One hundred percent of MDI products are designed, fabricated, tested and delivered from their facility on Long Island, New York. The staff has decades of experience in all key areas that allow them to comply with programmatic requirements that only larger scale organizations are able to usually offer their customers. More often than not, MDI provides clients with solutions for their power needs based on a custom or semi-custom requirement. Their clientele demand unique solutions for their programs and MDI strives to ensure their mission success.

MDI products range from simple **Point Of Load (POL)** regulators to multi-output **Rad Hard Fully isolated DC-DC converters**, **Solid State Relays (SSR)**, **In Rush limiters**, sequenced power switching modules, and **EMI Filters**. MDI products are found in: Exoplanetary, GEO and LEO space programs, Military aerospace, Naval and Ground systems, as well as Nuclear Power and High Energy Particle Physics research activities. In Space, in the air, on land, and in the oceans, MDI products and designs are hard at work.

In Space

- NASA Planetary Defense Coordination Office, **DART Mission (Dual Asteroid Redirect Test)** is going to "hudge" a small asteroid, 11 million km. away with a 500 kg. spacecraft traveling at 6km/s (Mach 16) with an Ion Thrust Engine.



our universe through such programs as the AMS (Alpha Magnetic Spectrometer) aboard the ISS searching for dark matter and ongoing subatomic particle physics research at CERN at the Large Hadron Collider.

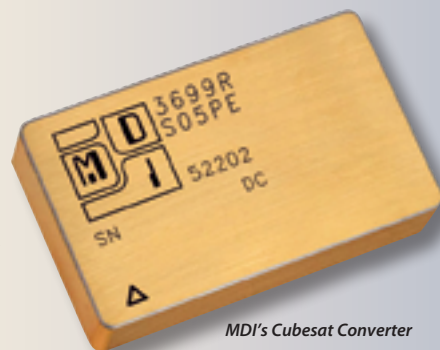
- Helping to develop systems for new astronaut space suits and health monitoring aboard the ISS.

- CMIS (Compact Midwave Imaging Sensor) for high spatial resolution stereo imaging of clouds so as to enable 3D wind and cloud height observations during both day and night.

- Continuing in the exploration of

- Working on next generation of spacecraft subsystems including scientific military and commercial constellations. This has covered a range of programs including space borne telescopes, Space borne lasers, Exoplanetary robotic exploration, and LEO Constellations.

- MDI is especially proud of their clients' recent successful launches to further Earth Observation Science systems across the globe.



MDI's Cubesat Converter

In Aerospace

- A Light Combat Aircraft pressure sensor power supply with a truly unique form factor.
- Continuing support of the warfighter on programs such as the AAGRM, SDB, LAIRCM, and Flight telemetry data systems through our defense contractor partners.



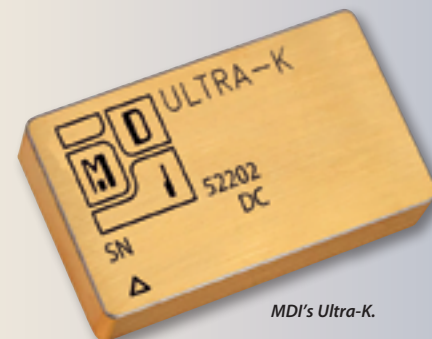
Undersea

- Working with one of the key domestic UUV developers to supply power systems for the unique requirements of the mission environment.

A more general overlook would be MDI's continuing advancement in product reliability and performance, while undertaking significant reductions in cost to manufacture and lead time.

The drive for lower cost spacecraft delivered in significantly less time than historically available has provided fertile ground for development in a number of areas including design, manufacturing, and qualification testing.

One such example is the **3700 Basic Building Block Series** of DC-DC Converter. While a fully hermetic package is offered, MDI has found alternative manufacturing techniques that significantly reduce the cost to manufacture of the assembly while maintaining the performance and reliability the industry demands.



MDI's Ultra-K.

As a "build to order house," MDI is continually faced by challenges that most high-mix/low-volume manufacturers encounter. Continually evolving product specifications, development & design, supply chain management, and production flow are some of the impediments encountered and overcome regularly, by utilizing their collective experience to the maximum extent possible.

MDI produces 30 to 50 new product designs every year. The constant industry demand for: higher power, smaller footprints, Rad Hard SSR's (Solid State Relays) in NO (Normally Open), NC (Normally Closed) and Form C configurations, GaN device implementation and optimization, higher efficiencies, better EMI performance are all key product development areas.

The Commercial Space market versus the Government/Military space market is going to witness some dynamic swings during the coming year. The drive for a balance between quicker delivery, lower cost yet proven reliable performance of commercially available components and subsystems will force the industry to consider new paths forward.

MDI looks forward to meeting these challenges with unique product and programmatic solutions in the year to come.

www.mdipower.com

Chris Alfenito is the Director of Sales and Marketing for Modular Devices, Inc., and is based in Shirley, New York.

By Thomas Van den Driessche, Chief Executive Officer



Throughout 2018, Newtec has continued to respond to the latest industry trends, cementing the firm's position as an industry pioneer. The company's projects and work have been highly focused on the future as operators prepare for the 5G era, the boom in High Throughput Satellite (HTS) services and as the first Low Earth Orbit (LEO) constellations emerge. Anytime, anywhere connectivity has also been a priority, with Newtec's work on in-flight WiFi further expanding.

These trends point to a myriad of changes underpinning the satellite industry; however, among them there is a single constant — **the need for more**. Consumers are using more data

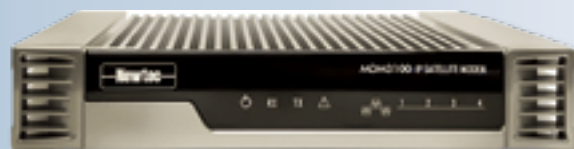
and that requires more bandwidth. They want more speed — even a millisecond drop in connectivity is becoming unacceptable and that means connections need to become more reliable. At Newtec, the commitment is to help operators meet this demand by pushing the limits of spectral efficiency to deliver the ultra-connected world all are moving toward.

Future-Proof Mobile Connectivity

Playing, perhaps, the biggest role in delivering this ultra-connected world is 5G. Set to revolutionize all aspects of our lives in all sectors, 5G will bring a huge shift toward a landscape dominated by wireless connectivity, with satellite set to become an essential part of that infrastructure.

The role that satellite has to play in mobile connectivity is already being experienced across the world, with a number of mobile network operators deciding to use satellite for cellular backhaul when delivering 2G, 3G and 4G services.

In example, **Mytel** — Myanmar's newest mobile operator — chose to work with Newtec's long-term partner, **Communications & Commerce (Com & Com)** (a joint venture company established between **Terabit Wave** in Myanmar and **OSB JSC** in Vietnam, to launch a mobile backhaul network. We delivered this solution with Com & Com, which was selected for this project due to their high performance, low operational expenditure (OpEx) and their support of Newtec's dynamic bandwidth allocation technology, **Mx-DMA**®.



A number of Newtec **MDM3100 Satellite Modems** have already been installed, empowering Mytel to deliver 2G,

3G and 4G services across Myanmar and increasing the company's coverage as it prepares for the expected growth in mobile traffic. Com & Com is responsible for fully managing the **Newtec Dialog**®-based network, supported by the platform's network management system. This is Myanmar's first all-4G network and the project really emphasizes the role satellite has to play in delivering fast mobile internet access at affordable rates.

Mytel is the latest operator in the Asia-Pacific region to select Newtec's mobile backhaul solution based on the Newtec Dialog platform as part of a larger series of recently installed networks in the region. The number of installations is also increasing in Africa and Latin America, with the latter region being home to one of the world's biggest mobile backhaul networks in terms of capacity.

Newtec recently signed a new agreement to expand this network, which is currently deployed on Ku-band, to Ka-band. This was the first mobile network deployed over Newtec Dialog, maximizing efficiency and Quality of Service (QoS). Our Mx-DMA technology will be used to support the transition from voice to data-centric mobile applications, providing very high service availability. Multiple mobile technologies, including 2G, 3G and 4G will be deployed, while the multiservice capability of Newtec Dialog will also allow enterprise services to be launched from the same network.

This growth in cellular backhaul projects is linked to the continued growth of HTS constellations, with forecasts predicting that by 2021, 272 Gbps, representing a CAGR of 62 percent, of mobile backhaul traffic will be backhauled over HTS. When doing so, delivering a good user experience is key for MNOs, including the desired level of throughput and reliable services. Optimized OPEX and Capital Expenditure (CAPEX) of the satellite backhaul services is also essential to enable an MNO's business case. Remote sites are often located in places without reliable power mains, requiring the remote tower to be powered by generators or solar power. Lower power consumption helps to further optimize the total CAPEX and OPEX cost of the remote sites.

To address these challenges, HTS service platforms need to be capable of delivering the throughput and packets per second for even the most demanding sites and include embedded optimization technologies to deliver the required 2G, 3G and 4G user experience. They should also be able to deliver highly reliable services in Ku- and Ka-band, with the lowest possible OPEX and terminal CAPEX.

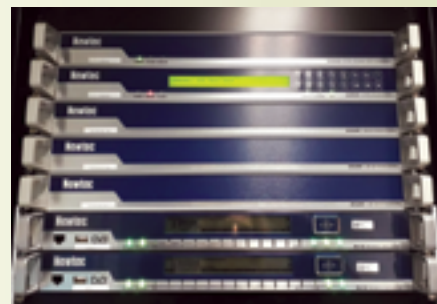
Pushing the Limits of HTS

Cellular backhaul is just one example of the range of services that HTS are enabling — but matching the innovation in the sky on the ground is vital for operators to effectively monetize their HTS infrastructures.

This is why an increasing number of operators are selecting the Newtec Dialog multi-service platform, to ensure optimal execution of HTS services strategy by enabling HTS benefits to be maximized and providing unprecedented bandwidth efficiencies and throughputs, thanks to the 500 Mbaud DVB-S2X forward and Mx-DMA® return link. Additionally, Newtec Dialog delivers the best connectivity experience and allows operators to enlarge their addressable markets in key HTS sectors, such as broadband, backhaul and mobility, as well as expand into emerging markets that are enabled by small, electronically-steered, flat panel antennas.

The platform is unique in its ability to optimally address the mix of fixed and mobility services and small and large antennas, all the while removing the dramatic cost increase and operational complexity traditionally associated with legacy VSAT platforms. These capabilities have been proven in a number of markets, with the mobility sector being a prime example and one of particular importance for HTS operators.

Milano Teleport is among the companies that have already decided to work with us in this area. Looking to enrich their services for the maritime market, they deployed a Newtec Dialog this year with two types of Newtec modems. Targeting mainly yachts (via the "**Orbis Yacht**" brand) and cruise liners (with "**iSeaglobal**") — both of which require very high-bandwidth connectivity — a number of vessels are already in service, with Milano Teleport seeing significantly reduced Operational Expenditure (OpEx) as a result of the Newtec Dialog hub located at their teleport in Italy.



Newtec equipment at the Milano Teleport.

Spreading WiFi Wings

Newtec's work within the commercial aviation industry also expanded during 2018. We operate over high capacity satellites such as **Eutelsat 172B**, which has been designed with applications such as in-flight connectivity in mind and our partnership with Panasonic is quickly progressing. Since we announced the partnership, **Panasonic Avionics** now has 350 aircraft flying with the Gen 3 Newtec modem to provide inflight connectivity and the plans are to have 1,000 installed by early 2019. The Newtec modem offers Panasonic's aero customers as much as 20 times the bandwidth of the original solution and can facilitate the increasing bandwidth coming on stream as HTS and **Extreme-Throughput Satellite (XTS)** services continue to be layered over Panasonic's existing global network.

Panasonic's network is built on their high throughput satellite service, which covers all dense mobility traffic areas around the globe with high throughput spot beams and wide overlay beams that support Panasonic's global inflight television service. Along with the Newtec modem, this supports the provision of in-flight services such as fast internet, video streaming, VoIP applications, improved TV picture quality and a broader channel choice, the capability to offer 3G phone services as well as greater bandwidth for crew applications.

As Newtec moves into 2019, this area, along with cellular backhaul, HTS technology and broadcast, will remain the company's focus — the company's ultimate aim is to meet the needs of tomorrow... today.

www.newtec.eu

Thomas Van den Driessche holds a Master's degree in electronics and marketing from the University of Ghent. Thomas started out as a Product Manager in the broadcast and AV market and was awarded several times by leading organizations such as NAB, Infocomm and Vanguard.

Over the past 18 years he has been active in the broadcast and satellite markets. Thomas Van den Driessche has been with Newtec for eleven years and has held various positions. His latest roles include Sales and Business Development Director Europe, VP Market Strategy and Chief Commercial Officer. Since January of 2017, Thomas is the CEO of Newtec.

Norsat International, Inc.

By Dr. Amiee Chan, President and Chief Executive Officer

2018 has been a year of tremendous market success for Norsat International through a wave of new product development and diversification into new markets.

During the past year, fly-away satellite terminals witnessed significant growth, especially within applications such as broadband disaster response and military intelligence. This proved to be beneficial for Norsat, as the satellite communications market is expected to register a CAGR of more than 8.46 percent during the forecast period of 2018 to 2023.

Through our constant industry interactions, customer requirements and R&D, Norsat is showing that products can be rugged, reliable, and cost effective. In 2018, Norsat developed and introduced next-generation terminals and a new lineup of compact microwave components and systems for the commercial and military markets. Whether customers are flying at 40,000 feet, in the middle of a rescue operation in a cave or driving leisurely across the country, Norsat delivers the best products to enable seamless communication.

Success Starts the Year



Norsat's **ATOM** series of block upconverters are world-renowned for being one of the most powerful BUCs, with the best industry size, weight, power and efficiency. With a strong focus on research and new product development, Norsat's ATOM 50 Watt Ka-band BUC and the industry's

first 4- and 5-band Ka LNBS were launched, making the Norsat Ka-band satellite components offering one of the richest in the industry.

New Markets Diversification

Commercial terminals have evolved over the years to become vital tools in the satellite industry. Norsat's market analysis revealed that light-weight, commercial terminals are becoming a mainstay for organizations that have to launch broadband connections in time-sensitive conditions. What originated as simple video or data uplink from a quick-deployable device has developed into an entire market segment. Toward the end of 2017, there was an immediate and increasing customer demand for commercial satellite terminals in numerous designs, each slightly unique from each other, envisioned for specific applications. Keeping this in mind, customer-focused product development proved to be a key motivator for Norsat this year.

A further step in our market diversification was the launch of Norsat's **WAYFARER™** series of ultra-portable commercial satellite terminals at the **NAB Show** in Las Vegas, in April. This was a strategic move to further meet the increasing needs of our non-military customers seeking high quality and high value solutions.

This series includes an easy-to-deploy drive-away, fly-away and fixed terminal solution. Products in this series are ideal for a variety of commercial applications including broadcast, oil and gas, mining, forestry, emergency response and remote enterprises, enabling us to reach out to new markets. Our commercial customers have praised the fast setup, tool-free installation and weather-proof construction.



Think Local, Act Global

With a history of more than 40 years of success, Norsat is well known locally in North America as the leading provider of innovative communication solutions for remote and challenging environments. This year, however, we have been witnessing significant orders from EMEA. This enabled Norsat to deliver its signature North American quality products overseas.

Europe holds one of the largest global market shares for the Satellite Services Market due to the presence of large integrators and operators and an increasing number of commercial customers using satellite communication as part of their overall communications plan. Additionally, the joint venture of European Commission and European ICT industry to provide the **5G Infrastructure Public Private Partnership** (5G PPP), will deliver solutions, architectures, technologies and standards for the ubiquitous next-generation communication infrastructures of the coming decade.

The company received a \$3 million order from this region in mid-2018. Another set of products that witnessed significant growth and were a major success were the 4- and 5-band Ka LNBS. Our 1:1 and 1:2 redundant switch system witnessed a surge in growth, as well.

Moving Forward

Known globally as an organization with a unique ability to 'customize fast', customers expect Norsat to deliver extremely specialized products quickly. Rather than a mass-market approach, we treat every customer's business as our own by developing solutions that adapt quickly to their applications. What has helped us survive and excel in the long run, for over four decades — is Norsat's exceptional dedication to the **LEAN Kaizen philosophy**.

Every year, we witness changing macroeconomic conditions, new technology with increasing competition. LEAN, done correctly, helps us maintain quality, be more flexible and adaptable to change as it occurs, rather than having customers suffer because of delayed responses. Every employee at Norsat believes that 'not a single process is exempt from improvement' — hence, striving for excellence is a continuous process. Norsat is one of the top organizations in Canada following LEAN, with every employee going through LEAN training, with six Green Belts, and three Black Belt certifications present in our current team. In 2019, our LEAN goal is ultimate customer delight. We are working toward achieving one of the shortest lead times in the industry with the highest quality products, by making our business processes more efficient.

As we move into 2019, the growth of the SATCOM market is anticipated to be driven by high demand for uninterrupted, customizable, energy-efficient communication systems with longer lifespans, greater functionalities and dependability — which is exactly what Norsat provides. Norsat will continue to expand our international customer base, closing deals in Europe, Asia, and South America. Moreover, we have already pledged a heavy investment in R&D and to all that is possible to ease the customer journey through the launch of the company's ecommerce platform. 2019 will, indeed, be a promising year for Norsat with significant new projects already underway.

www.norsat.com

Dr. Amiee Chan, President and CEO has over 20 years of experience in executive management and research & development in the telecommunications industry. Offering a rare blend of technical and corporate strength, Dr. Chan's strategic vision has driven Norsat's innovative product development program and resulted in consistent revenue growth since her appointment as CEO in 2006. Prior to joining Norsat, Dr. Chan worked at Creo Inc. where she guided the company through multiple product developments, beta programs, rollout strategies and product launches. Her strategic approach to business was reflected in the growth of Creo's \$80 million consumables product division.

Dr. Chan's work has been published over a dozen times. She currently holds three US patents in satellite technologies and has been involved in high level research teams such as the NASA ACTS Terminal Program. Dr. Chan holds an Executive MBA from Simon Fraser University where she majored in Strategy & New Ventures, as well as an Electrical Engineering Ph. D. in Satellite Communications from the University of British Columbia. Dr. Chan currently serves on the Dean's External Advisory Board for the Beedie School of Business at SFU, the Science World Board of Directors and the UBC Engineering Advisory Council.

ODYSSEUS Space

By Jordan Vannitsen, Co-Founder and Chief Executive Officer

ODYSSEUS Space is a young, startup company created in April of 2016 by French professionals from the European Space sector and then implemented in Taiwan.

ODYSSEUS Space is using its experience and expertise in Asia and in Europe to address the booming global market of small satellite applications. By using Taiwan's unique resources in terms of fast technology development and production costs, ODYSSEUS is developing the space technologies of the future for a fraction of the cost. ODYSSEUS Space will provide, at a relatively low cost, data useful for space exploration and exploitation. To achieve this goal, the company has

implemented a three phase roadmap.

During the first phase — **"Foundation"** (2016-2021), the company will demonstrate its space expertise, develop key smallsats technologies that will address already existing markets (constellations, etc.) while paving the way for deep space exploration using smallsats as well as build interest in the firm's technologies and a strong customers base

In the second phase, **"Expansion"** (2022-2024), the technologies developed during the first phase will be demonstrated in space, while additional R&D projects will be kicked off with partners to reduce the technological gaps for smallsat, deep space exploration mission.

During the third phase, **"Exploration"** (2024+), ODYSSEUS will fly its own Deep Space smallsat mission to an asteroid to demonstrate the company's interplanetary technologies and the capability to develop useful data for space resources detection and exploitation.

ODYSSEUS Space will provide three essentials solutions for the future of smallsats missions by 2022: **Autonomous Guidance Navigation and Control, optical communications** and **innovative propulsions systems**. With existing and new partners, the company is planning to contribute to additional technologies that will be required to explore the solar system with smallsats. Success can only be achieved through such key partnerships and joint development efforts.

The company's team members have worked on more than 15, international, smallsat missions, of which eight have already been successfully launched and operated. In parallel to the development of its own products, the company is currently providing engineering and management services to four smallsat missions on different continents.

2018, a Year of Consolidation

2018 was a key year for the company, with achievements in business and developments in crucial technologies.

ODYSSEUS Space signed an agreement with **Taiwan National Space Agency (NSPO)** to provide access to the excess capacity of the nation's four ground stations (S-and X-band) that are strategically situated in various locations across the island. Additionally, ODYSSEUS Space and **RBC Signals'** joined forces to enhance RBC Signals' global ground infrastructure network, coverage, and capabilities. ODYSSEUS Space makes available to RBC Signals and that firm's commercial satellite operator customers NSPO ground stations antennas, expanding RBC Signals' coverage capabilities in the Southeast Asian Region.

ARGO under test in a vacuum environment. Image is courtesy of ODYSSEUS/NCKU.



ODYSSEUS Space receiving the SpaceResources.lu challenge prize at the Space Exploration Masters award ceremony. Photo credit: AZO 2018.

In terms of technology development, the company has progressed on the **ARGO Project** that is addressing the fast growing smallsat market by aiming to commercialize a low cost and reliable attitude and control propulsion system for this class of satellites. Taiwan's **Ministry of Economic Affairs (MOEA)** renewed its trust in ODYSSEUS Space by approving a second grant to the company in 2018 to pursue development of ARGO to further test, develop and optimize the technology by delivering an initial, working prototype, to include the processing board and mechanical casing for the smallsat.

ODYSSEUS Space was also the winner of the **SpaceResources.lu** challenge of the **ESA Space Exploration Masters** competition that awards the best business ideas for space exploration and societal benefit. Initiated by the **European Space Agency**, this competition targets participants from around the globe. A total of seven prizes were awarded in collaboration with international partners, including a 500,000 euro prize from the **Luxembourg Space Agency** for support during the developmental stage. The company has initiated the process of relocating its headquarter from Taiwan to Luxembourg, while maintaining space activities on the island.

Addressing the Smallsat Market

2017 was a record year with 330 smallsats launched, a 69 percent increase from the 196 units that were reported launched in 2014.

During the last two years, many companies have developed satellite solutions, largely based on constellation concepts. The objectives of the many low-cost constellations in development are to provide global connectivity from a single network system (telecom segment), high-frequency change detection (Earth Observation segment) and low data rate/narrowband for data collection from ground sensors, such as remote devices and vehicles (Information segment). With the advances in satellite system miniaturization, smallsats are now providing operational services that were previously achievable only with bigger satellites and large government entities or companies, and at a higher cost.

Over the next 10 years, there are estimated to be more than 7,000 smallsats to be launched — constellations will account for 82 percent of this activity. Telecommunications and Earth Observation will represent 71 percent of the smallsats to be launched within this time period.

Assessing what role these emerging applications, such as on orbit servicing, manufacturing in space or on orbit space resources use, has yet to be determined and will be unveiled during the coming years. Nevertheless, it is quite likely these new applications will radically disrupt the existing markets. These smallsat applications might well become the most profitable of all. ODYSSEUS Space will answer new needs with solutions the company is now developing: autonomous guidance navigation and control, optical communications and propulsion. The company plans to demonstrate those solutions in space in 2022, with deep space demonstration of those solutions near an asteroid post-2024.

By Q1 2019, ODYSSEUS Space will expand in Luxembourg and will be open for investments. This will give the opportunity for the company to establish a new pole of activity in Europe in a country whose national roadmap of space resources exploration and exploitation is fully in line with the ODYSSEUS Space vision and business plans. Significant value in Europe and Asia will be created, thanks to the existing synergies that exist between the two continents in terms of R&D and manufacturing capabilities. Only through a global and joint effort will the wonders and richness of the solar system be made available to human kind.

odysseus.space

For more than eight years, Jordan Vannitsen has been involved in numerous, international, small satellite missions. His roles have included those of a System Engineer and Project Manager as well as the flight coordinator for cubesats at the European Space Agency, where he received the 2012 ESA Award for Teamwork Excellence.



Phasor has experienced yet another fast-paced and exciting year. Momentum has been building, and continues to build, for the electronically steered antenna (ESA) developer.

As the company looks forward to the release of its first commercial products in the first half of 2019, the company can look back on a year that has seen the company continue the transition from a technology development firm to a products company. Here's a snapshot of some of the highlights of 2018 and a glimpse into what can be expected from Phasor during 2019.

Phasor: The Business

In March, Phasor opened their **Technology Development Center in London**, which is a world class research and development facility. This center hosts the design, development and testing of Phasor's current and next-generation connectivity technologies tailored to commercial SATCOM mobility markets, including high-speed broadband for maritime, aviation, and land-based vehicles. The opening of the center marked an important milestone in the evolution of Phasor as a company and allowed for the expansion of facilities and staff.

In addition to the opening of the Technology Center, Phasor appointed senior executives that are leading critical areas of Phasor's global operations, from engineering to business development and supply chain management. Phasor boasts a growing team of technology and engineering professionals.

Phasor also secured various major commercial product contracts over the past year, valued today at more than \$300 million. These agreements underscore the company's maturation, demonstrate successful early commercial engagement and underscore the latent demand for innovative access technology in commercial mobile broadband markets and the analogous unmet need in government Communications-On-The-Move (COTM) markets, for enterprise-grade connectivity on land, sea and in the air.

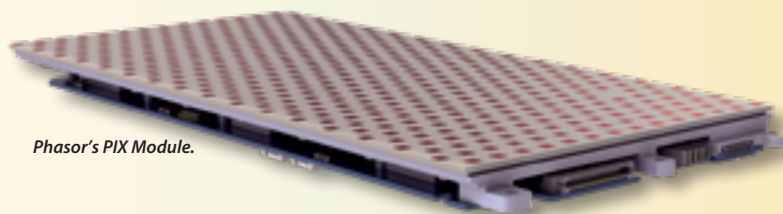
Phasor: The Technology

Technologically, Phasor has enjoyed a vibrant 2018. With the commercial product launch slated for the near future, the development of the ESA systems for land-mobile, maritime and aeronautical applications is moving into a new phase. There have been some notable milestones and partnerships in 2018.

March brought the signing of a partnership agreement between Phasor and Spanish satellite operator **Hispasat** in order to address rising connectivity demand for professional and passenger land vehicles in its geographical markets, such as Intercity buses. Phasor is collaborating with Hispasat on the development of a Ku-band ESA that will be tailored to the unique requirements of land-mobility applications, using the same core technology found in Phasor's commercial maritime and aeronautical ESA solutions. Drivers and passengers in buses, trucks and emergency or municipal vehicles, will be able to enjoy a high-quality connected travel experience for applications like operational telematics, and passenger Internet access, mobile telephone services, and even entertainment services on board. The ESA system is expected to be available within two years.

Related to the LEO market, in March, Phasor announced a strategic agreement with **LeoSat** who will launch a laser-linked constellation comprised of as many as 108 LEO communications satellites to provide gigabit-per-second connectivity speed to the enterprise market.

The agreement in place is set to serve a broad range of mission-critical enterprise network markets with an ultra-high throughput, low latency network infrastructure solution. As part of the alliance, Phasor will accelerate development of a Ka-band variant of its Ku-band ESA nearing commercial launch. This powerful Ka-band, NGSO – ready version of its ESA will be scalable to virtually any use-case requirement. Phasor's LEO-capable antenna technology will enable corporations, governments and other



Phasor's PIX Module.

mission-critical, high bandwidth users to access a network offering speeds about 1.5 times faster than terrestrial fiber in combination with high-throughput, ultra-security and very low latency. The engagement of Phasor is significant as it is an important step in the delivery of LeoSat's services and underlines the importance of the correct kind of access technology.

In June, Phasor entered into a commercial partnership with **Astronics AeroSat**. The companies are working together to produce scalable, dual-beam ESA-based aeronautical terminals, which will enhance the passenger and crew experience aboard connected business and commercial airlines. Astronics AeroSat will integrate Phasor's phased-array technology into an agile aviation antenna solution that will operate seamlessly with Geostationary (GEO) and Non-Geosynchronous satellites, such as the Low Earth Orbit (LEO) wideband constellations that are currently in development. The new antenna will feature dual-beam technology with a "make-before-break" capability.

The two companies will pursue and achieve certification and commercialization of the new dual-beam terminal across multiple commercial airframes and satellite communications networks, coupling Phasor's innovation with best-in-class avionics and terminal integration expertise.

In September, **Kepler's** first wideband LEO satellite, **KIPP**, was successfully auto-acquired, auto-tracked and communicated with, via Phasor's ESA. This was a highly anticipated milestone as this was the first time that a commercial, flat-panel, electronically steerable antenna had achieved such a feat. Phasor's antenna successfully acquired, tracked and received transmissions from KIPP as the satellite passed over Phasor's test range facility in the UK. For the test, Phasor's antenna was able to track KIPP for its entire pass down to 20 degree elevation angle, demonstrating the viability of the 70 degrees scan angle available from the Phasor electronically-steerable antenna.

That achievement now opens the door to a wide range of novel applications that can benefit from phased array antenna technology, which the duo intend to address. The combined capabilities of Kepler's ultra-low-cost satellites and Phasor's high-performance technology will allow the potential of high-speed LEO Ku-band mobile connectivity to be unleashed. Customers will be able to benefit from the ability to dynamically and seamlessly switch between satellite networks in order to optimize traffic management.

This marks another exciting beginning on Phasor's journey into the commercial market and to the prospect of bringing real capabilities to markets such as maritime, transportation, natural resources, IoT and other on-the-move applications.

More to Come

2018 was a busy year for the firm and the Phasor team is looking forward to launching the company's initial products into the market during 2019. Currently being worked by Phasor is the company's land mobile and maritime system, with field tests underway for the first release of products. Longer-term, Phasor's Product Roadmap includes a three-release strategy over several years, covering a range of form-factors, use-cases and frequency bands.

The year ahead promises to be an exciting and significant one as Phasor introduces its highly-anticipated technology to the market. The company is dedicated to making its breakthrough ESA available to the wide spectrum of mobile applications, enabling a level of connectivity that is transformative, delivering seamless, high performance connectivity — the future of mobile broadband.

www.phasorsolutions.com

David Helfgott has the responsibility for the company's strategic direction, to drive the development of the firm's Electronically Steerable Antenna (ESA) products and technology and to implement its operational programs. As a 20 year industry veteran, he has extensive experience in satellite broadband, mobile telecommunications as well as commercial and government SATCOM networking services. Mr. Helfgott has held leadership positions at Inmarsat, Cobham, DataPath and SES. He holds a BA Degree from the University of Virginia and an MBA from the Darden School.

Phasor's electronically steerable antennas (ESAs) are based on patented innovations in dynamic beamforming technologies and system architecture. Phasor's mission is to enable high-speed broadband communications while in-flight, at sea or traveling over land.



Phasor's Aero Antenna.

PLD Space

PLD Space is a company based in Elche, Spain, and was founded in 2011 by Raúl Torres and Raúl Verdú. Sensing a need in the market for small satellite launch providers, both entrepreneurs founded PLD Space with the purpose of offering dedicated commercial launch services for smallsats.

With more than 50 employees on staff, and 13,000 square meters of space for the development of rocket engines at Teruel Airport, the company has set the countdown for the launch of **MIURA 1**, a suborbital vehicle designed to launch technologies and experiments requiring space-like conditions.

Since inception, the company has received private and public funding that, today, exceeds 18 million euros. The project has the support of large institutions such as the **European Space Agency (ESA)**, the **European Commission**, the **Center for Industrial Technological Development (CDTI)**, the **National Institute for Aerospace Technology (INTA)**, **ENISA**, **IVF**, **Suma Teruel**, the **UMH Science Park** and more than 25 private investors and aerospace companies. With this economic support and the daily work of a team of professionals, **PLD Space** is today one of the most promising European companies in its market segment.

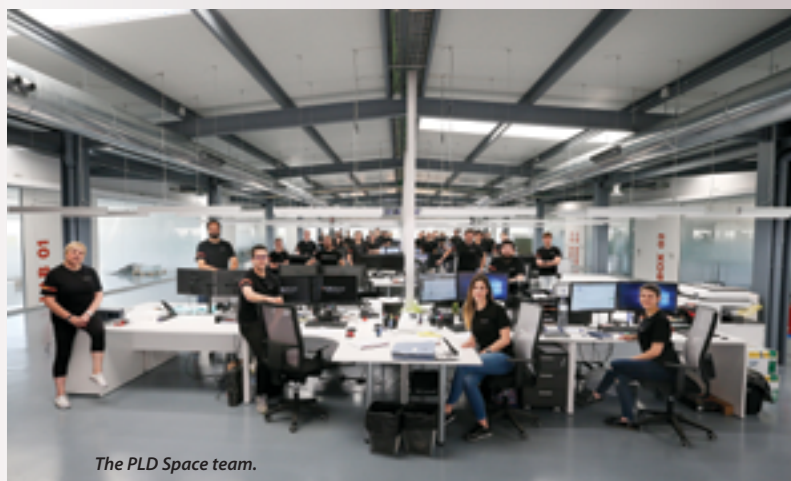
2018 has been especially important for the history of the company. In January, PLD Space received a two million euros grant from the European Commission for the MIURA (previously known as **ARION**) microlauncher program. This honor has been awarded through the *Small and Medium-sized Enterprises (SME) instrument Phase 2*, a part of the European Union's **Horizon 2020 Program for Research and Innovation**.

With this financial support, part of the rocket structure is currently being developed.

After months of hard work, this June PLD Space completed a 17-million-euro investment round, with the support of **Aciturri** and **JME Venture Capital**, which have joined a group of solid partners such as **GMV** company and **Alzis Group**, among others. With this economic boost, the company has been growing with the addition of a number of qualified employees

MIURA 1, the first liquid propulsion suborbital microlauncher in the history of Spain, is already in the manufacturing and assembly phase. The first launch, from the **El Arenosillo Experimentation Center**, belonging to INTA, is scheduled for the third quarter of 2019. This launch will enable in-flight validation of many of the technologies that will be used on the **MIURA 5**, one of the few rockets in the world dedicated to the smallsats launch industry.

The engine testing is another important step that is being carried out in Teruel Airport, with whom PLD Space has signed a 25-year concession for rocket engine testing. Additionally, this year important companies, such as **DLR**, have used the PLD Space test facilities for their engine development and have produced some great results.



The PLD Space team.

PLD's ability to cooperate with other companies has been a vital advantage in entering the private launch industry, not only in the use of the facilities, but also in the construction, launch and recovery of the microlauncher. PLD Space and **ZARM** have signed a Launch Agreement for the test flight of MIURA 1, becoming the first customer flying onboard the rocket next 2019. Furthermore, the world's leading manufacturer for world class launch vehicles, **RUAG**, will provide MIURA 1 and MIURA 5 with the fairing, one of the most critical structures of the microlauncher. RUAG has designed the fairings for European **ARIANE 5** and **VEGA** and **United Launch Alliance's ATLAS V**.

Recently, PLD Space made public how the recovery system will work for the first European recoverable microlauncher. Thanks to the airborne systems technology, MIURA 1 and the first stage of MIURA 5 will be recoverable. In conjunction with PLD Space's proprietary technologies for re-entry, MIURA 1 will use a combination of two different types of airborne system parachutes, a drogue parachute and a main parachute.

The Drogue parachute is a 3 meter parachute with decades of heritage. This technology was used as part of the **Space Shuttle Orbiter** landing deceleration system, the **NASA Orion** Earth Landing System and some Commercial Crew Capsules developed by U.S. space companies. In addition, PLD Space is using a 15.3 meter diameter, quarter spherical, polyconical parachute, designed for the **Air Force Security Assistance Training (AFSAT)** platform in response to a requirement for an extremely stable, drag efficient, lightweight and reusable parachute. Parallel to this, PLD Space will continue working with Airborne Systems in the development and testing — that will be carried next April 2019 — of the recovery system to be used on MIURA 5 first stage demonstrator.

In regard to future development, the Spanish company has also presented the new configuration of MIURA 5 at the **ESA Microlaunchers Workshop**. PLD Space's orbital microlauncher will have two stages. The first stage will contain five engines and 408 kN of thrust, while the second stage will have one engine capable of 68 kN of thrust. Both engines and stages will be developed by PLD Space, while the avionics will be developed jointly with GMV.

The vehicle diameter will be 1.6 meters, with a first stage length of 17 meters and a second stage length of 6 meters. The fairing will be 3.2 meters in length. MIURA 5 will be 32 tons at lift-off; the vehicle is designed to be small enough to provide dedicated launch services to smallsats.

Looking toward 2019, PLD Space is working against the clock to become a keystone provider in the technological and social development of Spain. The company will help the expansion of the small satellites market in Europe, while undoubtedly the institutional and financial support and the daily effort of a team of professionals are key factors for the success of this important project.

www.pldspace.com



Artistic rendition of the MIURA-1 in flight. Image is courtesy of PLD Space.

Rock Seven

By Nick Farrell, Director



As 2018 winds down, the most encouraging development in Rock Seven's ongoing expansion is the company's recent acquisition by the Machine-to-Machine (M2M) and Internet of Things (IoT) provider Wireless Innovation.

This is a mutually advantageous arrangement. Rock Seven's technical experience and expertise in the field of Iridium-based satellite tracking systems will reinforce and broaden Wireless Innovation's product and services platform. By the same token, belonging to a larger concern will open up a whole new layer of developmental and commercial opportunities for Rock Seven – and the long-term significance of this cannot be underestimated.

This has been a promising year for collaborations, with the announcement in June of Rock Seven's new partnerships with **Blue Sky Network** and **Network Innovations**. The California-based Blue Sky Network, a key supplier of communication and satellite tracking solutions, has created a stir with their cloud-based **SkyRouter** fleet management and analytics portal: the alliance with Rock Seven has brought about the successful integration of SkyRouter into Rock Seven's standalone, dual-mode Iridium/GSM **RockFLEET** tracker. Other items from Rock Seven's product portfolio also address the varying needs of Blue Sky Network's customer base: the **RockAIR** dual-mode tracking device, the **RockBLOCK** two-way IoT satellite communications system and the **RockSTAR** handheld two-way messenger.

Rock Seven's partnership with Network Innovations Inc., meanwhile, has seen the incorporation of RockAIR, RockFLEET, RockSTAR and RockBLOCK products into a flexible suite of tracking and IoT solutions as the company moves into IoT applications in the aviation, maritime, government and land mobile sectors. By implementing Rock Seven's highly configurable hardware platforms, Network Innovations can rapidly deliver complete IoT solutions to its clients, generating substantial Return on Investment (RoI) and promoting customer value.

Regarding the RockAIR flight tracker, Rock Seven's year began on a positive note with the news in January that the **United States Fire Service** (USFS) had approved RockAIR for use in its airborne firefighting operations. The carry-on, carry-off RockAIR — uniquely designed for easy dashboard or windscreen mounting in light aircraft and land vehicles — has quickly accrued an unassailable reputation as the most compact, cost-effective and conformable dual-mode solution for satcom and cellular connectivity. With its integrated back-up battery for safety and security, which automatically cuts in if the 9-30V DC or Micro USB power should fail for any reason, RockAIR defaults to economical GSM tracking when in cellular range, but switches to the strongest, most practical (and least costly) **Iridium** satellite network in more remote areas.

In July, the company announced involvement with the **BESPIN** and **HAPP** projects, both of which require Rock Seven hardware to collate and transmit space exploration telemetry. The **BESPIN** (**Balloon Ejection Student Prototype Investigation**) project was devised by an international group of students from the **Luleå University of Technology** in Sweden. The experimental project aims to pre-emptively assess the feasibility of a balloon-assisted, manned mission to investigate the upper atmosphere of Venus. A research rocket is due to be launched in March of 2019 that contains a **Free-Falling Unit** (FFU) which will be ejected from the rocket's nose cone at the mission's 80 km. apogee. The FFU consists of a flotation probe and a descent probe: it will freefall to an altitude of approximately 5 km., whereupon a parachute will open on the descent probe. Thereafter, a Rock Seven RockBLOCK will be used to convey operational and location data to a ground station.

Meanwhile, the **HAPP** (**High Altitude Photography Platform**) project, conceived by engineers **Christopher Couch** and **James Mayes**, is a pioneering incentive involving a jet-stabilized aircraft and balloon system designed to capture stabilized, 360 degree high-altitude video. Rock Seven's RockBLOCK is again an integral ingredient: the HAPP craft can drift by up to 100 km. in the course of a mission, but a RockBLOCK successfully relayed stable telemetry and system sensor data from the flight control computer on the craft's maiden flight. The U-Blox board and PCBs were open to the atmosphere throughout, with the craft flying at an altitude of up to 22 km.: this exposed the components to temperatures ranging from +42°C to -45°C, as well as pressures from 1atm down to 0.05atm.

Rock Seven hardware was also at the heart of the **MIRKA2-RX** mission, completed in October of 2018, which was formulated by students from the **University of Stuttgart's Small Satellite Group** to field-test technology for use in a future cubesat endeavour. The mission rocket included a micro re-entry capsule (MRC) which was ejected into the upper atmosphere, subsequently landing in the harsh, snowy terrain of the Swedish Alpine tundra. The mission team were able to locate the MRC thanks to telemetry received, via Rock Seven's API and server, from the RockBLOCK-hosted 9603(N) modem and antenna in the device.

Returning to more earthbound concerns, Rock Seven occupied a pivotal role in critical and timely environmental projects throughout 2018. In September, the company reported on **The Ocean Cleanup**, a resourceful but economical solution to tackle plastic pollution in the world's oceans. Each system uses a 600 meter long, U-shaped floater with a 3 meter deep skirt beneath it: the curved floater is carried along the ocean surface, at a slightly faster speed than the current, by wind and wave energy, collecting plastic refuse as it goes. During the research stages, Rock Seven's 9603 RockBLOCKs have been fitted to a number of drifting, open-source 'marker buoys' intended to simulate the movement of plastic particles around the systems. Data accumulated via the RockBLOCKs has proved invaluable, and the Ocean Cleanup foundation anticipates being able to clean up to half of the so-called Great Pacific Garbage Patch in five years.



September 2018 also saw Rock Seven detailing its involvement with **Rainforest Foundation UK**, helping to curb illegal extraction activities in the Congo Basin and the Amazon. The foundation's **ForestLink** real-time monitoring system relies on monitors living in the rainforest to report on suspected illegalities via a bespoke smartphone app: if GPRS isn't available, ForestLink uses Rock Seven's RockBLOCK and weatherproofed RockBLOCK+ devices to transmit data. Thousands of alerts have already been sent, prompting legal action and protecting millions of hectares of rainforest.



Monitors set-up: ForestLink hardware in Cameroon.

Also worthy of note is that the RockBLOCK 9603 is at the heart of the **Cryologger**, a multi-purpose research datalogger and telemeter developed by the **Water and Ice Research Laboratory** (WIRL) at **Carleton University**, Canada. The Cryologger gathers aquatic and cryospheric data relating to the drift patterns of icebergs as a means of achieving a fuller understanding of the effects of rapid climate change.

Speaking of the future, there's a wealth of exciting opportunities ahead for Rock Seven customers with the advent of the higher-bandwidth **Iridium NEXT** constellation and **Iridium Certus**, the new NEXT-based L-band broadband platform for web browsing, email and voice calls, which is on course to deliver a speed of 1.4 Mbps. Rock Seven offers competitively-priced pay-as-you-go or fixed-price Iridium contracts.

The Iridium SBD (Short Burst Data)-based RockBLOCK supplies sterling service, as amply demonstrated by diverse users, but it is fully compatible with Iridium NEXT, as are Rock Seven's RockFLEET, RockAIR and RockSTAR, so the company's products can continue to be integrated into IoT devices and support global mission-critical applications as the potential of satellite broadband communications evolves. In a world of speculation, Rock Seven's products and services provide certainties.

www.rock7mobile.com

RUAG Space USA, Inc.

By Carrie Rice, Director of Communications

Lower cost and increased flexibility are more than just buzz words in today's new space environment — these are requirements that the industry is demanding. And while changes in an already successful production process can seem intrusive, RUAG Space has actually found its niche.

Unique to the Market

One particular area wherein RUAG Space has evolved as an industry leader is the process for manufacturing carbon-fiber based satellite structures. RUAG Space has automated the production process which benefits the firm's satellite customers. The key element of this advanced process is the **Automated Potting Machine (APM)**.



RUAG's Automated Potting Machine (APM).

The APM was born out of a need for innovative manufacturing processes to address the new space market. It uses a *Computer Numerical Control (CNC)* machine to position special inserts filled with adhesive into the satellite structure's sandwich panels. The inserts allow customers to firmly attach equipment, instruments and/or sensors to the satellite structures.

A typical communications satellite has as many as 5,000 such inserts and, up until now, the aerospace industry has always positioned inserts by hand — a process that is quite time consuming. The APM, along with RUAG's patented insert, can place up to 15,000 inserts per day, reducing the lead time on satellite panel production down to one day. Plus, RUAG Space now has two of these machines in the company's Titusville, Florida, facility — where satellite structures are manufactured for OneWeb.

The bottom line in terms of speed? RUAG's automated manufacturing process for satellite panels lowers throughput time, significantly reduces cost and raises the quality for the firm's customers with precision insert placement. Also provided is an increase in flexibility whereby customers can modify insert patterns later in the process, lessening the need for compound glue additives — less time, less weight, less money.

Meeting New Space Demands

Another prime example of lower cost and more flexibility lies within the manufacturing process of the company's payload fairings. RUAG Space has a long history of fairing production for customers in Europe and the U.S. — with a 100 percent mission success rate — a heritage that has made RUAG Space a global leader in carbon structures for launch vehicles. However, in order for customers to continue to meet industry demands, RUAG Space has focused efforts on making access to space more affordable, becoming one of the pioneers in the *Out of Autoclave* production process.

In 2016, RUAG opened a new state of the art production facility in Emmen, Switzerland. It was here that RUAG inaugurated the new process that used an industrial oven instead of an autoclave, allowing the massive carbon fiber components — which constitute one half shell of the payload fairing — to be economically produced in a single piece. The ambient pressure of the oven hardens the composite structures, as opposed to the autoclave process of excess internal pressure, and the cost savings from such an industrial oven enabled the company to go bigger. A bigger oven means bigger products.

Entire half-shell fairing sections can be cured at a time, eliminating costly and time consuming vertical integration of numerous shell elements. The new process reduces throughput time by 50 percent and enables RUAG to increase the delivery volume and sequence for payload fairings.

Other major elements in the process, such as the laser-assisted layering, the completely automatic nondestructive testing and the ergonomic horizontal integration station, all contribute to the new, leaner, faster, better process that RUAG Space is best known for implementing.

The first RUAG Space Out of Autoclave fairing made its successful debut in June of 2017 on an *Ariane* launch, and the *Vega* fairings flew next. In the U.S., RUAG Space is now manufacturing *Atlas V-500* fairings for **United Launch Alliance** in Decatur, Alabama. Earlier this year, RUAG Space completed the bonding and curing of its first U.S.-made Atlas V-500 demonstrator fairing, and full production of its first flight hardware fairing will begin in 2018.

"RUAG Space is moving full steam ahead in the U.S., and the successful demolding of our first payload fairing highlights our progress and commitment to innovation," said Mike Morningstar, President and Country Manager of RUAG Space USA. "Space exploration continues to pique the world's interest, and we're pleased to be supplying the international space community with products and processes that go the extra mile — in terms of innovation and quality."

The U.S. facility was designed to replicate Emmen, with more lean process updates and boasts an even larger oven with the ability to cure a fairing up to 8.5 meters in diameter.

The ability to have these lean, Out of Autoclave processes on both sides of the ocean provide even more cost savings to U.S. customers as well as in Europe, avoiding costly transportation fees. This is representative of RUAG's dedication to meeting new space demands, and willingness to be in close proximity to customers.

More than Meets the Eye

At RUAG Space, diverse product portfolios gives the firm a strategic market advantage. For example, in an effort to meet the needs of the customer in terms of performance and cost, RUAG Space is making use of standard components for on-board satellite and launcher computers.

By using Commercial-Off-The-Shelf (COTS) electronic components and qualifying them for space — rather than expensive, specifically designed for space components, RUAG Space is bringing lower-cost options to the space industry. The use of COTS components generates 10 times the performance, reduces the lead time by a multiplier of 20, and costs 50 times less to build.

RUAG's willingness to innovate and grow within the new space environment does not just begin, nor end, with APM, fairing production, and other advancements. It is the culture of RUAG Space, led by Chief Executive Officer **Peter Guggenbach** and it extends to all product groups within RUAG Space, whether mechanical or electronics products, whether for launchers or for spacecraft.

Examples can be found across all product groups of RUAG Space on how innovative thinking and the improvement in processes is second nature to the company's culture. This is what keeps the firm's customers at the top of the market and is what enables the company to meet the demands of today's global industry. This is RUAG Space.

www.ruag.com



Fairing demolding in RUAG Space USA's Decatur, Alabama, facility. Photo is courtesy of the company.

Satcom Global

By Graeme Gordon, Global Commercial Director



With the demand for limitless high-speed data showing no signs of slowing down, 2018 for Satcom Global has been dominated by a strong focus on maritime connectivity. Advancements in satellite networks with increased coverage, improved and guaranteed connectivity speeds, and greater attention to user friendly interfaces, represent constant developments in maritime communications which are transforming the way shipping owners operate their business, and crew live their lives at sea.

Aura VSAT Growth

2018 witnessed Satcom Global's Aura Ku-band VSAT solution go from strength to strength, with an intensive and steady installation program inching us very close to the 1000th vessel live on Aura. Following trials which started in 2017, a number of ship management operators have completed the full rollout of the **Aura VSAT** service in 2018, including shipping titans **Euronav**, **Zodiac** and **MSI**. As a result of proven performance and industry leading speeds, Aura is delivering reliable business communications to 100's of new vessels, supporting these leading shipping operators in their efforts to enhance crew welfare through crew connectivity.

Access to a high quality and reliable connection for business operations remains a primary requirement for many of these shipping operators, as well as actively investing in a higher performance communications solution to benefit the crew and their expanding bandwidth requirements. With today's VSAT technology, owners and managers are investing in solutions where they can be much more generous with their connectivity, no longer having to compromise on how they allocate the data they have onboard. Satcom Global's modern, state of the art network facilitates this easily, essentially providing an open data pipe without restriction. In addition, the strong CIR guarantees performance, alleviating the worry that increased crew online access would be of detriment to business connectivity.

There is also a definite shift in behavior from ship managers, promoting BYOD access and crew use of chat platforms such as **WhatsApp** and **Viber**, which in the past have been restricted to reduce disruption and distraction from work tasks. More and more, we are seeing proof that access to reliable communications, positively contributes to the mental well-being of crew as well as operational efficiency and safety at sea, which may be helping to change purchasing priorities.

Aura Transcending Maritime Sectors

Shipping continues to be a key market for Satcom Global, but we are also seeing a notable uptake of improved communication solutions across a range of maritime sectors. As an example, the company's **Offshore Supply Vessel (OSV)** customer base has considerably expanded this year. OSV vessels spend prolonged periods out at sea, supporting offshore installations, requiring significant data packages to accommodate large file transfers.

Scientific and environmental research is another industry that is requiring a high quality and dependable satellite communications service to support sustained remote working. We are working with a number of maritime research agencies in the South Pacific enabling them to communicate with the shore side of the business, share data, stream live video of exploration and maximize their time at sea.

The company has also seen, first-hand, the rise in demand for connectivity from the commercial fishing sector, with a number of customers in New Zealand implementing Aura VSAT throughout their fleet of trawlers and fishing vessels. In addition to fuel saving and harvesting technology, investment in solutions like Aura VSAT is vital for improving operational efficiencies and supporting sustainable fishing practices.



As the demands from businesses operating at sea increase, so, too, do the demands from those spending their leisure time on the water. More and more recreational yacht owners and charterers demanding connectivity echoing requirements and expectations they have at home or in the office. Owners and guests onboard expect luxuries such as streaming films, following live sport and operating a home office at sea to keep their business running. As well as a consistent uninterrupted connection, the main demand from this market is for flexibility of service, *i.e.*, the ability to ramp up it up and down easily, and seasonal flexibility for when the service is not required.

Aura Network Developments

2018 has also seen Satcom Global make some major investments in the development of the Aura satellite network. In October of this year, the Aura VSAT network was successfully migrated to the **iDirect Velocity** platform, bringing improved satellite network management capabilities as well as enhanced coverage and capacity through access to additional satellite beams.

Satcom Global was in a unique position to support the migration with as little disruption to customers as possible, as the Aura service was developed with Velocity-ready **iDirect X7** modems from conception. This future-proof approach allowed a seamless 'over the air' migration for Aura early adopters, enabling them to easily transition to and take advantage of the enhanced capabilities Velocity will bring to the Aura service — all occurred without the need for physical hardware upgrades on board the vessel.

The Velocity upgrade has significantly enhanced Aura VSAT coverage and capacity by providing access to a number of new satellite beams. The addition of **SKY Perfect JSAT** satellite coverage in the Indian Ocean region is key for connectivity across major shipping lanes linking Africa, Europe and Asia, while additional coverage provided by **Astra 4A** enhances existing multi-beam coverage over the typically congested European waters. **SES-10** now provides improved coverage across Panama and the Caribbean, and access to the younger U.S. based satellite, **SES-1**, facilitates enhanced connectivity across the Americas.

Driving Maritime Business Expansion

As a strategic move in line with market demand, Satcom Global has relocated its headquarters in the Americas to a new location in Nashua, New Hampshire. As well as actively supporting existing and new land-based government and enterprise business, the newly expanded team will have a strong focus on developing sales and partner relationships in a wide variety of maritime sectors.

Steve Griffin, Director of Sales and Business Operations – Americas, looked to 2019 and the challenge and opportunities ahead and said, "Satcom Global's potential in the US market is huge. We already have a strong land customer base from a wide variety of different sectors including media, NGO's, government and enterprise, so along with improving our sales support and developing new opportunities with them, I am looking forward to diversifying and taking a more aggressive approach in the maritime and offshore markets. I strongly believe Aura VSAT will provide a welcome choice for to the maritime market in the Americas, offering high performance, cost-effective, connectivity with the flexibility to suit industry requirements."

The Future — Iridium Certus

In February of this year, Satcom Global was announced as an official partner for **Iridium Certus**, and as the company nears the close of the year, the firm is preparing for the hotly anticipated service launch.

Launching with a 350 kbps speed, reaching 700 kbps by the end of 2019, Certus is a huge jump in L-band capability. With its global coverage, it will also open up much more opportunity for those currently or looking to operate or travel the Polar regions, which have been a challenge for connectivity for many years.

Iridium Certus will soon become an integral part of Satcom Global's Aura configuration, providing the most advanced back-up available, greatly reducing the disparity between primary and back-up communications services. In addition, with Certus GMDSS ready, Aura will in turn become a GMDSS ready VSAT solution qualifying for global safety standards at sea.

As a communications provider, Satcom Global works closely with vessel owners and operators, to develop and provide them the right platforms and scalable services to meet their needs. The company looks forward to entering the new year with exciting new technology to bring to customers. With the uptake of VSAT showing no signs of slowing down and the introduction of Iridium Certus, 2019 is going to be an exciting year for the company.

www.satcomglobal.com

Graeme has spent over 15 years working in maritime satellite communications with Inmarsat, AND Group and Satcom Global.

Satcoms Innovation Group

By Marin Coleman, Executive Director



For the newly named Satcoms Innovation Group (SIG), previously known as Satellite Interference Reduction Group, 2018 has been a truly global year. We've held workshops on three continents, welcomed two new members (Natsat and Quadsat) and broadened the group's remit to focus on industry-wide innovation. I am excited about where this shift will take the organization, particularly as there is a great deal of development underway in the satellite sector with HTS, 5G and the super-networks of the future.

LEO Still Poses a Big Question Mark

SIG kicked off the year with our first workshop, kindly hosted by SES. I was joined by several of SIG's member organizations, including **Mark Steel** of **Inmarsat**, **Bob Potter** of **Kratos**, **Ian Hilditch** of **ETL Systems**, **Alvaro Sanchez** from **Integrasys** and **Rob Rainhart** from **Hawkeye**, the only non-member on the agenda. One of the main topics on the agenda was LEO, specifically, what issues we need to concentrate on, and should we be worried?

Low Earth Orbit (LEO) constellations are hugely exciting and present huge opportunities. Like High-Throughput Satellites (HTS), LEO looks set to help the satellite industry meet growing connectivity demands and cope with new, data-heavy applications. Connected cars and autonomous vehicles are just one possibility, but LEO could also help us connect rural communities and provide internet connectivity to the half of the Earth's population currently going without. However, we simply don't know how LEO will affect wider satellite operations. Given the size of the constellations proposed to deliver reliable communications, we could see problems arise from congestion and intermittent RF issues. For now, the benefits outweigh the risk. However, until the first LEO constellation is launched, there will remain an element of doubt.

This means, in my mind, we must prepare in advance for any outcome by learning more about the constellations proposed and the way spectrum and transmissions will be managed, and from that find and implement better monitoring solutions to handle this new era of communication. For example, currently we simply don't have the tools to identify individual LEO satellites which is essential to tracking problems, and that is a cause for concern. This is a subject that will undoubtedly appear on many conference agendas in the new year.

AI has Huge Potential

I participated in a special edition of Kratos' *Constellations* podcast. I joined **Mark Steel**, VP of Product Development and Strategy for **Inmarsat**, and **Bob Potter**, VP of Signals and Ground System Technology for **Kratos**, to discuss smallsats, interference, AI and EPFD limits. You can read about what was discussed and [listen to the podcast via this direct link](#).

I was also pleased to moderate a panel exploring the potential for Machine Learning (ML) and Artificial Intelligence (AI) to solve interference and manage future networks. AI has been a game changer in many other industries, but we haven't seen its potential explored much in the satellite sector. SIG believes it has the potential to significantly improve processes and efficiency in many aspects of operations, particularly when it comes to dealing with more diverse services and constellation challenges.

As satellite operation migrates towards being more of an ISP, managing incidents will require any operator to think more IT than RF. Using AI and ML can help that migration, but we must change the way we think. That's why we need certified procedures, high grade transparent information gathering standards and excellent data quality of machine as well as human input. As we ask careful questioning and feed suitable data to an AI-based solution, the more sophisticated it becomes in resolving issues through mathematical probability. This could be beneficial for satellite, especially when it comes to plugging the gap left behind by retiring engineers. But we need to start employing data scientists as well as IT experts. They, in turn, can then be taught about RF. My belief is that it may be possible to build some sort of 'digital assistant' system capable of predicting and identifying errors before they become disruptive.

There is a lot to do to make it work and it is also a visionary game changer with many difficult managerial questions to answer, such as the sharing of data, and the discussions up to CTO/CEO level to ensure understanding of what it means — including the strategic and technical risks — to assist the managerial evaluation and assessment.

Events Facilitate Change

SIG strongly believes it is essential to bring organizations together at the engineering level — engineers simply don't participate in trade shows, so SIG events such as the numerous events held during 2018, are essential if we want to facilitate working relationships within the industry. This year was the group's 20th anniversary, so for our European workshop we decided to return to where it all started — Paris. **Eutelsat** kindly hosted the event which was a great opportunity to recap on the last two

decades and reevaluate the future. This was where the change to SIG was born.

A week later, myself and SIG director, **Guido Baraglia**, headed to London to hold a workshop at the **MilSatCom** event. The workshop, titled 'Space Situational Awareness, the threats to SATCOMs, and the tools and technology needed to mitigate these threats', even featured a live RFI geolocation demonstration. A point of discussion was how to make MILSATCOM more resilient to the by-products of a more crowded space environment. To this end, AI was yet again cited as an effective solution.



IBC was also an important date in the SIG calendar — almost everyone from the satellite industry into the same room as the broadcasters. Our champagne reception also seems to be becoming an annual event, with ETL Systems kindly hosting on their booth for another year. In my opinion, satellite doesn't get the attention it deserves at IBC, a shame given how it is a key enabler of broadcast video. We also held a member's only meeting to pre-brief our membership on the change to SIG, which we announced at our first ever joint event with Intel-Sec in Singapore at **Satellite Technology Asia 2018**. We combined the audiences of both Intelligence-Sec and the Satcoms Innovation Group for the two-day workshop. Our activities in the APAC region don't end there, as I also headed to Indonesia ahead of Satellite Tech Asia to moderate a panel on day three of APSCC all about space debris. The subject is undoubtedly one of growing importance, and something SIG hopes to look at in more detail over the course of 2019.

Interference Remains a Problem

One area which has experienced a great deal of development in the last few years is Very Small Aperture Terminals (VSATs), the burst mode, TDMA systems. It's no surprise given that they are reportedly one of the most common causes of interference. Installation and product approval issues are a large reason for this, as VSATs tend to be operated and installed by non-satellite professionals. As such, developments have focused heavily on increasing automation to tackle this. Some of this includes tools which can ensure VSATs are aligned correctly from deployment, while others can automatically monitor and report errors within a matter of minutes so disruption can be kept to a minimum.

Aside from human error, a big cause of VSAT issues relate to poor product quality, particularly for comms on the move. This is a difficult thing to solve, due to the pressure to deliver cheaper satellite services. However, effort from operators such as **Arabsat**, **Eutelsat**, **Inmarsat** and **SES** are clearly helping to limit the problem of poor product quality. Inmarsat has a stringent type approval process for any terminal to be allowed to operate on its network to ensure service quality and correct operation at all times. Others have managed to put a stop to much potential interference by asking users to commit to using specific antenna models from an approved list of manufacturers.

It appears far less long-term incidences of VSAT interference are now occurring, thanks to the operators and solutions such as **SatGuard** and **SatMotion Pocket**, provided by Kratos and Integrasys, respectively. In short, most of the industry seems to have accepted that we must work together to prevent interference and have got on board to do their bit to solve it. That's why we think it's the right time to become the Satcoms Innovation Group.

Innovation is the Future

In 1998, the Satellite Users Interference Reduction Group (SUIRG), was born. Acting mainly as a forum for operators, users and manufacturers to work together, the group set out to better understand the issue of interference and come up with a way to solve it. In 2011, it became the Satellite Interference Reduction Group (IRG). Since 1998, we have reached many milestones including the inception and introduction of Carrier ID and many other interference mitigation technologies built by our innovative members.

In recent years, there has been considerable headway, both in terms of raising the awareness of interference and in terms of encouraging technology developments that go a long way to eradicating the problem. To help us widen our remit is why we have rebranded to the Satcoms Innovation Group (SIG).

In short, this change means that our group can now encompass all types of innovation within the satellite communications industry. We aim to promote innovation in the Satcoms industry to improve operational efficiency, reduce the risk of service impacting events, and improve quality of service. This does of course still include a commitment to minimizing satellite interference. But we believe it is essential that we encourage innovation in other areas where it could improve performance and boost the competitiveness of the satellite industry. Find out more about this expansion here.

[satig.space](#)

Satellite Vu

By Anthony Baker, Chief Executive Officer

2018 has been a dynamic year for Satellite Vu and one that has brought some important recognition of our vision. As we look forward to becoming commercially operational, the company faces a pivotal year in 2019 as we prepare to launch the first of the firm's multifunctional satellites.

The Satellite Vu fleet will comprise seven small satellites. Our specially developed payloads will produce high resolution infrared imagery which is interpreted and converted into timely data using unique algorithms that end-users can readily access.

Data produced by Satellite Vu can also be overlaid onto other forms of data such as social media, mobile phone and proprietary information. This results in another layer of intelligence from which new business insights may be generated. The satellites will re-visit a target site multiple times a day, throughout the day and night, and produce imagery regardless of the weather conditions so that constant, near-real time monitoring is possible. Satellite Vu's smallsats will provide Big Data that will be converted 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 Plastics Campaign

The focus in 2018 has been very much on the issue of plastic pollution and how Satellite Vu is going to enable governments to effectively tackle what is rapidly becoming an uncontrollable situation. The value of plastic pollution is reportedly \$139 billion per year. The effect of plastics on marine life is devastating and today, plastics are inevitably also in humans. The Plastics campaign kicked off in March when the company unveiled Satellite Vu to the industry in Washington DC and has garnered a great deal of attention.

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 organizations 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 this problem. 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, will 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 localization 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.

Following on from the debut of this campaign, we gave a presentation at the **Satellite Finance Network (SFN)** in the UK, which also served to explain our ambitions in terms of plastics monitoring. The SFN works to attract investment, to identify regulatory barriers and other impediments to growth and to promote business opportunities between companies. The SFN presentation enabled us to raise awareness in the UK. As a UK-based organization (we also hope to launch our satellite from the UK), this was an important opportunity for the firm.

Recognition

Over the past year, Satellite Vu has gained considerable recognition in terms of the capabilities we offer to tackle plastic pollution.

In May, Satellite Vu won the **European Space Agency's (ESA's) Ocean x Space** competition, which was held during the 8th edition of ESA's annual Business Applications Conference in Stavanger. The competition invited small companies of 50 employees or less to submit ideas for innovative, space-enabled services in the maritime sector. Among 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 reinforced the importance of what Satellite Vu is striving to achieve. Gaining recognition from ESA meant a great deal to us and further validates what we are doing.

In October, Satellite Vu was invited to exhibit at **GITEX** in Dubai by the **Mohammed Bin Rashid Space Centre (MBRSC)**. Part of the overall event was the **Supernova Challenge** competition and the company was awarded the title of **Best International Start-Up** and claimed a \$10,000 prize. The judges' criteria focused upon the originality of the idea, its potential in terms of longevity, actualization and profitability, the team, the functionality of the product or service and its impact on social, cultural and environmental issues. As a result of the exposure at GITEX, Satellite Vu has been approached by a number of companies and government organizations that wish to explore applications using our technology.

A Look Ahead to 2019

2019 will be a pivotal year for Satellite Vu. The company aims to have our platform operational and we will be generating revenue. Additionally, our future satellite sensor will be in the final stages of completion.

2019 is set to be an exciting and ambitious year and the team is looking forward to making it a success and seeing our technology doing good things for the planet. From a financial standpoint, the firm is currently funded by seed funds. However, we anticipate that we will close on a grant and a large revenue generating contract this year and we will seek new investors early next year.

In terms of our technology, after working with a number of manufacturers on the design of our satellite, we have down-selected to two firms. We expect to make an announcement in early 2019.

In terms of our software platform (which we will use to be able to showcase our imagery and support image enhancement and analytics), we have identified all partners and technology solutions to enable an early start of service. In 2019, we expect to begin the sale of services — and revenue generation.

Expect further announcements covering other applications of commercial value that our technology will fulfill. The company is currently working with a range of partners on these applications and real-world solutions.

An exciting 2019 is expected by Satellite Vu as the technology developed by the company is expected to be doing its part to make this world a far better place.



Anthony Baker, the CEO of Satellite Vu, after receiving the Supernova Challenge Award for Best International Startup at GITEX.

www.satellitevu.com

Electronically Steered Antennas is probably the area where most innovation is taking place in our industry during the past couple of years. NSR forecasts 1.9 million Flat Panel Array antenna shipments in 2027. The shipment breakdown indicates the majority of these to be used for broadband access, Non-GEO applications, hence requiring low cost, electronically steered antennas.

Two major trends are pushing the industry: the increasing uptake of Aero and other mobility implementations and high-speed data satellite constellations (LEO/MEO). The satellite industry is facing a challenge to develop a low cost, electronically steered antenna for the likes of **OneWeb, Telesat, SpaceX** and others.

More than 20 companies are "competing" in a race to develop such antennas.

SatixFy took on this challenge in September of 2016, with a target to show a first prototype in two years' time. The tasks facing the company were extremely complex: defining the correct requirements to meet future needs, choosing the correct technological solution and securing the funding for development and executing the plan.

What Will the Market Need?

The most obvious requirements are affordable antennas for mass deployment and being able to track and perform a handover in LEO orbit — such needs require a form of electronic steering.

The technology investment would need to fit mobility and broadband and, in addition, future use cases such as Internet of Things (IoT). A new service model is emerging where capacity is increased and service grades differ by using multi-orbit satellites. For example, in-flight service will receive broadcast/multicast content from GEO and low latency internet service from LEO. Such service model is best served with an antenna capable of beam forming multiple beams simultaneously and directing them to different orbits.

The Technology Choice

Many differing technological approaches were taken by various companies as they try and solve the market need equation. SatixFy is a developer of silicon technology and a great believer in silicon economics. The company's algorithms implemented on advanced silicon process nodes deliver the best fit for volume manufacturing, without a need to use complex materials or experimental physics.

SatixFy's beam forming is digital True Time Delay implementation, excelling over analog phase shifting when higher instantaneous bandwidth, larger number of elements or a combination of both is required, which is typically the case with modern HTS transponders.

SatixFy's affordable antenna is comprised only of a Circuit Board with printed antenna elements and a combination of *Digital Beam Former* (DBF) and RFIC chips mounted on it. SatixFy's choice was designing an all-digital, generic Beam Former ("Prime" DBF) combined with band specific RFICs ("Beat" RFIC), both using the most advanced CMOS silicon process for low cost and low power. Digital beam forming has the advantage of creating multiple beams simultaneously without being limited in bandwidth or having beam squint, as could occur in analog phase shifting.

Finding the Correct Partners

The technology development project was co-funded with the **UK Space Agency** through the **European Space Agency ARTES** program. SatixFy opened a large antenna design center in the UK (Farnborough) and assembled a team of talented engineers to work on the project. An AERO antenna for the In-Flight connectivity market is being developed in a joint venture with **Singapore Technologies Engineering**.

Delivering On the Promise

In 2018 SatixFy taped out two chips, "Prime" DBF and "Beat" Ku-band RFIC. These two chips are the key building blocks for an **Electronically Steering Multi-Beam Antenna** (ESMA). This was a major milestone achievement for the company, having embarked on the idea only two years ago.

"Prime": a generic digital beam former. Uses True Time Delay technology to point wide band multiple beams simultaneously both in transmit and receive. Prime chips can be cascaded digitally to support various antenna sizes (small to very large) and shapes (flat or conformal).

"Beat": A band specific RFIC (first version is Ku-band) containing all the RF electronics (PA, LNA, etc.) for multiple transmit and receive antenna elements. Each antenna element has a dedicated beam forming channel so full control is achieved on every element enabling control of each individual element separately.

SatixFy also designs and builds the antenna boards — 64 and 256 element Ku-band antenna boards will be available in 2018.

To enable design partners enjoy an early adopter advantage, SatixFy has built "Prime" and "Beat" evaluation and development environments. These development boards enable measurement and characterizing of every single element and forming of beams from multiple elements. Coupled with a software package, it provides a tool kit to design and build antennas based on the key building block ASICs.

A small mobile *Antenna Measurement Test Range* (AMTR) provides additional means for developers to quickly analyze and measure the performance and capabilities of the antennas they design.



SatixFy's Antenna Measurement Test Range.

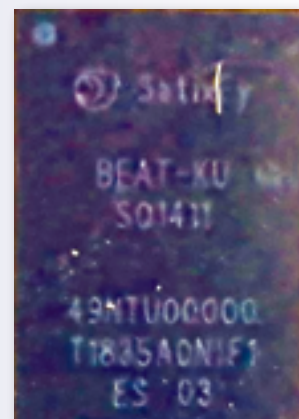
During the past couple of months, SatixFy has been demonstrating this breakthrough antenna technology at major satellite conferences and trade shows. L-band and Ku-band beam forming demonstrations show the capability of the antenna to quickly form multiple beams simultaneously as well as the ability to track a moving source at high speed.

To create a complete terminal the antenna needs to be coupled to a modem. There are two connectivity options. The first is using standard L-band IF interface, which is agnostic to the modem. Each beam requires a separate L-band interface and a modem. The second is connecting the DBF via high speed SERDES lines directly into a digital interfaced modem SoC and process multiple beams in a single modem chip. SatixFy's **SX3000** modem Soc is tightly coupled with the beam former and can achieve a very cost effective multibeam terminal solution.

For SatixFy, 2018 was the year wherein the electronically steering antenna dream became a reality.

www.satixfy.com

Gil Shacham has extensive product management, product marketing and business development experience in the wireless marketplace. He is the Vice President of Marketing and Product at SatixFy. Gil held senior positions in Gilat Satellite Networks as head of product management as well as in Clariton Networks and Alvarion where he dealt with WiFi, WiMAX and cellular products.



SED Systems

Over the past year, the theme for Calian's SED Systems division (CGY:TSX), continues to be growth and innovation. SED Systems is a global supplier of sophisticated satellite communication systems, solutions and products, and we've been serving our customers for more than 50 years.

The company's systems engineering services line includes communication ground systems and services, communication gateways and planning systems, and a line of SED communication products tailored to support customers in the satellite industry. SED offers a tightly integrated approach with our engineering design services and manufacturing capacity co-located in a single purpose-built facility. We have the expertise, capacity and resources required to design, build and fully test each component of the deliverable ensuring performance in the harshest of conditions.

Satellite advancements in capacity, functionality, speed and complexity are bringing significant opportunities, as well as, industry challenges including requirements for increased performance and flexibility of the ground system hardware and software. SED, along with our partners, has been developing innovative new technologies to ensure these challenges are overcome. Recent contract wins are evidence of our leading position in the delivery of complex satellite Earth station projects and programs.

Communication Ground Systems and Services

At SED, the communication ground systems and services business unit provides RF ground systems for satellite tracking, communications and control. After a busy year of deploying a number of fixed and transportable RF ground systems, SED announced its largest satellite ground systems contract, including numerous RF gateways incorporating advanced technologies.



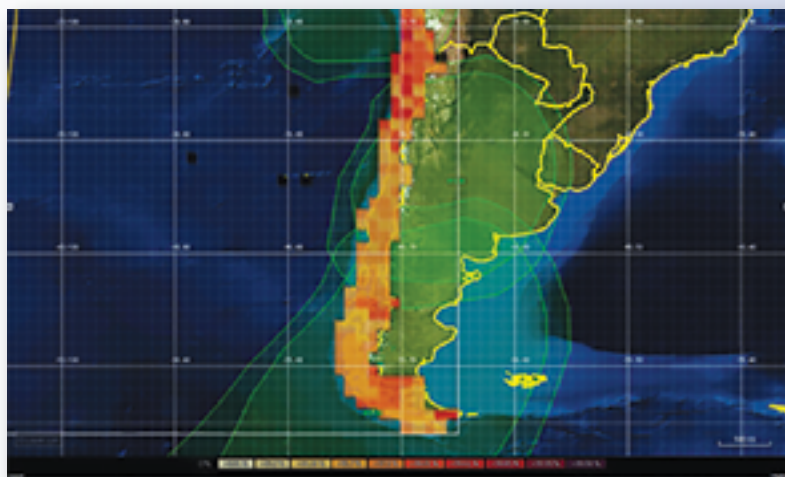
Communications Ground Systems and Services.

The President of SED, **Patrick Thera**, said, "We have been investing in new technologies to support future satellite ground systems requirements in anticipation of opportunities in need of these technologies. We are very pleased to see that we are now in a position to capitalize on these investments. Commercial advanced technologies are just starting to emerge in the industry, which enable satellite operators to add increased bandwidth and throughput to their network offerings. This new work helps to establish us as a front-runner in ground system offerings"

With its focus on customer satisfaction and management of requirements, the ground communication systems group, provides solid turnkey RF gateway solutions for L-, S-, X-, C-, and Ku-band frequencies as well as higher frequency bands with challenging requirements such as Ka-, Q- and V-bands. During the year, SED also supported a number of programs for Earth Observation (EO) and deep space exploration.

Communication Gateways and Planning Systems

The firm's communication gateways and planning systems business unit provides software solutions for satellite communications, capacity management and performance monitoring. Over the past year, a variety of satellite capacity and real-time management solutions have been deployed around the world. Large LEO constellations and high throughput satellites with complex payloads have been driving demand for intelligent planning and capacity management tools to support services on these networks. SED has been addressing demand for intelligent planning and capacity management with innovative real-time satellite resource management and capacity planning software solutions.



Communication Gateways and Planning System.

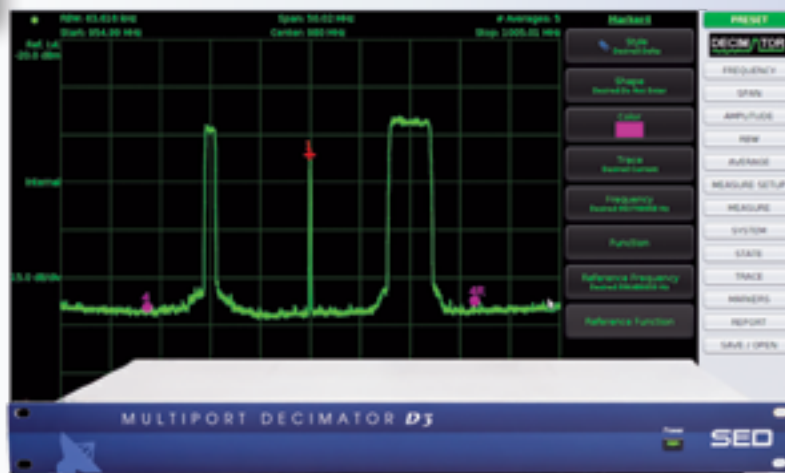
The company's innovative software solutions provide operators of complex networks with the tools they need to efficiently direct satellite capacity to meet geographical demands. SED has invested in a large engineering staff with experience in systems engineering, software development, hardware development and embedded logic design. With the growth of our engineering pool over the past year our team has the agility and experience required to support the most complex needs of our customers and the satellite industry in general.

Communication Products

SED's line of satellite communication products continues to provide customers with innovative and high performance units that they use in their networks or integrate into their service offerings. They also serve as the building blocks for the systems we deliver enabling us to offer a more compelling value proposition based on innovative technology, reduced risk and time to market, and lower costs.

While the firm's existing modulator product line supports standard DVB-S/S2/S2X applications, SED specializes in developing innovative products based on newer technology and architectural concepts. Our multichannel modulator and intelligent switching technologies offer an attractive and reliable way to reduce capital and operating expenses. In addition, our SDTS modulator saw a significantly increased presence in the satellite precise positioning market. We have development underway in several new and exciting areas with product announcements forthcoming in 2019.

SED's **Decimator Spectrum Analyzer** product (see the screenshot below) had its best year ever in 2018. Decimator is extremely popular for standalone operations in teleports and gateways, as well as inclusion in satellite carrier monitoring systems from SED and other vendors.



Over the past year, the company has continued to evolve the capabilities within Decimator and provided new features within the unit firmware. The recently introduced **CarrierWatch** software which cost effectively enhances the Decimator's built-in carrier monitoring and reporting functionality was very popular with satellite gateway and teleport operators. Stay tuned during 2019 for more Decimator evolution as the product's capabilities are enhanced even further.

2018 has been an exciting year for SED Systems. Together with our partners, we're looking forward to continued growth, challenges and opportunities in 2019.

www.sedsystems.ca

Sky and Space Global

By Meir Moalem, Co-Founder and Chief Executive Officer

The 2018 end-of-year represents the beginning of a new chapter for Sky and Space Global Ltd. (SAS), bringing the company even closer to reaching its goal of connecting the underserved globally with full 24/7 cellular coverage by 2020. With over three billion people across the equatorial belt alone that have no access to reliable and affordable communications, SAS is poised to transform people's lives over next 24 months.



In October 2018, SAS began construction on the world's first commercial constellation of nanosatellites, the **"Pearls,"** on track to launch this coming year, ultimately launching 200 smallsats but with service immediately available upon the launch of the first batch of 15-30 satellites. The Pearls will make SAS the first telecommunication and New Space company to use smallsats to provide cost-effective narrowband communication connecting people, businesses and machines in remote geographies and rural areas across the globe. After the launch and deployment of the first batch of Pearls, SAS will be able to provide Machine-to-Machine (M2M) and Internet of Things (IoT) connectivity. Once the constellation is launched, SAS will offer instant voice and instant message services via local service providers to anyone in the equatorial belt, anywhere, anytime.

2018 was filled with challenges and successes' that have shepherded both product development and preparing for 2019 with a focus on realizing the company's vision. Since June 2017, SAS has launched and maintained a first of its kind communication network of three nanosatellites, called the **"3 Diamonds,"** that have served as the company's proof-of-concept. This is the foundation by which we have successfully proven our technology. 2018 saw many partnerships and Memorandum's of Understand (MoU) established and signed upon the Pearls' launch.

2018 — The Year

2018 began with the company's announcement of its first field trial for Point-of-Sale (POS) device connectivity with **Paratus Group**, a Pan-African telecommunications company. This agreement has and will continue to create a path for SAS to deliver connectivity to thousands of POS devices across Africa by 2019. POS is a multi-billion dollar global market growing at a fast rate, and SAS will service it through its Pearls at a fraction of current costs.

Additionally, in February 2018, SAS commenced with M2M and IoT tests in partnership with **Globalsat Group**, the first Pan-American Mobile Satellite Service (MSS) consortium. Upon completion of the testing program, the companies entered negotiations for a binding commercial agreement to offer SAS's services to the customer base in May 2018. The relationship between the two companies will enable Globalsat and SAS to offer services in South and Central America. Our disruptive approach to satellite connectivity will translate to zero-forklift deployment or ground infrastructure buildout while radically reducing Capex investment and OpEx costs for service provider partners in these regions.

Later in March 2018, two major milestones were reached. First, SAS raised \$15 million in a **Heavily Oversubscribed Placement**. Then, SAS created a PSTN gateway via its **Chatellite** app, enabling calls and texts from any Public Switched Telephone Network (PTSN) number. Lastly, the company announced its first revenues generated through its "3 Diamonds" nanosatellite network, and as expected, shared \$1 million

in annualized revenue from current contracted customers. This month represented a key turning point for the company in overcoming typical new market and startup challenges to legitimize its core services.

Furthermore, two key company milestones related to the design of the product occurred in June 2018. One was the completion of its first Spectrum Monitoring via the "3 Diamonds" nanosatellite network. The other was the successful completion of a Critical Design Review (CDR) with **D-Orbit**, a satellite system company focused on convenient orbital management. By successfully proving their products ability to perform spectrum monitoring and the confirmation that their nano-satellite network surpassed industry standards, SAS increased their communication solutions' credibility to build passed the proof-of-concept project.

Later in October 2018, the company completed another CDR of the Pearls by **GomSpace**, a leading global aerospace construction partner. This was a major milestone that resulted in SAS immediately beginning the production phase of the "Pearls" hardware.

SAS also signed contracts with a series of service providers including in many regions around the world including Ghana, China, the Caribbean and Brazil. Later in 2018, SAS also signed MoU agreements with **Briskcom**, **SkyX**, **Penteton**, **Surge Telecom**, **Unizen Technologies**, and **Applied Satellite Technology**. These agreements highlight SAS's dedication to providing connectivity to the unconnected worldwide by 2020, not just in some regions.

From pioneering the deployment of communication nano-satellites to enabling financial transactions and ensuring cyber-security integrations, SAS is on track for its commercial product launch in 2019. Due to their efforts, the company received the **2018 Global Company of the Year Award** from **Frost & Sullivan** for its demonstrated accomplishments and superior performance in leadership, technological innovation, customer service and strategic product development.

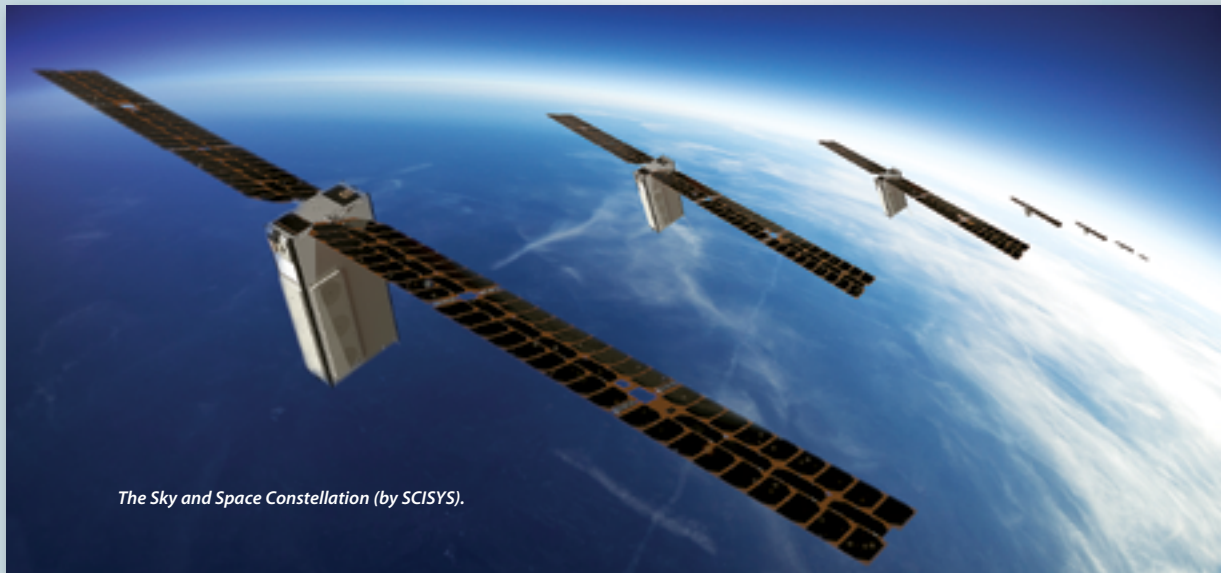
Key Industry Predictions for 2019

As the world's population continues to grow, and businesses require more and more interconnected operations, terrestrial communication networks will not be able to meet the huge demand required as a result of infrastructure limitations, specifically in rural regions. Smallsat communication networks are the only existing solution that will solve this issue and SAS will be the first to provide it.

The company also predicts that the New Space industry, specifically for smallsats, will become more prominent and capabilities will be more clearly defined in 2019. The industry is starting to formalize with clear winners and losers. New Space companies' innovative solutions will meet expectations or fall flat, and those that are first-to-market will have the upper hand.

www.skyandspace.global

Mr. Meir Moalem is a Co-founder and CEO of Sky and Space Global Ltd. and has been its Managing Director and CEO since its establishment in 2015. Mr. Moalem is a jet fighter pilot, Lt. Col (Res.) of the Israeli Air Force. He has more than 20 years of experience in management, R&D and operation of state-of-the-art projects in Space Systems and Unmanned Aerial Systems, among those acting as a deputy squadron commander and leading the MEIDEX experiment on Space Shuttle Columbia (STS-107) as the project manager for Israel's first astronaut flight, Managing Israel's satellite projects (such as Ofeq, Tecsar) and more.



The Sky and Space Constellation (by SCISYS).

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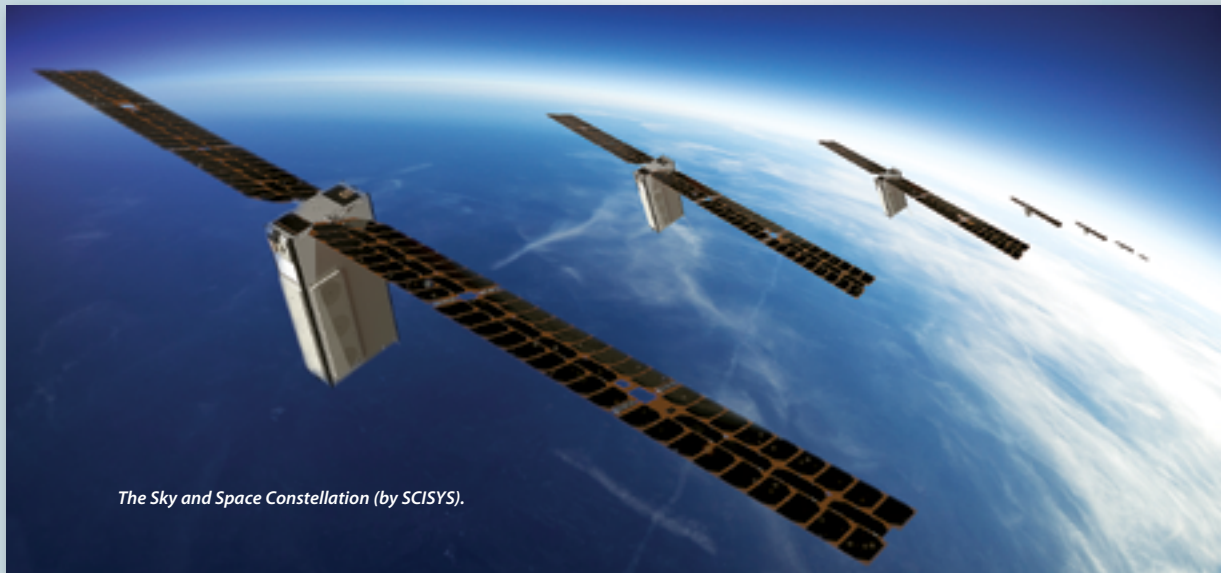
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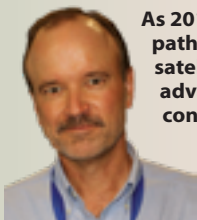
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The Sky and Space Constellation (by SCISYS).

ThinKom Solutions, Inc.

By Bill Milroy, Chairman and Chief Technology Officer



As 2018 comes to a close, ThinKom Solutions, Inc. continues a path of rapid growth in the company's core business of airborne satellite antenna technology and is well positioned to take advantage of the opportunities opening as new LEO and MEO constellations come into play over the next few years.

First, here's a quick overview of our company and technology. ThinKom was founded in 2000 and received its first major U.S. government contract for K/Q-band airborne antennas in 2003. In 2011, we developed the first low-profile antenna proven for high-speed Ka-band and EHF communications on a U.S. military

wide-body aircraft.

We achieved a major milestone when **Gogo** selected our antenna for inflight connectivity in 2013 and the following year Gogo launched its 2Ku IFC powered by ThinKom's **ThinAir® Ku3030** antenna. The Ku3030 received blanket worldwide FCC regulatory approval in 2015 and the next year **Delta Airlines** began a major program to fit 2Ku on more than 600 aircraft. Since then, the list of 2Ku airline partners has grown to more than 20, including **American Airlines, Alaska Airlines, Air Canada, GOL, Cathay Pacific, British Airways, KLM, Air France, and Japan Airlines** — to name a few.

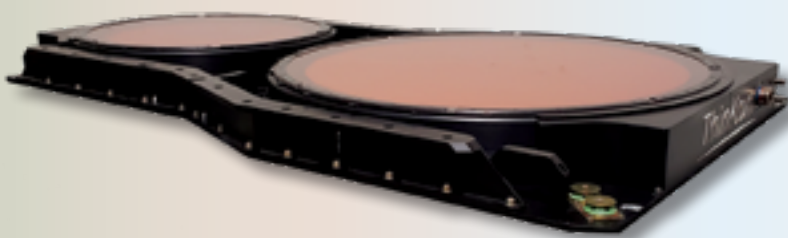
Steep Growth Curve

Today, there are nearly 1,000 aircraft flying with ThinKom's Ku3030 terminals, averaging about 3,700 flights per day, with a total of four million hours of inflight service at above 98 percent availability.

To support this steep growth curve, we are investing in expanding and upgrading our facilities and infrastructure. We've added 4000 sq. ft. of office space, continued to expand and optimize the firm's production flow, added new temperature test chambers, new test positioners and a spherical nearfield chamber. The ThinKom facility has an approved **FAA Part 145 Repair Station** and we also recently updated our company certification to **AS9100D**.

The growth in our Ku-band airborne satellite antenna business is primarily driven by two factors. The first is the insatiable appetite among today's passengers for uninterrupted, reliable, high-quality, high-bandwidth connectivity in the air. The second is the unique value proposition of our patented VICTS phased-array antenna technology, which combines the technical benefits of gimbaled mechanically steered and electronically scanned arrays to deliver consistent high performance in the harshest environments. The result is gap-free, pole-to-pole coverage, high beam agility for network flexibility, a low-profile antenna radome producing near-zero drag in flight, low prime power consumption and installation flexibility, along with the IFC Industry's highest spectral (OPEX) efficiency.

At the same time, we have made substantial progress with a new family of Ka-band airborne antennas. The **ThinAir® Ka2517**, introduced to the market in 2016, completed **DO-160** certification in 2017 and we expect to receive **STC** on **Airbus 320** airframes by mid-2019. Ka2517 terminals were installed earlier this year and are currently in service on a fleet of U.S. command-and-control aircraft under a modernization program to replace aging Ku-band phased-array systems.



Land-Based SATCOMs

While our airborne antenna business is booming, we are also continuing to build the terrestrial SATCOM antenna business. ThinKom works with major third-party integrators and prime contractors to supply Ku-, Ka- and X-band systems for mobile, man-portable and fixed antenna solutions to a wide range of corporate and government customers. They are used in broadcast/media applications, military, homeland security, disaster recovery, and emergency management missions.

In April, the company partnered with **COMSAT, Inc.**, to complete a coast-to-coast expedition to test and validate a seamless continuous high-speed satellite communication solution in a moving vehicle under a wide range of conditions. The demo SUV was fitted with our roof-mounted low-profile **ThinSat® 300** phased-array antenna with a package of modems, routers, switches, power inverter and operator interface inside the vehicle. The ThinSat unit supported broadcast-quality links at highway speeds and in off-road terrain and delivered an average of 1 bit/Hz spectral efficiency (without the need for "spreading").



Multi-Constellation Interoperability

The pages of *SatMagazine* and other industry media are filled with stories on the proliferation of proposed low-cost smallsats in constellations of hundreds or even thousands of satellites in Low Earth Orbits (LEO). Even if only a small percentage of these systems are actually deployed, they will have the potential to disrupt the market with inexpensive bandwidth, promising unique benefits in terms of latency, coverage, throughput and redundancy. At the same time, the major operators of GEO satellites are upgrading their fleets with HTS, dramatically increasing the available bandwidth.

At ThinKom, we are watching these developments carefully. Lower-orbit satellites offer an attractive value proposition. On the other hand, GEOs are ubiquitous and redundant and thoroughly proven. ThinKom's position is that users and sellers of satellite connectivity should not have to make an either-or choice. Why not have the best of both worlds? To that end, the firm has designed our antenna systems with the versatility to support an integrated, multi-constellation solution that offers gap-free, pole-to-pole coverage, with automatic beam switching, rapid outage recovery and network optimization for different geographical regions.

In recent months we have achieved several milestones toward that goal. In September, ThinKom and **Telesat** signed a Memorandum of Understanding (MoU) for joint development of a Ka-band enterprise user terminal (EUT) for Telesat's planned LEO constellation. As a first step, ThinKom's Ka2517 phased array antenna system, which is currently in production for commercial and government in-flight connectivity, will be used for over-the-air testing on Telesat's Phase 1 LEO satellite in the coming months.

In August, ThinKom completed the first successful ground tests of the Ka2517 antenna with the **SES O3b** MEO satellite network. For the test, a vehicle-mounted Ka2517 aeronautical antenna acquired successive O3b satellites at 13 degree elevation and successfully tracked them for 30 minute periods while the satellites traversed across the sky from west to east. These ground tests will be followed in the next few months by in-flight tests over the O3b network. This will be the first in-flight demonstration of a ThinKom antenna communicating through a Non-Geostationary (NGSO) constellation and will demonstrate the ability of the VICTS phased-array to auto-track and perform seamless beam switching through the full range of aircraft roll, pitch and yaw motions.

These and other agility tests reveal that ThinKom's antennas consistently achieve beam switching speeds of less than one second, which is fast enough to ensure continuous connectivity while moving seamlessly from beam to beam and constellation to constellation. In short, our phased array VICTS technology provides all the benefits of electronically steered arrays with none of their limitations in terms of instantaneous bandwidth, limited low-angle performance, high power consumption and low aperture efficiency.

To summarize, ThinKom had a great year in 2018 and stands poised to play an important role as the industry leader in phased-array antenna technology as the next generation of satellite services takes shape.

www.thinkom.com

By Taylor Cantwell, Marketing Communications Specialist

Tyvak Nano-Satellite Systems, Inc., a Terran Orbital Corporation, has grown exponentially over the past year.

Tyvak quickly outgrew their first U.S. headquarters in Irvine, California, at the end of 2017. Having doubled in size, Tyvak is now celebrating the first year spent in the new 40,000-square-foot facility this November. More than half of the building is dedicated lab space, which houses state-of-the-art equipment to support the development of new space systems.

With this growth came the need for an organizational restructure at Tyvak in order for the firm to freshly address the increasing demands of their customers. Tyvak recently welcomed **David Caponio** as their new Vice President of Commercial Space and Launch, and **Todd Mosher** as Vice President of Civil Space and Domain Awareness. Joining **Karen Anderson**, Vice President of Defense Space and Intelligence, Caponio and Mosher round out Tyvak's three business units.

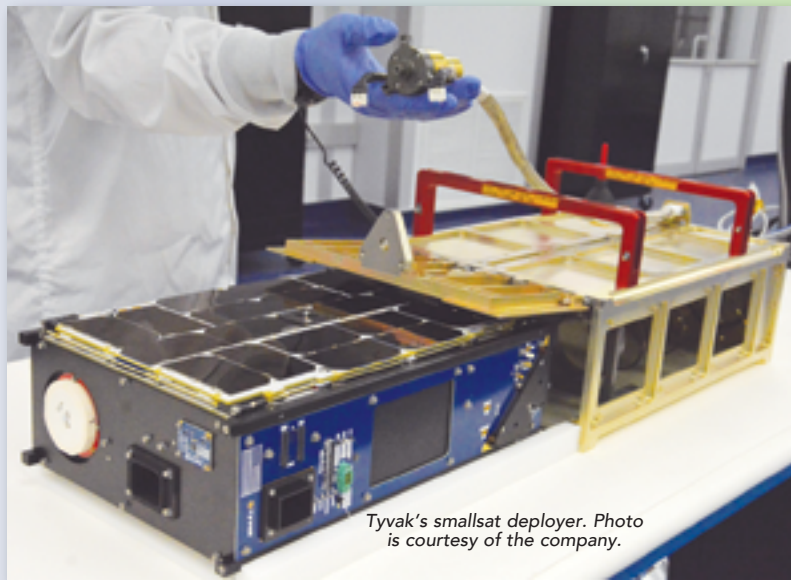
These additions will lead ongoing satellite programs, while developing new applications in their market segments.

Tyvak International's European headquarters also has a new, 10,000 square foot home in Torino, Italy. The Italian are actively acquiring new contracts and have ten smallsats in development for a diverse set of customers.

In addition to their employees, mission success has always served as a main priority for Tyvak. Despite experiencing a few launch delays, the milestones achieved over the past 12 months outshine the challenges.

Tyvak and **NASA JPL** successfully developed **RainCube**, the first radar instrument on a 6U smallsat, sponsored by **NASA's Earth Science Technology Office (ESTO)** through the **INVEST-15** program. Tyvak is responsible for the spacecraft and integration of the JPL-built payload. Tyvak also spearheaded the vehicle's launch integration and managed on orbit operations from their Mission Operations Center in Irvine, California. This mission will enable future precipitation profiling Earth science missions on a timely and economical platform.

Most recently, Tyvak's **CICERO** 6U nanosatellite for **GeoOptics** successfully deployed from **Rocket Lab's Electron**, "It's Business Time." The GPS radio occultation satellite, used to enhance weather monitoring, launched from Auckland, New Zealand.



Tyvak's smallsat deployer. Photo is courtesy of the company.

CICERO uses Tyvak's **Endeavor** platform that has been further developed to increase its responsiveness and autonomous operations. As part of this demonstration, CICERO automatically reached a fully controlled state in less than 20 minutes and obtained nominal payload data just 12 hours after launch. The data was then automatically downloaded by Tyvak, verified and processed by GeoOptics, and immediately made available to users.

However, this is not the first time that Tyvak has accomplished this goal. Tyvak's **GEOSTare**, a 3U smallsat mission, launched earlier this year, was fully functional during its first pass and successfully completed an enhanced situational awareness (SSA) demonstration shortly thereafter.

Anticipating further growth, Tyvak has ambitious plans moving into 2019. **LunIR**, formerly known as **SkyFire**, a 6U smallsat developed by Tyvak for **Lockheed Martin**, will test game-changing instrumentation in a lunar fly-by mission to characterize the surface of the moon and inspect landing sites. Once deployed into lunar trajectory, LunIR will also collect spectroscopic and thermographic data from the moon's surface.

Tyvak's **CubeSat Proximity Operations Demonstration (CPOD)** is also expected to launch in 2019. The pair of 3U smallsats will complete additional demonstrations of rendezvous, proximity operations and docking to continue validating and identifying new miniature, low-power proximity operations technology.

During the new year, Tyvak will remain mission centric with an **Agile Space** perspective and an unwavering focus on their customers. The company plans to unveil several iterations of their next-generation smallsat platform and conducting in-flight testing of their avionics system.

Furthermore, the company is also preparing for a record-breaking number of missions that are currently in development. These missions include the deployment of sub-meter imaging satellites and demonstrating unprecedented synthetic aperture radar (SAR) capabilities, resulting in high-resolution data.

Platform development for Tyvak's mini-geosynchronous telecommunications satellite will also be finalized next year.

Tyvak Nano-Satellite Systems, Inc. continues to understand the unique challenges and unlimited opportunities of satellite miniaturization while remaining the default choice for customers with advanced operational needs.

www.tyvak.com



Tyvak's Cicero smallsat deployer. Photo is courtesy of Rocket Lab

Viasat

By Mark Dankberg, Chairman of the Board and Chief Executive Officer, Viasat



Mr. Dankberg offered his thoughts regarding 2018. He co-founded Viasat Inc. in 1986 and has led the company's rapid growth. Under his leadership, Viasat has consistently been one of America's fastest growing technology companies.

As a start-up, Viasat was selected to the Inc. 500 list of fastest growing private companies three times. After listing on the NASDAQ exchange in 1996, Viasat has been recognized multiple times by leading business and industry publications.

Mark offered his thoughts regarding Viasat and the opportunities that are ahead...

"Global inequality has previously been exacerbated by the opportunity made available to the haves versus have-nots. These inequalities can be seen in the 'digital divide' which exists between nations and regions where some have access to high-speed connectivity and others do not. Regions with broadband can grow their economies, attract further investment and plough that money straight back into their communities — ultimately creating a circle where the haves get ever-better services and the have-nots are left stagnate.

"It's obvious that providing faster connections to all regions should be a priority — providing the everyday benefits the internet affords, and giving people access to more economic opportunities. However, the service needs to be affordable and sustainable: not requiring years or decades of investment and infrastructure.

"This is exactly the issue Viasat addressed this year with our satellite-enabled 'Community Wi-Fi' service. Rolled out across Mexico this year and available in rural parts of the U.S., the service uses Viasat's existing satellite network — comprised of our ViaSat-1 and ViaSat-2 satellites — to provide high-speed internet over WiFi hotspots to communities where broadband has been historically unavailable or unusable. We're working to bring this solution to the global population through our next-generation satellite constellation, ViaSat-3, which will provide global broadband coverage to serve people anywhere without internet access.

"Specifically in Mexico, we are using our existing satellite network to deliver an internet service that can be deployed with minimal local infrastructure investment, and low ongoing costs—making it simple for these communities to fund through the increased economic opportunities the connection offers. We have already reached hundreds of thousands of Mexican citizens, and we expect to reach millions more. Once ViaSat-3 comes online, beginning in 2020 — we plan to expand the service into other regions where the digital revolution has, so far, left many communities behind.

"This year we also began to lay the groundwork for Viasat 3, signing up United Launch Alliance (ULA) and SpaceX for the upcoming launches. ViaSat-3 is set to revolutionize satellite delivered broadband. When we started construction of ViaSat-1 in 2008, the fastest Direct-To-Home (DTH) speeds for satellite broadband were about 1 Mbps. When ViaSat-1 entered service in 2012, we increased that to 12 Mbps.

"ViaSat-2 entered service in 2018 with 100 Mbps DTH speeds. We expect that the first ViaSat-3 satellite will enter service in late 2020 capable of speeds as high as 1 Gbps. We anticipate those speeds and the associated service pricing will be very competitive in many terrestrial locations that are still under-served by fixed or mobile wireless of any



Artistic rendition of the Viasat-3 satellite on orbit. Image is courtesy of Boeing Satellite Systems.

generation, and satellite broadband will be the only way to achieve such speeds for people flying in airplanes, cruising at sea, enduring natural or man-made disasters, or for our armed forces defending us in distant lands.

"Providing satellite services is our mission and we're excited about the opportunities to compete and collaborate to bring the benefits of broadband internet everywhere and every time."

Early in December, Viasat Inc. introduced **Viasat Urban Wi-Fi**, a new satellite-enabled WiFi service for cities throughout Mexico. Viasat Urban Wi-Fi is being deployed first in Mexico City, with plans to bring the high-speed, high-quality broadband service nationwide by the end of 2019. Major Mexican cities expected to receive the service, include: **Cabo San Lucas, Guadalajara, Guanajuato, Puebla, Tijuana and Veracruz**, to name a few.

Viasat Urban Wi-Fi will offer city residents across Mexico a satellite internet service with speeds, quality and pricing that is highly-competitive to other terrestrial internet offerings. In fact, Viasat Urban Wi-Fi will offer speeds up to 100 Mbps to consumers at affordable prices.

Other expected use cases for Viasat Urban Wi-Fi in city environments include the need for a resilient connectivity system—as a supplement to existing cellular networks—in times of natural disaster or national security relief.

"Satellite broadband is not just for the remote communities in Mexico — it can also deliver a great internet experience to consumers living and working in major city centers as well as government and healthcare officials in need of a communications backbone during disaster relief," said Kevin Cohen, Viasat country manager, Mexico. "We need to open the dialogue that the digital divide doesn't only exist in remote areas; it also exists today in urban locations. The introduction of our Viasat Urban Wi-Fi service in Mexico City, is proof that satellite internet can deliver fast, affordable connectivity anywhere in Mexico."

Viasat Urban Wi-Fi leverages the advanced **ViaSat-2** satellite system coupled with Viasat's satellite-enabled hotspot platform to bring high-speed, high-quality broadband internet to major cities.

Viasat Urban Wi-Fi can be deployed in a matter of hours with minimal local infrastructure investment, showcasing Viasat's ability to quickly bring cost-effective internet service to urban areas where connectivity gaps exist between demand, affordability and availability.

Cohen continued, *"Viasat is here to connect Mexico, and we are determined to bring digital inclusion to every part of the country. Today we are providing affordable satellite-enabled Community Wi-Fi hotspot services within walking distance to over one million Mexican citizens; we are bringing high-speed satellite broadband service to enterprises, businesses and federal programs across Mexico; and we are even starting to serve passengers and flight crews on airplanes across Mexico with high-speed in-flight connectivity. The Viasat Urban Wi-Fi service will now bring a best-in-class satellite internet service to serve urban communities, enabling us to deliver optimized internet experiences virtually anywhere in the region."*

www.viasat.com



Artistic rendition of the ViaSat-2 satellite on orbit.

Walton De-Ice

By David Walton, Vice President

2018 has been an exciting year for Walton De-Ice, (W.B. Walton Enterprises, Inc.) as the company approaches 40 years of satellite industry experience helping to protect the Earth segment from the effects of weather.

The company's main focus has been keeping Earth station antennas snow and ice-free with the firm's **Plenum Hot-Air De-Ice** systems, and the more recent invention — the energy-saving **Ice Quake**. From our original hot air (Plenum) design which mounts behind antennas from 3.7 to 32 meters, to our **Snow Shield, Rain Quake** and **Ice Quake** for Walton De-Ice systems for 0.6 to 6.3 meter antennas, the company delivers the most innovative and effective solutions to help protect critical satellite networks from degradation and outages due to weather.

This year, we introduced a new solution to protect VSAT, LEO, MEO, GEO terminals and transportable terminals from the effects of wind, sandstorms, heat, ice, snow and debris, and similar hostile environmental effects.

Ka-Band Market Leadership and Growth

Market demand arising from continued HTS and mobility growth has greatly benefited our business from satellite operators, service providers and integrators this past year as they have invested in new Ka-band ground infrastructure. The company continued to expand Ka-band leadership in the de-icing field, with many hundreds of Ka-band large antenna systems now successfully deployed.

For Earth station antennas from 3.7 to as large as 32 meters, the Walton Plenum Hot Air De-Icing systems maximizes pointing accuracy that is so critical for protecting Ka-band systems. Unlike competing anti-icing solutions, such as electric pad systems that can cause reflector distortion, Walton Hot Air De-Ice systems heat the entire antenna reflector uniformly, which minimizes reflector distortion that can cause signal problems at the Ku- and Ka-bands. Walton systems also uniquely offer maximum flexibility with electric, natural gas and liquid propane gas heater options. Infrared testing of optimal antenna heating distribution offers precision performance validation for the most demanding Ka-band customer applications

Also for Ka-band, where antenna wetting alone can add significant degradation to link performance, not to mention the effects of any water in the feed bore sight, Walton De-Ice's Rain Quake antenna covers help Ka-band (HTS) terminals squeeze even more bandwidth and bits out of links during rain events.

C-/Ku-Band De-Icing

Walton teleport customers with C- and Ku-band traditional services continued to leverage our new automation and control features, along with the Ice Quake system, a super-low energy consumption solution for shedding snow off antennas from 0.6 to 6.3 meters. The Ice Quake can deliver as much as 100x energy-savings when compared to traditional anti-icing solutions, which is why this product has been adopted in teleports as well as cable and broadcast facilities.

Unleashing New Possibilities

In recent years, customers in locales such as the Middle East and Africa who experience the effects of sandstorms sought new methods to help protect their vulnerable antenna terminals. LEO/MEO developers asked for other solutions as they looked for more cost-effective ways to protect terminals from other harsh conditions.

Walton De-Ice had delivered some customer-specific integrations for these field requirements, for civil and defense applications. Customers told us they needed a solution to keep certain types of antennas operating in extreme and harsh environments, such as wind and sandstorms. Traditional antenna radomes are not built

for transportable operation, yet many of today's military, first-responder, and oil & gas applications on land can require deployable systems where harsh elements demand radome-like protection. The solution — enter the world's first, portable, satellite Earth station antenna radome, the **Walton Portable Radome** (see image below).



The Walton Portable Radome (*Patent Pending*) unleashes a entirely new set of possibilities for operating satellite terminals in extreme location, weather and mobile conditions. This unit provides a uniquely deployable weather protection solution for applications such as military vehicular mount terminals, Comms-On-The-Pause (COTP) terminals, VSATs, transportable uplinks, first responders terminals, disaster recovery networks, and LEO/MEO gateways.

This lightweight, rapidly deployable radome protects VSAT and transportable antennas from rain, snow, ice, wind, sand, debris and heat. Whether the mission demands staying on-air during an 85 miles per hour (136 kph) windstorm, a sandstorm, a blizzard, hail, or torrential rains — the Portable Radome helps make satellite networks more survivable and deployable in extreme or harsh environments. The Walton Portable Radome (available for C-, Ku-, X-, or Ka-band) also affords operators significant cost saving versus conventional radomes for civilian or military networks.

Operational in an 85 mph (136 kph) constant wind load, the self-supporting structure requires no power. It quickly assembles in less than an hour and requires no tools — unlike conventional radomes which can require two days and a crane to install, depending on their specifications. The flyaway lightweight (2.13x1.68 meter / 44.45 kg.) model is airline baggage checkable. Yet, for all these benefits, it can also support permanent site requirements. The Walton Portable Radome employs rugged, RF-passing, hydrophobic antenna cover materials. Field-testing has shown a minimal G/T decrease of only 0.31 dB at 20 GHz when the Portable Radome covers a small antenna, such the Ka-band terminal type that is used by the French Ministry of Defense.

Additionally, in very hot climates, an efficient forced air/HVAC system can be added to the Walton Portable Radome to protect equipment temperatures underneath the radome and prevent equipment damage.

LEO/MEO/GEO Gateways

The Portable Radome can also be used for fixed site ground networks. For LEO/MEO/GEO constellation infrastructure, this product can deliver gateway site cost-savings and other advantages compared to traditional radomes.

Looking Ahead

After beta testing multiple designs and customer-specific requirements and trade-offs, the company unveiled the baseline design in Q2 of this year and received enthusiastic response and interest from traditional and new customers. Walton De-Ice continued to tailor the Portable Radome product features based on additional user input and testing over the next several months and decided to focus initially on serving the needs of specific growth segments of the market.

Looking to 2019, the company is especially excited about the opportunities to work with existing and new industry partners, operators and integrators, to help deliver the benefits of the firm's latest technology into LEO/MEO/GEO infrastructure, DoD programs, Earth station systems, and transportable network missions.

www.de-ice.com

David Walton is Vice President of Walton De-Ice (W.B. Walton Enterprises, Inc.), where he is responsible for the Snow Shield, Ice Quake products and new product development. He has more than 37 years of satellite industry experience in the design, manufacture, and deployment of earth station technology, and holds several patents for his inventions in this field. He can be contacted at: david@de-ice.com.



WORK Microwave

By Thomas Fröhlich, Chief Executive Officer

To sum up 2018, any observer would immediately note that the satellite industry is evolving. Today's operators are delivering higher quality broadcast and high-speed broadband offerings over constrained networks and they need flexible, scalable and future-proof SATCOM solutions in order to achieve those goals.

This past year has been exciting for WORK Microwave. The company has experienced strong growth in SATCOM sales and continues to build on the success of several major customer wins over the last three years.

In 2018, WORK Microwave was awarded the largest single order in the company's history by a key system integrator. Our ground station equipment will be used within teleports to support a high-speed satellite network that features a wide range of next-generation technology advancements, including higher frequency bands such as the Q/V bands, more powerful solid-state amplifiers as well as more efficient antenna designs that allow for 500 Gbps throughput.

Looking beyond the success WORK has experienced in 2018, here are four key takeaways about where the firm believes the SATCOM industry is headed in the future and how the company is helping operators address the challenges they face today and tomorrow.

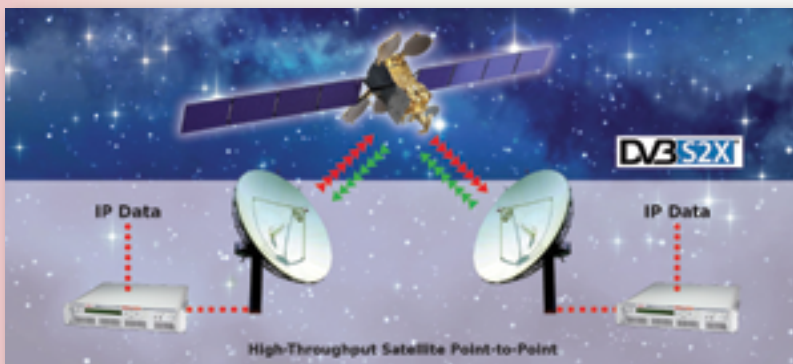
Multi-Frequency and Wideband Solutions

As mentioned earlier, change is rampant in the satellite industry and that will continue into 2019. WORK is noting significant growth in data services and that is causing frequencies to move higher and bandwidth to increase. This creates new business opportunities as well as challenges for satellite operators. Whether operators respond with GEO, MEO, or LEO, they have multiple options to fulfill the demand for more data. HTS (High Throughput Satellite), UHTS (Ultra High Throughput Satellite), UHDS (Ultra High Density Satellite), and mega LEO constellations may provide the most efficiencies and cost savings.

WORK Microwave is helping operators address this trend through our multi-band converters. As the industry's leading provider of frequency converters, WORK Microwave shipped more than 1,000 frequency converters in 2018. That massive number demonstrates the industry is tackling growth in data services and is continuously exploring higher frequencies.

Satellite performance is improving and that, in turn, requires superior quality ground equipment to enhance factors such as phase noise, group delay, and stability. WORK Microwave's SATCOM analog and digital solutions meet these challenges head on, helping teleport operators, satellite operators, and service providers realize their business objectives, including the critical need for flexibility, scalability, and a future-proof infrastructure.

One of the ways the company is enabling operators to adapt to future requirements for data services with ease and affordability is through our end-to-end solution for wideband applications. Announced at IBC2018, WORK Microwave's **AX-80** series of FPGA-based satellite modem, modulator, and demodulator platform supports the new DVB-S2X standard for ultra-wideband transponders up to full 256APSK and 500 Msps. Through an all-IP structure, the platform supports native network operation as well as data streaming over IP, providing satellite operators with the flexibility that is critical in today's fast-changing connected world. While there are many wideband prototype solutions in the market, WORK Microwave is proud to offer the first commercially available end-to-end wideband solution.



WORK Microwave's A-Series AX-80 Platform

Q- and V-Bands Will Heat Up

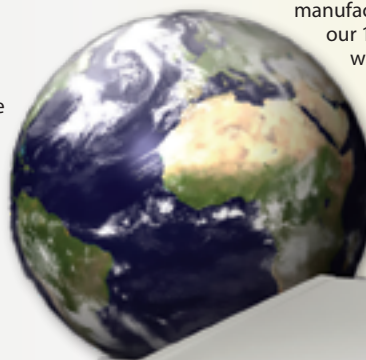
As operators seek to expand their capacity and keep pace with the demanding communications requirements fueled by bandwidth-intensive broadcast and data services, they are looking more and more at Q- and V-band, going beyond the capabilities of Ka-band platforms. Recently, WORK Microwave introduced the industry's first V-band block upconverter as an available product to help operators keep pace with this important requirement.

We believe that Q- and V-bands will shape the blueprint of future broadband communications systems, as these bands will significantly enhance the performance of the next generation of high throughput satellite programs. Moreover, they make more bandwidth available for users in Ka-band and would also reduce the number of hubs required. This, in turn, will help drive down the cost per bit. WORK Microwave's Q- and V-band technology has been successfully deployed by operators around the world for more than four years.

Navigation Simulators in High Demand

Today there is a growing need for multi-frequency / multi-RF simulators in high-end market applications. Due to this demand, in 2019 the company will further invest in our professional navigation simulators business. With more than 30 years of SATCOM expertise in analog, RF and digital design, WORK Microwave knows what it takes to optimize professional navigation simulators.

An RF-based GNSS signal simulator is the definitive tool to validate the performance of GNSS receivers and systems for research and development, manufacturing and system integration testing. Using our 12 years' experience in the navigation field, we're excited to make enhancements to the firm's **Multi-GNSS RF Navigation** simulator.



The firm's focus will be in developing high-quality RF features that support users to realize scenarios that meet the challenges of today's global navigation needs. Some highlights currently being addressed are realistic multi-path simulations,



intentional and non-intentional interference and support for regulated services. This is another example of the continuous innovation and synergy across product teams happening at WORK Microwave.

Driving Innovation

Given all of the change and growth occurring in the SATCOM industry, WORK Microwave expects there will be significant technology innovation in 2019, especially in the areas of digital, IP and FPGA solutions.

Innovation happens when there is collaboration. This year, WORK Microwave launched an engineering services program to help other businesses with everything from design and development to consultancy, prototyping, and small series production. What makes these engineering services unique is that complete end-to-end product development and production processes are offered, with electronic engineering, mechanical engineering, manufacturing and testing expertise under one roof. With over 30 years of engineering experience in RF and digital signal processing, we can resolve any design challenge.

In the future, the demand for higher quality broadcast and data services will only continue to grow. Satellite operators can respond by partnering with bold and innovative technology providers that support higher throughput, higher frequency bands, and offer engineering service expertise.

work-microwave.com

Thomas Fröhlich has more than 20 years of professional experience in space and security systems. Prior to leading WORK Microwave, he held engineering, project management, and executive positions for the Airbus Group in Germany and France. He has a degree in mechanical engineering and a Ph.D. in engineering from the Technical University of Munich.