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The fastest spacecraft ever...

The successful launch of ULA's Delta IV Heavy rocket occurred on Sunday, August 12 at 3:31 a.m. ET, launching NASA's Parker Solar Probe — so far, all has proceeded on schedule.

NASA's Parker Solar Probe will be the first-ever mission to "touch" the Sun. The spacecraft, about the size of a small car, will travel directly into the Sun's atmosphere about 4 million miles from our star's surface. Among the many at this special event was the renowned Dr. Eugene Parker, for whom the Parker Solar Probe was named.

This is one of the most remarkable space missions to date and includes the fastest spacecraft in history. At its closest approach, Parker Solar Probe will reach a top speed of 430,000 miles per hour — that's 120 miles per second. The incredible velocity is necessary in order for the spacecraft to not be drawn into the sun during close approaches.

The renowned Dr. Parker at the ULA launch event. Image courtesy of NASA LIVE.

Temperatures will climb to 2,500 degrees Fahrenheit; however, the science instruments will remain at room temperature protected behind a 4.5-inch-thick carbon composite shield.

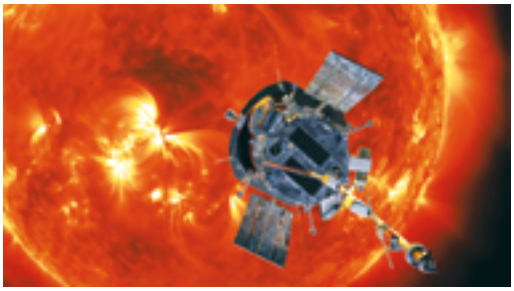
NASA selected ULA's Delta IV Heavy for its unique ability to deliver the necessary energy to begin the Parker Solar Probe's journey to the sun. After launch, the spacecraft will orbit directly through the solar atmosphere — the corona — closer to the surface than any human-made object has ever gone.

The Delta IV Heavy is the nation's proven heavy lifter, delivering high-priority missions for the U.S. Air Force, National Reconnaissance Office and NASA. With its advanced upper stage, Delta IV Heavy can take more than 14,500 pounds directly to geosynchronous orbit, as well as a wide variety of complex interplanetary trajectories.

This Delta IV Heavy is comprised of three common core boosters each powered by an Aerojet Rocketdyne (AR) RS-68A liquid hydrogen/liquid oxygen engine, producing a combined total of more than 2.1 million pounds of thrust. The second stage is powered by an AR RL10B-2 liquid hydrogen/liquid oxygen engine. Due to the extremely high energy required for this mission, the Delta IV Heavy's capability will be augmented by a powerful third stage provided by Northrop Grumman.

This will be the 37th launch of the Delta IV rocket, and the 10th in the Heavy configuration. To date ULA has a track record of 100 percent mission success with 128 successful launches.

With more than a century of combined heritage, United Launch Alliance reports it is the nation's most experienced and reliable launch service provider. ULA has successfully delivered more than 125 satellites to orbit that aid meteorologists in tracking severe weather, unlock the mysteries of our solar system, provide critical capabilities for troops in the field and enable personal device-based GPS navigation.



An artistic rendition of NASA's Parker Solar Probe in front of the Sun. Image is courtesy of NASA/Johns Hopkins APL/Steve Gribben.

The Parker Solar Probe will make repeated journeys into the sun's corona and trace the flow of energy to answer fundamental questions such as why the solar atmosphere is dramatically hotter than the sun's surface, what accelerates the solar wind that blows outward through the solar system and what is the source of high-energy solar particles.

Parker Solar Probe will make 24 elliptical orbits of the sun and use seven flybys of Venus to shrink the orbit closer to the sun during the seven-year mission.

The probe will fly seven times closer to the sun than any spacecraft before, a mere 3.9 million miles above the surface which is about four percent the distance from the sun to the Earth.

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"Innovation" is far more than just a term that's being bandied about by industry and marketing mavens and actors... "Innovation" is an agency of change, of solidifying dreams into a reality, of bringing the future into today.

Innovation is also an action... Satellite Innovation drives technology into areas never before realized, where a look ahead becomes a current possibility, where a cognizant thought can be cemented into a positive enhancement for satellite and space market segments to the delight of users, companies, organizations, nations, agencies, militaries, and students.

With innovations for the space and satellite market segments increasing in scope, with more and more deliverables arriving on market that possess heretofore "impossible" and now amazing technical capabilities, there are an ever increasing number of eyes and dollars attuned to the "how to" monetize this arena than has ever been witnessed before in the history of the space and satellite industry.

Every few days, it seems as though another space startup emerges, with the hopes of fitting and satisfying a niche that will be a successful part of this explosive market. For years, experts have been questioning what market segment the world's first trillionaire will emerge from to step onto the world stage — with the potential that the space industry offers, most major venture capital firms are eying this industry as the segment that will see this occur.

Satellite communication (SATCOM) is the basis for most of the revenue for current privatized space. In an upcoming event that is focused on the business of satellite communications, leaders and innovators will be focused on exactly where the next growth segments are likely to develop and to also accurately determine business potentials and realistic timelines.

Keynotes at this event include:

- ***Steve Collar*** *– CEO, SES, and previously CEO of O3b, known as the fastest growing operator for many years, now runs SES, the largest private satellite operator*
- ***Mark Dankberg*** *– Founder and CEO of ViaSat which operates communication satellites that offer capabilities in internet, mobile, defense and direct user connectivity.*
- ***Steve Jurvetson*** *– Billionaire Venture Capitalist, prominent investor in SpaceX, Planet Labs, Tesla, Hotmail, and more*
- ***Charles F. Wald*** *– Retired Four Star General, now Vice Chairman at Deloitte, is responsible for providing leadership strategies with the U.S. Department of Defense (DoD).*

The impressive list of 120 speakers who will be presenting at Satellite Innovation (***satinnovation.com***) represents the most prominent lineup of SATCOM leaders for an event of this size providing the industry's best networking opportunities through numerous events, breaks, sessions, and exhibition areas where more than 50 companies will be showcasing their technologies and products. This major event will also offer an abundance of meeting space that is highly conducive to business development discussions. More than 800 executives are expected to attend Satellite Innovation.

If you wish to participate in the explosive satellite and space industries, this is undoubtedly the event to accomplish your goals — join satellite and space industry leaders and innovative mavericks today by registering at SatInnovation.com — and become a participant in the future... today.

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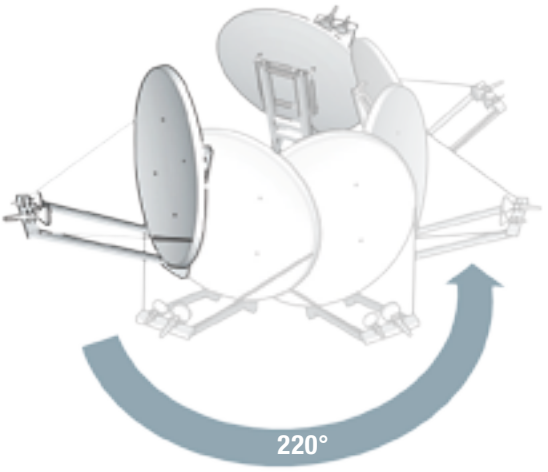

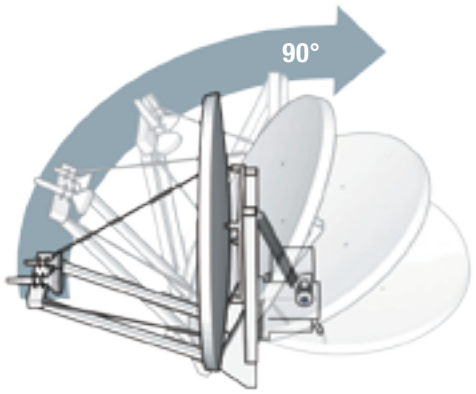

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The United Launch Alliance Delta IV Heavy rocket launches NASA's Parker Solar Probe to touch the Sun, Sunday, August 12, 2018, from Launch Complex 37 at Cape Canaveral Air Force Station, Florida. Parker Solar Probe is humanity's first-ever mission into a part of the Sun's atmosphere called the corona. Here it will directly explore solar processes that are key to understanding and forecasting space weather events that can impact life on Earth. Photo is courtesy of NASA/Bill Ingalls

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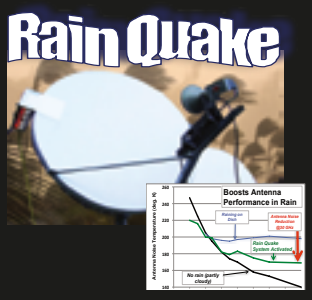

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Uplink: Innovation — The Aerospace Company

The Aerospace Corporation (Aerospace) has developed a new and innovative smallsat standard called a Launch Unit (Launch-U).

This standard provides major benefits to the smallsat industry by increasing access to space and decreasing launch costs. This standard also enables the space community to come together to work innovative solutions for sharing costs, adopting new business models, and adapting to regulatory or statutory changes.

The space community was in search of a standard to make launching smallsats more flexible. Given Aerospace's role as an objective technical advisor, the community identified the corporation as the ideal partner to work across all elements of the space enterprise, from satellite and launch manufacturers to service providers and government officials.

Carrie O'Quinn, the senior project engineer for Aerospace's Research and Development Department and the Launch-U lead, emphasized that, currently, there are no industry standards for satellites between the size of a cubesat (approximately the size of a toaster) and an EELV Secondary Payload Adapter (ESPA) class satellite, which is about the size of a large dorm refrigerator. Carrie said that the Launch-U standard seeks to change this through the company's volume recommendation of 45 x 45 x 60 cm. That's roughly the size of two carry-on bags strapped together. The Aerospace Corporation also addresses a mass range, fundamental frequency, and loads in the recommendations.

Carrie added that the group's vision for the Launch-U standard is the solution the industry is looking for, stating that this is not envisioned to be a requirement levied on spacecraft developers, but rather a standard that is embraced by all as a game-changer. Launch vehicle providers, integrators, and aggregators can begin considering how Launch-U satellites will affect their business models, once implemented.

The space access industry is altering at an exceedingly rapid pace and is driven by smallsat and small launch vehicle development, the increasing popularity of multi-manifest missions, and a widespread interest in reducing launch cost and timelines while deploying even more spacecraft. Currently, industry experts estimate that 6,000 to 20,000 smallsats could be launched over the next 10 years.

For industry, the next step is to develop hardware and other technical solutions needed to support the Launch-U.

www.aerospace.org/launch-u

When Dr. ***Randy Villahermosa***, Aerospace's General Manager of Innovation, was asked about innovation, he said, "*The space industry was born out of a passion for innovating at the frontiers of our imaginations. That's very much still true today, and the industry will continue to leverage innovations across an even broader range of technologies.*"

Regarding The Aerospace Company's work on innovative technologies, he noted, "*Launch-U is a great example of applying just the right expertise at the right place to open vast new opportunities. There are plenty of examples where smart standardization has transformed industries, and space is likely to benefit from that as well. For example, we have a project called Slingshot that is exploring new approaches to making satellites modular. We're excited about the possibilities of using machine learning to help process and sort through the deluge of data that satellites' systems produce and have several projects in this area. There's a growing recognition of the need put the smartest minds on how to operate safely in space. We have a project that is developing a prototype transponder that will make it safer for satellites to operate as space becomes more crowded.*

In conclusion, Dr. Villahermosa said, "*We see automation and artificial intelligence as playing a role in future space innovations. We live in a connected world, and it's not hard to imagine that extending into space as satellite systems become more networked together. In just about every aspect of space, there are innovative ideas we're pursuing to help lead the way on shaping the next generation of space systems. Robotics in space is starting to become more real, and that's opening new avenues to rethink how satellites are launched and operated in the future. There's an early stage version of this where satellites are flying in formation — we have projects called Hive and Fuse that are focused on just that.*"

(HIVE: ***aerospace.org/story/hive-satellites-redefine-disaggregation***)

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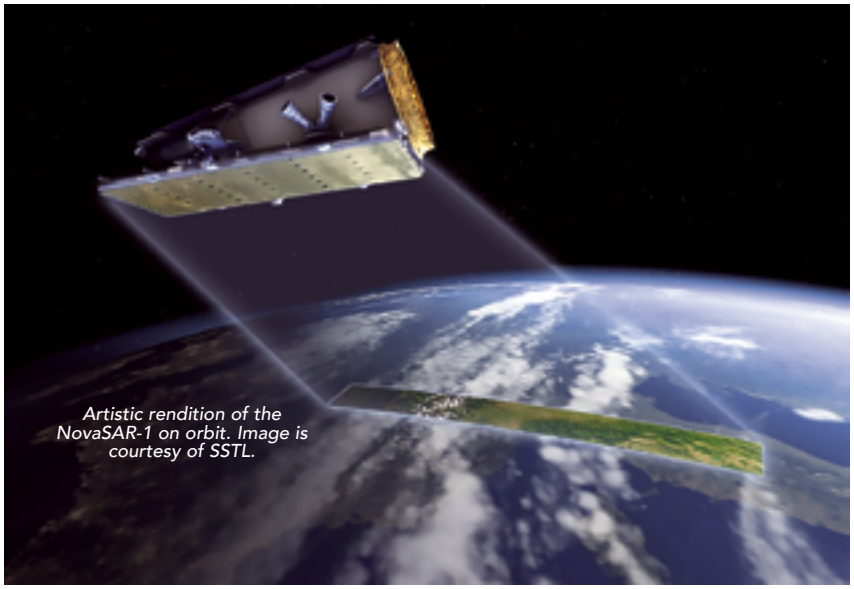
SSTL hires ISRO's PSLV for launch



Artistic rendition of the NovaSAR-1 on orbit. Image is courtesy of SSTL.

The small satellite parade continues with the announcement coming from Surrey Satellite Technology Ltd. (SSTL) that the company has signed an agreement with Antrix Corporation Limited, the commercial arm of the Indian Space Research Organisation (ISRO), for the launch into a 580 km. Sun-synchronous orbit (SSO) of NovaSAR-1.

NovaSAR-1 is a small Synthetic Aperture Radar (SAR) satellite, and SSTL S1-4, a high resolution Earth observation satellite.

The two satellites will launch on PSLV-C42, due to lift-off in September 2018.

NovaSAR-1 is a technology demonstration satellite mission designed to test the capabilities of a new low cost S-Band SAR platform.

The spacecraft was designed and manufactured by SSTL, with an S-band SAR payload developed by Airbus Defence and Space in Portsmouth, UK, and an Automatic Identification Receiver (AIS) receiver supplied by COM DEV to track ships at sea.

NovaSAR-1 will be operated from SSTL's Spacecraft Operations Centre in Guildford, UK.

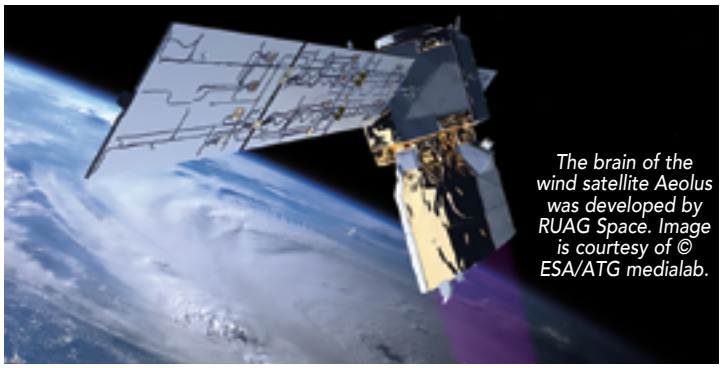
The UK Space Agency has invested £21M in the development of NovaSAR-1 and will benefit from access to data from the spacecraft, significantly boosting the UK's sovereign Earth Observation (EO) capabilities and leveraging additional inward investment to the UK by creating highly skilled jobs in the UK space industry, and stimulating the growth of data analysis services.

Also aboard the PSLV-C42 launch will be the SSTL S1-4, a sub-one meter resolution EO satellite with a mass of 440 kg. that will further enhance SSTL's existing in-orbit observation capabilities.

www.sstl.co.uk/

www.isro.gov.in/

RUAG's 'brains' support Aeolus



The brain of the wind satellite Aeolus was developed by RUAG Space. Image is courtesy of © ESA/ATG medialab.

A special upcoming launch in late August is set for the European Space Agency's (ESA) wind satellite, Aeolus which will use a special laser to observe air currents and winds. RUAG Space created the central computer (or "brain") that is powering the satellite.

The RUAG Space site in Sweden designed and produced the Satellite Management Unit, which is the central computer for the Aeolus satellite. Peter Guggenbach, CEO, RUAG Space said they are proud to be creating the 'brains' behind numerous satellites currently in orbit. More than 350 of their On-Board Computers have been successfully launched into space, and they look forward to continuing to work with partners such as ESA for these important missions.

Aeolus is the first space mission to acquire profiles of the wind on a global scale. These near-realtime observations will improve the accuracy of numerical weather and climate prediction and advance the understanding of tropical dynamics and processes relevant to climate variability.

RUAG Space also delivered structures and mechanisms for the satellite as well as the thermal insulation, which protects the Aeolus satellite from extreme heat and cold in space. RUAG Space is Europe's market leader in thermal insulation for satellites. The products have been delivered to the satellite builder and prime contractor Airbus Defence and Space.

Aeolus will be launched on a Vega rocket. The rocket will be equipped with a payload fairing produced by RUAG Space and — like the satellite — with a central computer or "brain" from RUAG Space.

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Uplink: Innovation — VT iDirect

Progress toward satellite integration with 5G architecture

By Greg Quiggle, Vice President, Emerging Products

While terrestrial and mobile service operators have always been on the cutting edge of next-generation networks, satellite networks have traditionally had to play catch up, spending extra time on the backend to find ways to seamlessly integrate into the prevalent standards and technologies

Now, the mobile and terrestrial industry is beginning to adopt the new 5G standard for higher data rates, higher efficiencies, massive scalability and lower costs. 5G, too, is expected to dramatically change how satellite is integrated into the larger mobile networks. This time, however, the satellite industry is making it a priority to participate in the development of 5G from the get-go.

Even though the full 5G future is still a few years away, it's easy to understand the excitement that's already building in the satellite industry. The new standard will transform how the whole industry operates and how users experience the new connectivity services.

The 5G buzz is prompting questions such as: What will it take to integrate satellite into this standard? And how can satellite leapfrog the developments and adopt the advances from the terrestrial and mobile industry into satellite networks today?

A Unified Industry

The satellite industry can find some answers to these questions by paying close attention to the key technological pillars on which the telecom industry is building the 5G revolution. These include network programmability, function virtualization and service orchestration.

Satellite service providers can mirror these three pillars and complement the work of telecoms by adopting parallel foundational principles, such as:

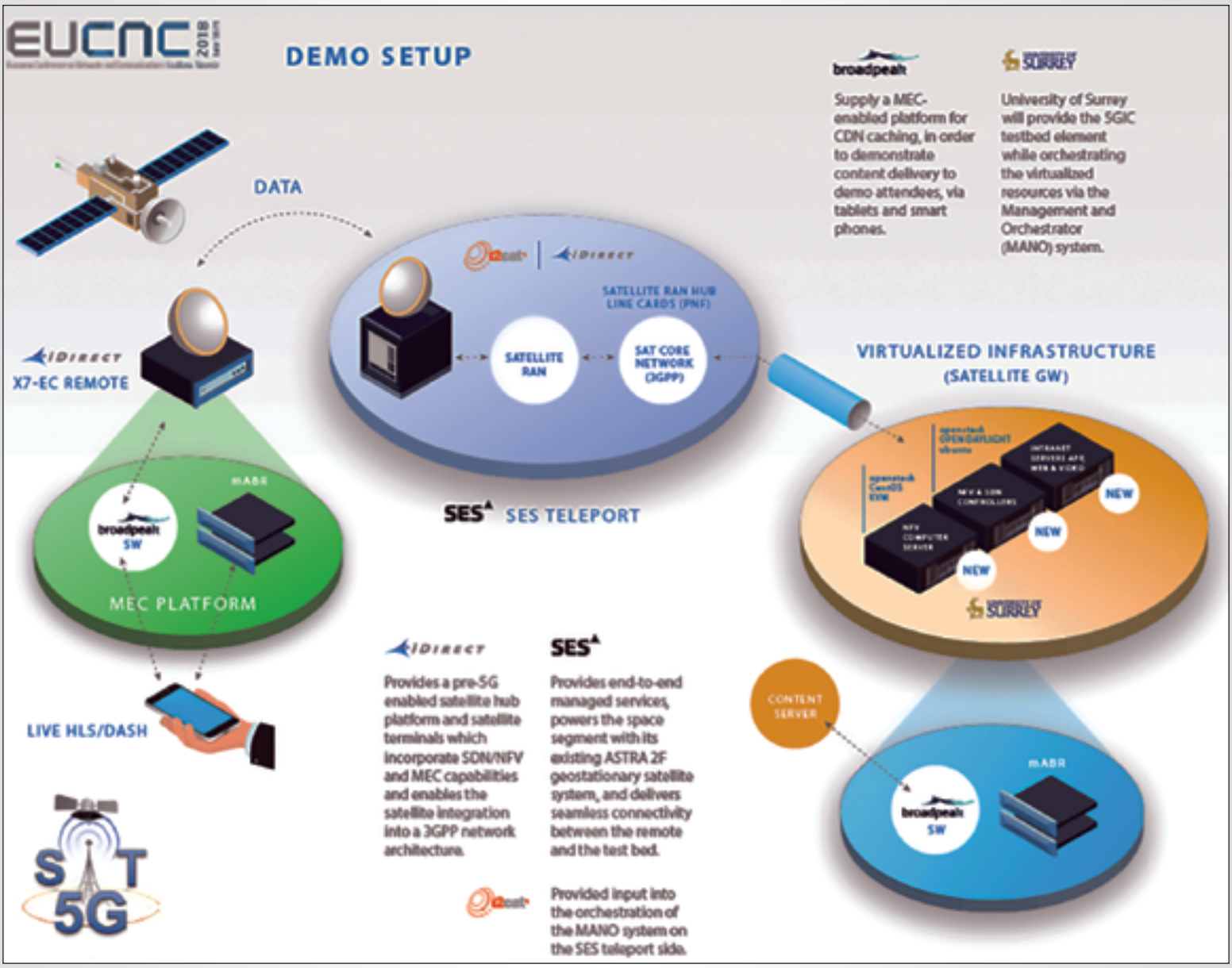
- *Software Defined Networking (SDN) — Separating the data plane from the control plane, so control plane decision making is centralized through a programmable interface*
- *Network Function Virtualization (NFV) — Pulling network functions out of boxes and turning them into pieces of software that operate as needed within the cloud*
- *Service Orchestration — Automating the provisioning workflow using service chaining, which will reduce the time for implementing network changes from weeks to minutes*
- *Evolved Packet Core (EPC) – Managing the complexities of an ever-changing mobile network, making sure the user can access it from anywhere and maintain expected services*

Through satellite 5G, service providers will be able to exchange inflexible, hardware-based networks for reconfigurable, software-based networks. Satellite will be crucial to 5G networks to ensure security, bring ubiquitous connectivity and mobility, and to increase broadcast capabilities. Developing an integrated network is especially important for telcos to support the rapidly accelerating demand for bandwidth around the world for consumer and enterprise applications.

Embracing a 5G-based architecture will also elevate the relevancy of satellite communications as a tier one participant in global telecom. Toward that end, iDirect has already started researching how to best incorporate SDN, NFV and EPC within a standardized satellite architecture and how to integrate satellite/5G technologies into a hybrid terminal that is easier to integrate and deploy.

iDirect is not alone in this endeavor. For the first time, companies within the satellite industry are proactively coming together to find a common approach for integrating technology with their mobile and terrestrial counterparts, instead of waiting and reacting later.

In example, this past June, iDirect and a team of partners from the Satellite and Terrestrial Network for 5G (SaT5G) consortium, a group funded by the European Commission specifically to work on the integration of satellite into 5G



networks, successfully hit a major milestone in the integration of satellite with 5G architecture at a recent industry event in Europe.

The SaT5G team took the opportunity at EuCNC2018 in Slovenia to demonstrate the research, development and validation of key principles in a live, first-of-its-kind test that marked a significant step forward in the massive transformation of the global communications industry. Specifically, iDirect along with SaT5G members SES, Broadpeak, i2CAT and the University of Surrey demonstrated key benefits of satellite integration with an SDN / NFV / MEC-enabled pre-5G construction testbed, with an in-orbit geostationary satellite system as a proof-of-concept for integration of those features into a full 5G network.

The Demo

The EuCNC2018 demo achieved the first of a number of goals SaT5G has developed in order to reach full seamless integration with 5G over the next few years. This first-of-its-kind demo showcased a successful satellite integration into a 3rd Generation Partnership Project (3GPP) network architecture. Specifically, the demonstration presented the integration of an SDN, NFV and MEC-enabled pre-5G construction testbed, with an on orbit geostationary satellite system. The demonstration also showcased satellite backhauling features and efficient edge delivery of multimedia content in pre-5G networks.

Each of the demo's five participants supplied their technical specialties to make a comprehensive, successful system.

Forging Toward the Future

iDirect is continuing to lead the way into the satellite-integrated 5G future. This year, iDirect has presented on the opportunities, challenges and changes 5G will bring at the GVF-EMP Cellular Backhaul Program during 5G World and IoT World, CASBAA Satellite Industry Forum, CommunicAsia, and also participated in 5G conferences such as ISNCC.

In particular, iDirect sees the movement toward 5G as a path to open access to satellite, creating a converged, end-to-end network. Adapting satellite to work seamlessly with 5G cellular and terrestrial networks will empower end-users from anywhere in the world with consistent, reliable, high-performance experiences. Service providers will be able to decide how they can best serve customers — whether it's through satellite, terrestrial or mobile networks.

The 5G future is a lot closer than many people might think. If iDirect and the firm's SaT5G partners continue to work at their current pace and continue to see success, the world's definition of connectivity is about to change.

For more information, visit:
IntelligentPathForward.com/satellite-5g.

Greg Quiggle is Vice President of Emerging Products at VT iDirect, where he is responsible for driving strategic market development for emerging LEO satellite, 5G and connected car growth initiatives.

InfoBeam

Inmarsat mines Auxilium partnership

Inmarsat and Auxilium, a leading Australian mining technology solutions company, have established a formal partnership to deliver the most effective Industrial Internet of Things (IIoT) and communications solutions for Australian mining companies.

The partnership will see Auxilium deploying satellite connectivity from Inmarsat in its IIoT solutions. This will ensure that mining companies can access IIoT and communications services regardless of how remote their location, and without the need to invest significant sums in building a terrestrial communications infrastructure in order to connect their mining operations.

Auxilium designs and manufactures technically advanced mining equipment, technology and services to support high-value mining and construction assets. It deploys satellite connectivity to enable the seamless transition of data from mine site to the control center, which can be thousands of kilometers apart.

Inmarsat's L-band satellite network offers the most reliable, secure connectivity for IIoT applications globally. With satellite availability up to 99.9 percent, rugged and energy efficient terminals, and low latency data transmission, it is the ideal solution for remote monitoring and automation applications.

By combining Inmarsat's network and Auxilium's innovative solutions, mining businesses will be able to benefit from operational efficiencies and enhanced profitability regardless of how far they are from their head office.

Previously, organizations, particularly those of medium- or junior-size have struggled to justify the cost of installing terrestrial connectivity networks in remote locations, or have suffered with unreliable satellite connectivity.

This partnership will give Auxilium's customers access to the world's broadest and most reliable portfolio of satellite services, and will enable the provision of solutions at a lower cost, with no requirement on the part of mining companies to make significant investments in terrestrial infrastructure.

Wayne Panther, Founder of Auxilium, said that IIoT is changing the mining industry and is fast leading to the emergence of safer, more efficient and more profitable ways of working. However, many mining companies struggle to obtain the requisite connectivity for IIoT data transfer or on-site communications and are often faced with making huge investments in terrestrial infrastructure.

He noted that with Inmarsat's satellite capability, the company can eliminate the need for this investment and deliver robust and reliable connectivity that works wherever the mine is located. They reviewed several providers of satellite communications, even taking terminals and phones into the pit, and Inmarsat was the only provider whose connectivity worked wherever they were located.

Chairman of Auxilium Systems Nathan Mitchell noted that this partnership between Inmarsat and Auxilium Systems brings the ability to improve the firm's capabilities in delivering real-time, mine-based communications and automation to Australian mining companies and other sectors. This will lead to further improvements in efficiencies and real-time decision making that will continue to see Australian mining at the forefront of technological advances and further demonstrates Auxilium Systems' ability to provide industry-leading solutions to their current and future clients.

Joe Carr, Director of Mining at Inmarsat Enterprise, commented that mining companies are under huge pressure to extract products at a profitable margin. Working with Auxilium is going to enable Inmarsat to deliver solutions on a managed services model, reducing up-front investment and strain on capital expenditure budgets. Auxilium's expertise in creating technical solutions that solve key business challenges for mining companies is unparalleled.

He added that by combined with Inmarsat's broad portfolio of connectivity services and the world's most reliable satellite connectivity experience, the company believes that, together, the companies can provide the mining sector with a really compelling proposition.

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Ecliptic + Rocket Lab agreement

Rocket Lab USA and Ecliptic Enterprises Corporation have entered into an agreement to support Rocket Labs launch of Ecliptic-managed hosted payloads on the kick stage of Rocket Lab's Electron rockets.

An MoU between the two California-based firms was signed on August 1. Under the framework of this agreement, hosted payloads supplied by Ecliptic and their customers will constitute any payload launched, but not separated from, the kick stage once reaching orbit.

Such payloads typically involve focused advanced technology and proof-of-concept demonstrations, accomplishment of selected risk-reduction objectives and/or accomplishment of focused science or business mission objectives. These payloads will be operated after the Electron's primary mission — deploying satellites into LEO — is complete.

For those missions designated by Rocket Lab to accommodate hosted payloads, Electron's capable kick stage, proven on the Electron's first successful launch to orbit in January this year ("Still Testing"), will serve as the platform for one to several hosted payloads per mission, providing a structure for payload mounting, power, command and telemetry functions and attitude control.

Ecliptic will deliver fully integrated hosted payloads to Rocket Lab for final integration onto Electron's kick stage.

Once on orbit, Ecliptic avionics will control all hosted payload operations and related data handling; Ecliptic will also manage the end-to-end mission service and experience for its customers.

Ecliptic's U.S. domestic and international customers will be from commercial and government sectors, as well as from academia, media and non-profit arenas.

Hosted payload missions can be tailored to meet the orbital inclination and lifespan requirements of customers as required.

Electron will launch the hosted payloads into a wide range of Low Earth Orbits, with inclinations ranging from approximately 39 degrees to near-polar, Sun-Synchronous Orbit (SSO — ~90 degrees).

A payload serving as a pathfinder for this hosted payload program, NABEO, a drag sail technology demonstrator designed and built by High Performance Space Structure Systems GmbH (Munich, Germany), is integrated and ready for launch on the next Electron mission ("*It's Business Time*").

The first official mission of Ecliptic's hosted payload program is scheduled for 1Q 2019 and will include a 2 kg. hosted payload provided by Ecliptic and Beyond Sensors LLC (also Pasadena, California). Three additional missions are planned during 2019, each with up to 25 kg. of hosted payload mass.

Ecliptic is exploring additional payloads to be launched on a quarterly cadence in 2020-2022, with each mission accommodating up to 50 kg of hosted payload mass.

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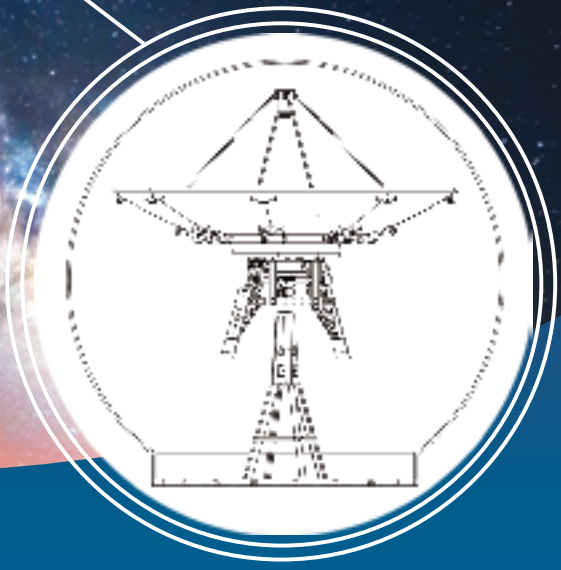

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UK's space industry test facility plans

The UK is taking their space industry plans to the next step with contracts worth £19 million for the first of the major facilities — the National Satellite Test Facility (NSTF), which is to be built and operated by STFC's RAL Space on behalf of the UK government.

The contracts are the first steps in meeting the UK space industry's need for a set of co-located world-class facilities for environmental testing of space payloads and satellites.

The three successful contractors will supply the large space test chamber, vibration facility and the combined electromagnetic compatibility (EMC) and antenna measurement system.

Satellite test facilities at this scale, in one location do not currently exist in the UK.

Once operational in 2021, the NSTF will provide the space sector across the UK with all the major testing facilities they need under one roof, without incurring expensive international shipping costs.

The NSTF will expand and complement the existing RAL Space facilities at the heart of the Harwell Space Cluster.

This major national infrastructure will support the UK's space sector as it seeks to capitalize on the estimated 3,500 to 10,000 satellites that are due to be launched by 2025.

Sean Stewart, NSTF Project Manager, RAL Space said, "*Alongside the existing RAL Space assembly, integration and validation facilities, the NSTF will put all the test equipment needed by industry and academia in one place and accessible to everyone. Awarding these contracts is one of the early and hugely significant milestones towards building the NSTF.*"

The large space test chamber will be built by Angelantoni Test Technologies and delivered in six large loads to be assembled on site at the NSTF.

With an internal, usable size of 7 meters in diameter by 12 meters long, the chamber will be the largest of its kind in the UK and among the giants of Europe.

It has a temperature range of 95K to 400K, providing the conditions needed to test a variety of complex science missions as well as commercial satellites for Earth orbit.

The Astroscale and Catapult companies hope for involvement in this opportunity. Astroscale Ltd., the UK branch of Astroscale Pte Ltd. (Astroscale), is leading a £4 million grant from the UK Government to help establish a National In-Orbit Servicing Control Facility at the Satellite Applications Catapult in Harwell, Oxfordshire. The National In-Orbit Servicing Control Facility will support advanced robotics activities in the hostile environment of space, specifically enabling the provision of a commercial service for de-orbiting smallsats.

The new facility will initially control Astroscale's pioneering ELSA-d mission, the first project to demonstrate the core rendezvous, capture and de-orbit technologies used by the ELSA (End-of-Life Service by Astroscale) program.

ELSA-d is comprised of two satellites, the 'Chaser' and the 'Target'. The 'Chaser' is equipped with optical sensing instruments and a capture mechanism which will attach to a Docking Plate on the 'Target' satellite. The Chaser and Target will then de-orbit together, burning up as they re-enter the Earth's atmosphere.

Upwards of 15,000 satellites are expected to be launched over the next 10 years, including into orbits that are already highly populated.

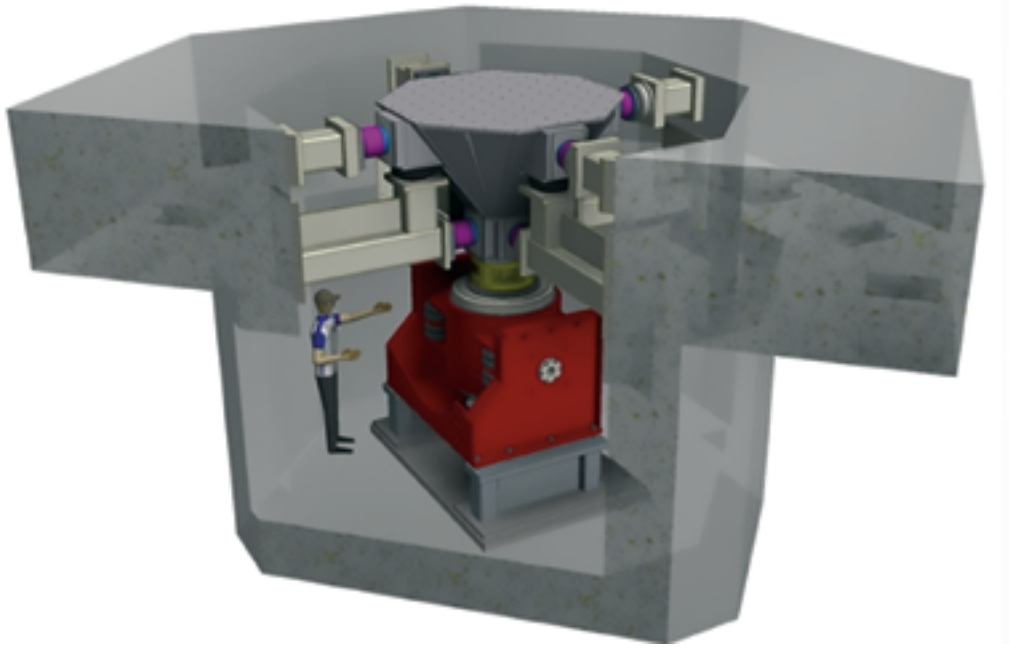
There are growing concerns that a collision between uncontrolled space debris and an active satellite could cause global commercial and security risks and lead to a cascading debris effect making these orbits unsustainable.

This issue was highlighted in August 2017 when the governments of Japan and the UK signed a memorandum of understanding to strengthen collaboration on mitigating space debris.

As part of the operational system, the new Centre will use highly advanced algorithms developed from state-of-the-art European Space Agency (ESA) software and technologies used in the recent pioneering Rosetta mission.

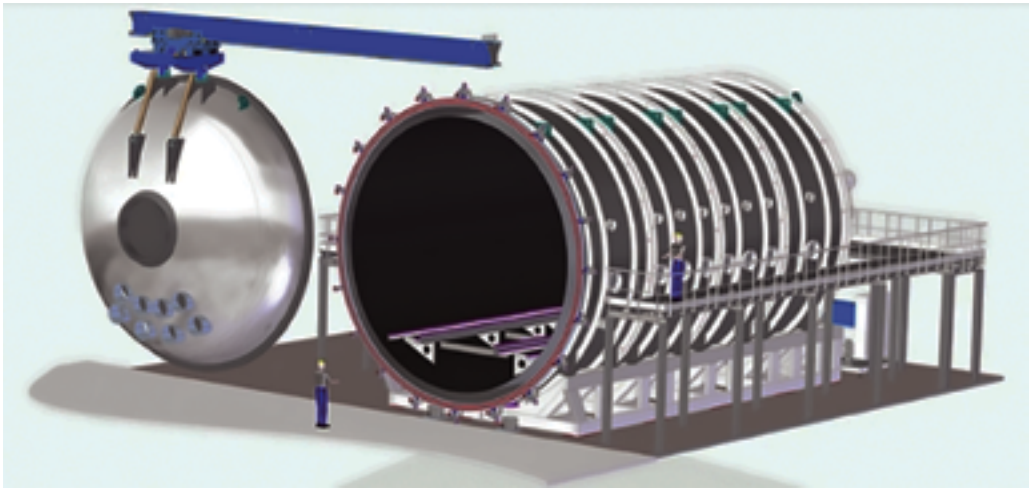
The grant has been awarded through the Government's Industrial Strategy Challenge Fund, which supports innovative businesses that address important industrial and societal challenges.

astroscale.com/
sa.catapult.org.uk/
www.harwellcampus.com/space-cluster/



Artistic impression of the vibration facility, vertical system. Image is courtesy of NVT Group.

The Harwell Space Cluster. UK.



Artistic impression of the Large Space Test Chamber. Image is courtesy of NVT Group.

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Satellite advances for a better world...

By Rob Schwarz, Chief Technology Officer

SSL, a Maxar Technologies company, designs and builds advanced spacecraft systems that enable the firm's customers to connect, inform and protect people around the globe.

The company is focused on next-generation small satellites (smallsats) for Earth Observation (EO) and communications, and has a growing business with the U.S. government. The company also brings innovation and technical advances to the world's highest performance geostationary satellites.

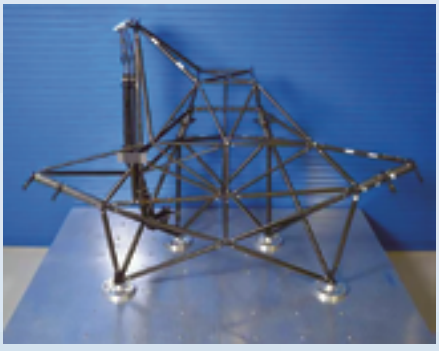
Satellites that can help farmers better manage their crops, or help identify remote populations for vaccine programs, all help to make the world a better place. The satellites built at SSL incorporate advanced technologies that bring internet connectivity to remote locations where building out terrestrial infrastructure simply is not practical. The satellites assist in delivering better healthcare and education to these populations and enable economic development that improves lives.

SSL is a leader in commercial geostationary satellites with 90 commercial GEOs on orbit today, more than any other satellite manufacturer. SSL delivered four advanced communications satellites to the launch base in just several of the summer months of 2018. Each spacecraft will be used to connect people and transform lives around the world. SSL has a long history of iterative satellite design and gradually incorporates advances into every spacecraft system. These advances range from solar electric propulsion and more efficient antenna designs, to advanced payload architectures and new spectrum utilization. By building on its heritage, the company provides very innovative systems that also ensure the reliability that comes from a 60 year history of success.

Today's smaller satellite platforms require a leap in design and technology advances. SSL is based in Silicon Valley in California and is influenced by the latest digital technologies, disruptive next-generation manufacturing, and creative, out-of-the-box thinking about what satellites and spacecraft can and should do. SSL builds spacecraft constellations for EO; robotics systems for building and fixing spacecraft on orbit; and is collaborating with NASA to provide a spacecraft that will travel to the asteroid belt between Mars and Jupiter that will enable scientists to study a mysterious, all metal asteroid.

Technology Advances

The company is focused on advances that provide higher value, greater flexibility and shorter schedules for their customers' most critical missions.



SSL's first antenna strut tower design. Image is courtesy of SSL.

Additive manufacturing, also known as 3D printing, is a great example of a technology that is now regularly incorporated into all SSL spacecraft. In 2016, SSL launched their first antenna, a strut tower design (***see the photo to the left***) that was enabled by additive manufacturing. The company was one of the first satellite manufacturers to actually fly 3D printed components when JCSAT 14, built for Japanese satellite operator Sky Perfect JSAT, was launched. More recently, the company announced that 3D printing and other advanced technologies were used on a satellite for Spanish operator Hispasat.

The strut-truss design methodology used on the satellite, which brings a range of communications services to Europe, the Americas, and North Africa, contains more than 200 carbon fiber composite struts, making the antenna three times the size of the tower flown on JCSAT-14. In addition to the 3D printed nodes that enabled the antenna tower, more than 200 additively manufactured metal and polymer components were incorporated throughout Hispasat 30W-6. The use of this technology improved the overall assembly schedule, performance, and operational lifetime for the spacecraft.

Four Satellites This Summer

The high performance of the SSL satellites launched during the summer of 2018 is enabled by additive manufacturing, as well as many other advances. These satellites include improved power systems, more automation and some have very high throughput spotbeam architectures to meet the growing demand for massive amounts of data sent over the internet. A strong team effort was required to launch four commercial GEOs between mid-July and early September; thankfully, SSL's passionate workforce always demonstrates that they are up to the task.

Telstar 19 VANTAGE, launched in mid-July, is one of a new generation of Telesat spacecraft designed to serve today's bandwidth intensive applications. The satellite supports a range of services, including advanced broadband connectivity for consumer, enterprise and mobility users across the Americas and Atlantic from a prime orbital location of 63 degrees West, the same location used today by Telesat's Telstar 14R.

In early August, the SSL built satellite for Telkom called Merah Putih, launched from the Cape Canaveral Air Force Station in Florida. Merah Putih is named for the red and white colors of the Indonesian flag and was designed as part of the critical telecommunications backbone connecting thousands of islands in Indonesia, other parts of Southeast Asia, and to expand service to South Asia.

Merah Putih's all C-band payload enhances both internet and telephone service for populations in remote regions and offloads backhaul for cellular service. With a launch mass of roughly 5,800 kg, the satellite incorporates many technology advances, including an antenna strut tower that was built using 3D printed parts. Merah Putih has 24 C-band transponders and 12 transponders for Extended C-band covering South East Asia and 24 C-band transponders covering South Asia.

Photo of the Telstar 19 VANTAGE satellite, courtesy of SSL.

Telkom decided upon a C-band payload for to ensure high reliability in regions that are characterized by heavy rainfall. Telstar 18 VANTAGE is the third in Telesat's VANTAGE series of satellites. These are designed to maximize throughput and spectral efficiency while optimizing network performance by combining broad regional beams with powerful HTS spot beams for Telesat's customers in enterprise, mobility and government markets.

Telstar 18 VANTAGE packs exceptional performance onto a single spacecraft with multiple payloads for high-speed internet service. The satellite provides extensive C-band coverage of Asia and possesses Ku-band high throughput spot beams over Indonesia and Malaysia. In addition, the satellite has five additional Ku-band regional beams. These high performance beams will enable Telstar 18 VANTAGE to meet growing demand for mobility, enterprise networks and telecom services across the Asia region.

In early August SSL, also shipped the multi-mission Azerspace-2/Intelsat 38 communications satellite to the European Spaceport in Kourou, French Guiana, for launch in early September. This is one more SSL-built satellite that integrates state-of-the-art technologies and design to bring information, connectivity and entertainment on the ground.

Azerspace-2 will assist the Azerbaijani company, Azercosmos, meet the growing demand for Direct-to-Home (DTH) television, government, and network services in Europe, Central and South Asia, the Middle East and Sub-Saharan Africa and is Azercosmos' second telecommunications satellite and will expand on the service currently available from Azerspace-1.

For Intelsat, the satellite has a payload that will provide continuity of service for the Intelsat 12 satellite, which was also built by SSL and was launched in 2000. At 45 degrees East, the satellite enables Intelsat's media customers to deliver enhanced service offerings across Central and Eastern Europe and Asia Pacific and also provides the broadband connectivity needed to support the services rendered by Intelsat's corporate network and government customers operating in Africa.

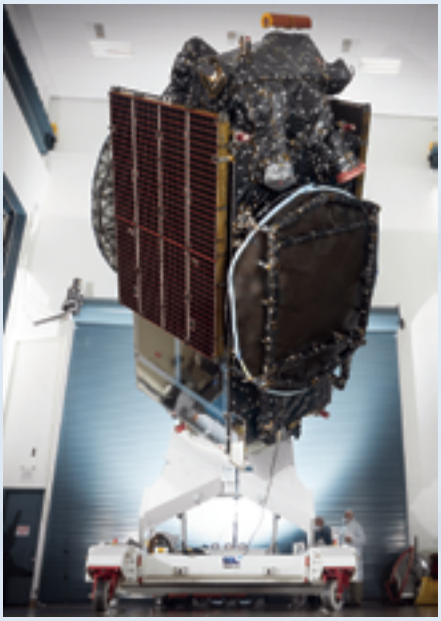


Photo of the Merah Putih satellite. Image is courtesy of SSL.

Next Generation Satellite Systems

In addition to all of SSL's advances to provide the highest performance and capacity to the firm's geostationary customers, the company focuses on next-generation LEO-based infrastructure solutions and EO satellites. SSL has built, or is building, more than 90 smallsats — since 2016, the company has delivered 11 satellites for Planet, with two more planned for launch later this year.

The company takes an agile, "new space" approach to building smallsat constellations, an approach that is supported by a long heritage of expertise. SSL's cost-efficient solutions for emerging applications include the use of Commercial-Off-The-Shelf (COTS) hardware that is screened to meet appropriate radiation levels, together with flight-proven high reliability hardware and software.

A state-of-the-art "*factory of the future*" will speed production for standard platforms, such as the SSL 100 and SSL 500. However, SSL's experience with industry leading processes is what ensures the correct balance of high reliability, speed to market and value. The company is simplifying space for start-ups and can deliver the correct resources to help customers from mission concept to on orbit operation.

The linchpin in this next-generation capability is the highly advanced satellite constellation that SSL is currently building for DigitalGlobe, the global leader in Earth imagery and information about the changing planet. Called WorldView Legion, the Low Earth Orbit (LEO) satellites will more than double DigitalGlobe's high-resolution capacity in important regions.

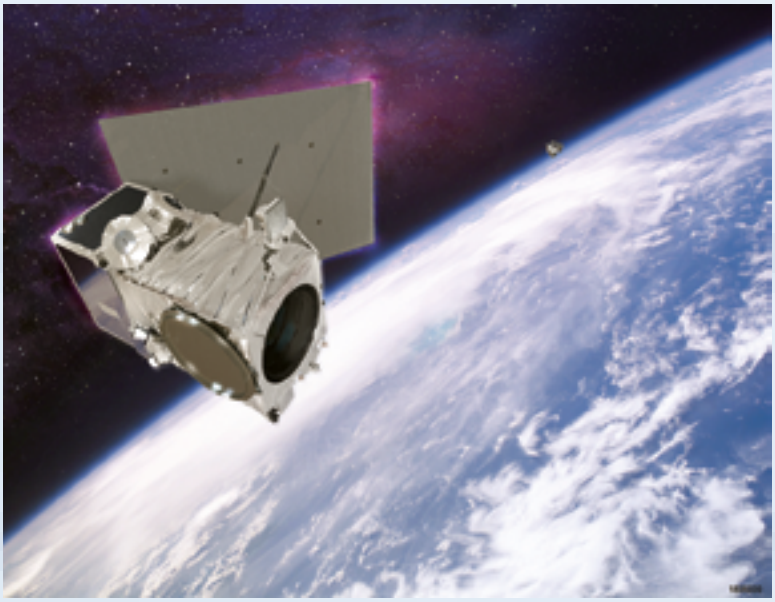
DigitalGlobe and SSL are both Maxar Technologies companies and this program demonstrates SSL's emerging leadership in EO satellites as well as Maxar's broadening corporate capability to provide end-to-end solutions from the space to the ground segment to the delivery of decision-driving analytics. The WorldView Legion constellation is a cost-effective solution to deliver high-resolution, sub-meter accuracy, and fast revisit rates and SSL will leverage this design for U.S. government and allied government space infrastructure needs.

Photo of the Telstar 18 VANTAGE satellite. Image is courtesy of SSL.

Communications Satellite Constellations

However, innovation in LEO doesn't end with EO. SSL is also developing technologies for innovative communications satellites that benefit from the low latency orbit that can serve Internet of Things (IoT) applications. The company formed a consortium with Thales Alenia Space to pursue the development and manufacture of Telesat's highly advanced global LEO satellite constellation and end-to-end system.

Photo of the Azerspace-2 / Intelsat-38 satellite. Image is courtesy of SSL.



Artistic rendition of the finalized, SSL-built WorldView Legion for DigitalGlobe. Image is courtesy of SSL.

Telesat's LEO constellation is expected to provide global availability and to become a core component in satisfying many of the world's most challenging communications requirements, such as accelerating 5G expansion, ending the digital divide and establishing new levels of performance for commercial and government broadband on land, sea and in the air.

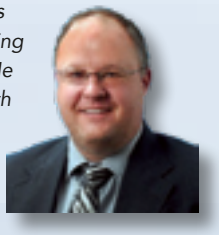
Thales Alenia Space and SSL were selected by Telesat to complete a preliminary design as well as to perform a series of technical reviews leading to a firm proposal for manufacture and launch of the LEO satellites and deployment of the ground system infrastructure. Telesat anticipates deciding by mid-2019 on a prime contractor for the program, with the Thales and SSL consortium one of two competitors.

Innovation for a Better World

As a Maxar Technologies company, SSL is committed to developing new technologies and tools with a commercial mindset that benefits not only customers but human kind.

SSL and the additional Maxar Technologies companies are accelerating innovation for the new space economy. Accelerating innovation means bringing technologies and capabilities together at a much faster pace, driving solutions that improve performance, removing complexities, and realizing economic benefits. With an eye to the future, the SSL team continues to innovate to meet the many challenges on Earth that can only be solved from space.

www.sslmda.com



Rob Schwarz is the Chief Technology Officer at SSL. He has more than 20 years' experience in the space industry working in space systems engineering and product development. He is passionate about uncovering challenges and working with talented teams to find creative and innovative solutions that improve performance and reduce time to market. Rob holds degrees in Mechanical Engineering and Aeronautics/Astronautics from Rutgers University and MIT.

Innovation is Crucial

Mr. Robert Zitz, the Chief Strategy Officer for SSL, offered his thoughts regarding Innovation, an element that is so critically important to SSL as well as for any company in this industry.

"As in any business endeavor, innovation is the key to continued growth. Customers and consumers' needs are evolving and the space industry is evolving to meet those needs. Participants in the space industry are fortunate because we can help make life better on Earth with innovations in environmental science, sustainable energy, medicine, and connecting more people to the world economy. In addition, space innovation in the areas of earth observation, communications and positioning, navigation and timing (PNT) improves our national security. SSL is proud to be a leader in many of the enabling technologies."

When asked what innovative missions or projects does SSL have underway he noted, "*SSL is an industry leader in high throughput, focused beam communications satellites in geostationary orbit and expect to be a driving force in low earth orbit communications satellites. We build high resolution Earth observation satellites that are delivering critical information to our commercial and government customers. SSL is playing a leading role in solar electric propulsion, space robotics and we have key projects underway developing on orbit servicing and on orbit assembly capabilities.*

When discussing the innovative technologies he believes will drive the space and satellite industry over the next year or so, Mr. Zitz said, "*I believe we will see much more 3D printing to enable geometries and large structures that were not possible before. Miniaturization of electronics and more efficient antenna designs and power systems will contribute to increasingly capable spacecraft in smaller form factors. Robotics will flourish and revolutionize space by permitting on orbit manufacturing, assembly and servicing."*

He added, *"I envision large constellations of smaller satellites using advanced onboard processing performing missions autonomously. Not all space technologies are in orbit, much of the future depends upon ground system technologies. We are working closely with our Maxar sister company Radiant Solutions, which does advanced mission management and big data processing. We recognize machine learning, artificial intelligence and blockchain technologies will be crucial to success in future space-based capabilities.*

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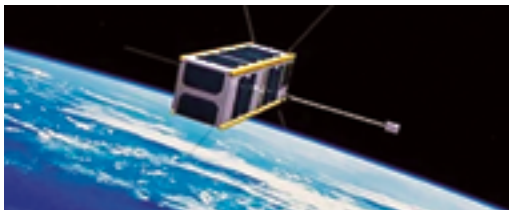
Hiber + KSAT are grounded



Artistic rendition of a Hiber smallsat.

KSAT's Svalbard ground station.

Dutch company Hiber and Norwegian KSAT have announced a new, long-term partnership to create a state-of-the-art and reliable ground station infrastructure for Hiber's Low Power Global Area Network (LPGAN), named Hiberband.

The first two satellites of the Hiberband constellation (Hiber One and Hiber Two) will be launched in the last quarter of this year.

The new ground station network starts with a redundant network with two stations; one on top of Hiber's Research and Development Centre in Delft, the Netherlands, and one on Svalbard in Norway.

The ground stations use motorized 4.5 meter Cobham S-band antennas that will receive the data messages from Hiber's satellites.

Both stations also have UHF-VHF antennas for the constellation Telemetry, Tracking and Command (TT&C) and are connected to the Hiber Mission Control Centre in Delft.

Both antenna systems are extremely robust and built to last for the coming decade.

KSAT's Svalbard Ground Station is uniquely located at 78 degrees North, close to the North Pole, which optimizes contact time for communication with the Hiber satellites that fly in a polar orbit.

KSAT has introduced KSATLite, a global integrated ground network optimized for smallsats and smallsat constellations. Building on the foundation of expertise that KSAT has acquired through 50 years of ground station service operations, KSATLite is able to leverage many of the key strengths of the existing infrastructure.

hiber.global/
www.ksat.no/

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Boeing lands Millennium Space

Millennium Space Systems two satellite platforms: ALTAIR™, which is constellation optimized, 10 to 200 kg., and AQUILA™, offering precision pointing, 200 to 2000 kg. Images are courtesy of Millennium Space Systems.

Boeing [NYSE: BA] will acquire Millennium Space Systems, a provider of agile, flight-proven smallsat solutions, under an acquisition agreement that will expand Boeing's satellite and space portfolio, talent and capabilities.

Millennium Space Systems was founded in 2001 and is based in El Segundo, California. With approximately 260 employees, the company has developed high-performance satellites for exacting missions ranging from 50 to more than 6,000 kg.

The acquisition, which is subject to customary conditions, is expected to close by the end of third quarter 2018. Once finalized, Millennium Space Systems will become a Boeing subsidiary, operating under its current business model and reporting to Mark Cherry, VP and GM of Phantom Works.

The terms of the agreement were not disclosed. The transaction will have no impact on Boeing's 2018 financial guidance or the company's commitment to returning approximately 100 percent of free cash flow to shareholders.

Stan Dubyn, the CEO of Millennium Space Systems, said that he is proud of the talented and dedicated team the company has built at Millennium Space Systems over the past 17 years. By combining the firm's tools, talent, technologies and culture, they'll be able to do even more incredible things as part of Boeing.

Leanne Caret, the President and CEO of Boeing Defense, Space and Security, added that Millennium Space Systems' expertise in vertically-integrated smallsat solutions perfectly complements Boeing's existing satellite portfolio and will allow the company to meet the needs of a diverse customer set. Boeing looks forward to incorporating Millennium Space Systems' end-to-end mission solution capabilities into the service offerings in satellite operations and data solutions.

www.boeing.com

www.millennium-space.com

Comtech EF Data's China contract

Comtech EF Data's CDM-625A satellite modem.

DoubleTalk Carrier-in-Carriers is based on the company's patented "Adaptive Cancellation" technology that allows transmit and receive carriers of a duplex link to share the same transponder bandwidth.

Comtech EF Data has won a tender by a major Mobile Network Operator (MNO) in China to replace the older generation of lower efficiency modems to provide more reliable services at a much lower OPEX.

This latest order for $1.9 million, specified Comtech EF Data's CDM-625A Advanced Satellite Modems, Up & Down Frequency Converters and the CX-U Series RAN Optimization by their subsidiary, Memotec.

According to the company, the purchase highlights the customer's long-standing confidence in the Comtech mobile backhaul solution.

For more than 10 years, the MNO has used Comtech's infrastructure equipment to support 1000+ sites that are serving China's rural communities and disaster recovery efforts.

By leveraging Comtech EF Data's bandwidth efficient satellite modems and Memotec's 2G traffic optimization solutions, the MNO has been extremely successful in lowering the total cost of ownership (TCO) of backhauling traffic over satellite.

Some of the leveraged features include industry best VersaFEC-2 Forward Error Correction, the DoubleTalk Carrier-in-Carrier bandwidth compression, lower rolloffs, and 2G TDM optimization.

Fred Kornberg, President and CEO of Comtech Telecommunications Corporation, said the company is pleased that this customer has — once again — selected the firm's mobile backhaul solution, demonstrating their strong faith in Comtech EF Data products and the China-based sales and support staff.

He added that this equipment will provide the performance that enables MNOs to operate at their highest level of performance and allows them to truly monetize investments, to drive down OPEX and to increase profitability.

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Space Force to become real...

The U.S. Defense Department will establish a sixth branch of the armed forces, the U.S. Department of the Space Force, by 2020, Vice President Mike Pence announced.

In a speech at the Pentagon, the Vice President also announced plans to establish a new combatant command — U.S. Space Command — as well as a Space Operations Force and a new joint organization called the Space Development Agency. The announcement follows a seven-week review by DoD, directed by President Donald J. Trump, of "*the process necessary to establish a space force as the sixth branch of the armed forces.*"

"*In his inaugural address to the nation, President Trump declared that the United States stands 'at the birth of a new millennium, ready to unlock the mysteries of space,'*" Pence said.

Space Force

Just as advances in aviation technology drove the emergence of air as a new battlefield in the 20th century, advances in space technology have made it clear that space is the new battlefield for the 21st century, the vice president said. The U.S. will meet the emerging threats on this new battlefield, he said, and carry on the cause of liberty and peace into the next great frontier.

"*The time has come to establish the United States Space Force,*" Pence said.

The new branch will be separate from, but equal to, the five other branches, he said.

"*To be clear: the Space Force will not be built from scratch, because the men and women who run and protect our nation's space programs today are already the best in the world,*" *the vice president said. "Across this department and our intelligence agencies, there are literally tens of thousands of military personnel, civilians and contractors operating and supporting our space systems -- and together, they are the eyes and ears of America's warfighters around the globe,*" he added.

Peace Through Strength

Actions by U.S. adversaries make it clear that space is already a warfighting domain, the vice president said.

"*For many years, nations from Russia and China to North Korea and Iran have pursued weapons to jam, blind and disable our navigation and communications satellites via electronic attacks from the ground,*" Pence said. "*But recently, our adversaries have been working to bring new weapons of war into space itself.*"

In 2007, China launched a missile that tracked and destroyed one of its own satellites, the vice president said. And Russia is working on an airborne laser to disrupt space-based systems, he added.

"*Both nations are also investing heavily in what are known as hypersonic missiles designed to fly up to 5 miles per second at such low altitudes that they could potentially evade detection by our missile defense radars,*" *Pence said. "In fact, China claimed to have made its first successful test of a hypersonic vehicle just last week.*"

In every domain, America will always seek peace, the vice president said. "*But history proves that peace only comes through strength,*" he added. "*And in the realm of outer space, the United States Space Force will be that strength.*"

Action Steps

A report to be released shortly represents a critical step toward establishing the Space Force, Pence said. It identifies several actions that DoD will take as the nation evolves its space capabilities, "*and they are built on the lessons of the past,*" Pence said.

First, the report calls for the creation of the U.S. Space Command, a new unified combatant command for space.

"*This new command … will establish unified command and control for our Space Force operations, ensure integration across the military, and develop the space warfighting doctrine, tactics, techniques, and procedures of the future,*" he said.

Second, the report calls for the establishment of a Space Operations Force — an elite group of joint warfighters, specializing in the domain of space, who will form the backbone of the nation's newest armed service. This force will draw from across the military to provide space expertise in times of crisis and conflict, Pence said.

"*Third, the report calls for a new joint organization — the Space Development Agency — that will ensure the men and women of the Space Force have the cutting-edge warfighting capabilities that they need and deserve,*" he said.

Finally, the report calls for clear lines of responsibility and accountability to manage the process of establishing and growing the Space Force, including the appointment of an assistant secretary of defense for space, the vice president said.

"*Creating a new branch of the military is not a simple process,*" Pence noted. "*It will require collaboration, diligence and, above all, leadership. As challenges arise and deadlines approach, there must be someone in charge who can execute, hold others accountable, and be responsible for the results.*"

Ultimately, Congress must establish the new department, the vice president said. "*Next February, in the president's budget, we will call on the Congress to marshal the resources we need to stand up the Space Force, and before the end of next year, our administration will work with the congress to enact the statutory authority for the space force in the National Defense Authorization Act,*" he said.

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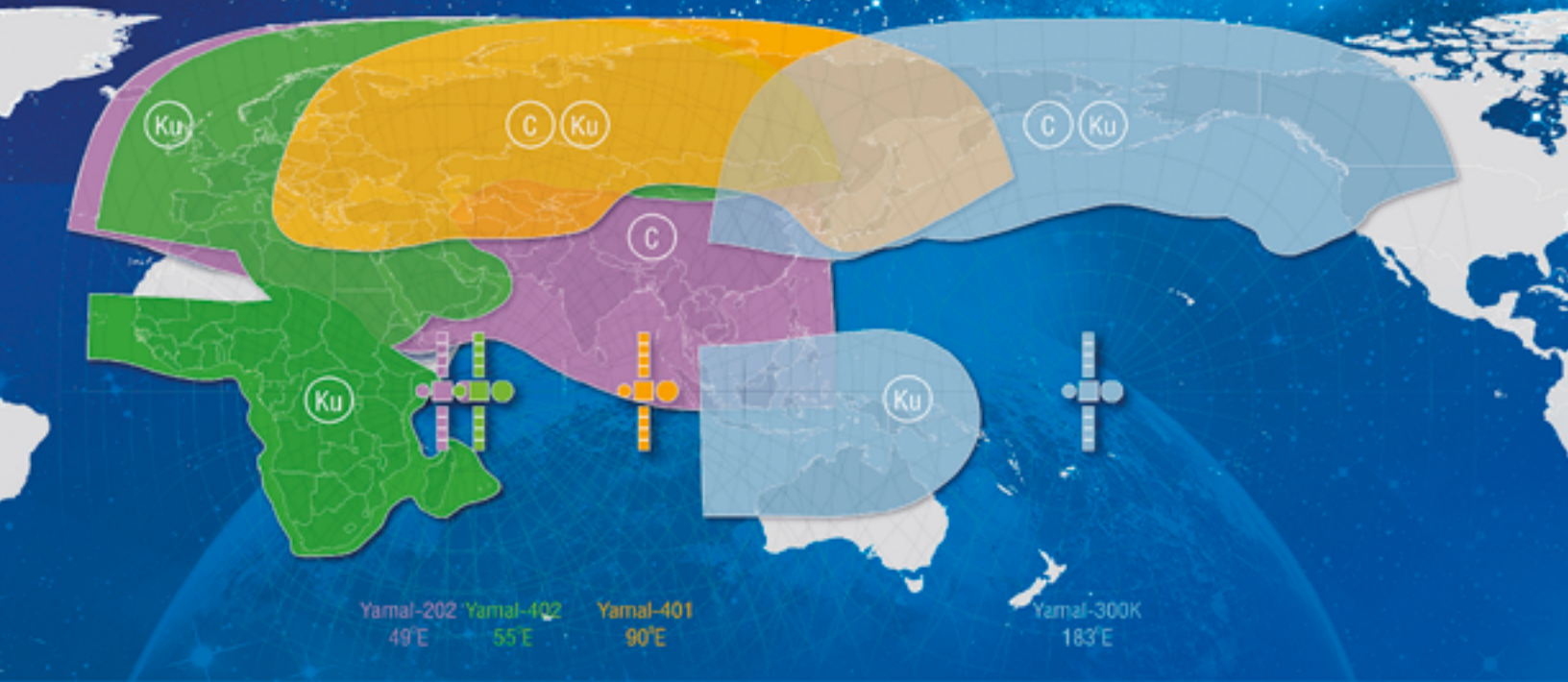

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or contact Nikolay Denisenko by +7 916 9059326 or denisenko@.gazprom-spacesystems.ru

GAZPROM SPACE SYSTEMS

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It's about time...

Orolia's respected atomic clock solutions have been selected for the Galileo Global Navigation Satellite System (GNSS).

Under contracts totaling 26M euros, Orolia will deliver the most stable, accurate timing solutions available to date building on Orolia's reputation of providing the most precise timing technology for satellite programs.

The quadruple clock redundancy designed into each satellite ensures that even if a failure occurs, overall system performance will not be compromised.

Each satellite will carry two Rubidium atomic clocks and two passive Hydrogen Masers. Under these contracts, Orolia will supply its Spectratime Rubidium Atomic Frequency Standard and its Passive Hydrogen Masers physics package for an additional 12 Galileo satellites.

These new satellites will reinforce Orolia's world leadership position in the number of active atomic clocks in space, including more than 100 in the Galileo system.

Orolia CEO Jean-Yves Courtois stated that they're honored to continue supporting the European Commission with precise timing for Galileo. These new contracts further emphasize Orolia's position as the world's leading provider of resilient positioning, timing and navigation (PNT) solutions.

In addition to serving as Europe's independent PNT source, Galileo can also serve as a secondary signal source for systems such as GPS, GLONASS or BeiDou in the event of service disruption. Galileo delivers the highest accuracy of any GNSS system in operation today.

The quadruple clock redundancy designed into each satellite ensures that even if a failure occurs, overall system performance will not be compromised.

More than 150 Orolia Spectratime atomic clocks are flying to support Galileo, IRNSS, BeiDou, GAIA and other missions, some for more than ten years. Orolia provides the expertise necessary to design solutions for highly reliable space applications.

Orolia designs and manufactures a full range of high-performance, low cost GNSS synchronized crystal solutions, Rubidium and Maser sources, smart integrated GNSS reference clocks, rugged PNT devices, GNSS simulation and clock testing systems that support applications including defense, government, space, maritime, enterprise networks, aviation and telecommunications.

Also, in response to the growing threat of GPS/GNSS interference in military operations, Orolia presented their Assured Positioning, Navigation and Timing (PNT) Solutions at the Eurosatory exhibition that occurred earlier this year.

In addition to showcasing their proven technology solutions, Orolia also distributed their latest whitepaper, "*A Holistic Approach to Trusted, Resilient PNT*," which presents innovative strategies and opportunities to protect against GPS/GNSS spoofing and jamming in military environments.

The world's leading provider of Resilient PNT solutions, Orolia is also a European leader in delivering trusted technology solutions for critical programs such as the European GNSS system Galileo, and the European Commission's Horizon 2020 HELIOS project for next generation air, land, and sea search and rescue technology.

Orolia recently announced a 26 million euros contract to support new Galileo satellites and introduced their GADSS ELT commercial aircraft emergency tracking beacon as part of the HELIOS project at the Paris Air Show last year.

On the global stage, Orolia has also recently received a $34 million contract from the U.S. military to provide personnel recovery devices to covertly locate and help rescue warfighters who are lost, captured or in distress.

"*At Orolia, we're committed to delivering innovative, yet practical technology solutions to meet Europe's most critical defense and security needs*," said Orolia CEO Jean-Yves Courtois. "*We provide timing and location data you can trust, and our solutions are often the first line of defense in protecting critical intelligence, navigation and communications systems.*"

Military forces require continuous access to trusted PNT resources anytime, anywhere. Yet vulnerabilities give adversaries the opportunity to deny access to, or even falsify, navigation and timing data. Orolia delivers Assured PNT capabilities for warfighters to detect, mitigate and help prevent threats such as interference, jamming and spoofing.

Orolia's solutions are flexible, scalable and configurable based on required features, performance and budget considerations.

Their complete, end-to-end solutions include GNSS jamming and spoofing detection, alternative sources of robust, encrypted satellite-based PNT data, and military personnel recovery systems.

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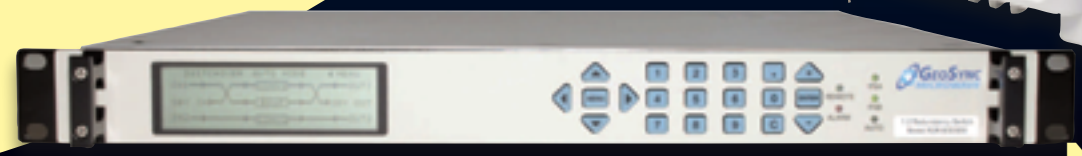

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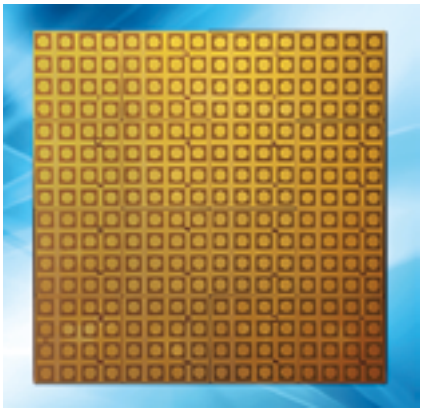
GeoSync Microwave™

Engaging in innovative design, development and the manufacture of mobile, satellite-based antenna systems that are focused on the delivery of broadband internet to any location, C-COM Satellite Systems has developed a proprietary, one-button, auto-acquisition controller technology for rapid antenna point a to GEO satellite with the press of a single button.

"Today we are a step closer to achieving our objective of developing and manufacturing an affordable intelligent antenna system capable of supporting the latest constellation of satellites, which will play a significant role in delivering high speed broadband solutions to mobile satellite communication markets," said Dr. Leslie Klein, President and CEO of C-COM Satellite Systems Inc.

Approximately 8,000 iNetVu® auto-acquire antennas have been sold by C-COM's extensive dealer network into more than 100 countries. These systems are providing services to a wide range of verticals, such as Oil & Gas, MILSATCOM, disaster management, SNG, cellular backhaul, telemedicine, mobile banking and other industries

Also under development by C-COM is a next generation, Ka-band, flat panel antenna that is based on advanced phased array technology. In partnership with the University of Waterloo's Centre for Intelligent Antenna and Radio Systems (CIARS). In June, the company successfully tested their 16×16 subarray phased array antenna using 4×4 Transmit and Receive building block modules *(see image to the right)*.



The primary goal of this research project is to focus on the development of a new modular, low-cost, intelligent and conformal Ka-band antenna. The now proven modular approach allows antenna designers to develop any size and shape of phased array panels using the smallest intelligent active 4×4 subarray. This 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. The developed technology platform can be easily extended to the rapidly emerging millimeter-wave 5G and complex radar systems. CIARS also achieved good beam steering up to 70 degrees from boresight, a significant achievement.

SUV with phased array antenna installed on roof. Image is courtesy of C-COM.

With nearly 50 percent of the world's population having no access to basic health services, with the vast majority of this population living outside cities in peri-urban or rural areas where few hospitals exist, is a major concern of the company as C-COM works to address such "hospital deserts".

The company's Director of International Business Development, Drew Klein, said, "*Innovation is critical in all industries, especially in technology and reminds me a bit of the line from Shawshank Redemption, with a bit of a twist, "Get busy innovatin' – or get busy dyin'.*

"*The longer you tread water, the more likely it is that someone with a big enough boot will come and stand on your head. In the SATCOM business, specifically in this niche market of antenna design, C-COM, and a few others, are seeking to truly change the game. Some of our competitors are standing still and, if the new technologies take off, there's a good chance they will be left in the dust. Based on C-COM's successful tests to date on our Ka-band electronically steerable phased array antenna, combined with our existing auto-acquire mobile VSAT business, which is arguably the biggest in the commercial markets worldwide, C-COM is in an enviable position.*

"*The potential in this market extends beyond satellite — huge promise exists in 5G, automotive radar, and many other vertical markets yet to be identified. However, the goal will be to create an affordable, robust antenna for Comms-on-the-Move (COTM), for planes, trains, boats, buses, cars, helmets, backpacks, as well as a solution to deliver this technology for consumer use taking advantage of the large number of LEO/MEO and GEO satellites that are being deployed today and will be in orbit in the next few years. This is an ambitious project which we are running along side our existing Comm-on-the-Pause (COTP) business, where we have aggressively marketed and sold our world renowned iNetVu brand into more than 100 countries. C-COM is a world leader in this market and we expect to be a world leader in the next generation antenna market, as well.*

"*I think it's clear — the world is seeking flat, active, conformal, modular solutions to replace the bulky reflectors with which we have all grown old. Parabolic antennas will not be able to provide the required solutions for the new constellations being launched into low and medium orbits that phased array antennas will be able to deliver, such as: tracking multiple satellites simultaneously, low weight, low height, small size, conformal, modular, no moving parts, etc. New advances in microelectronics, nanotechnology, and advanced technology constellations will make it possible to match up satellites with modern phased array electronically steered antennas deployed on the ground to deliver large amounts of bandwidth to our bandwidth hungry world as we move into the next phase of trying to connect the next 3.5 billion people around the world who remain disconnected from the internet.*

www.c-comsat.com

InfoBeam

ETL Systems StingRay debuts

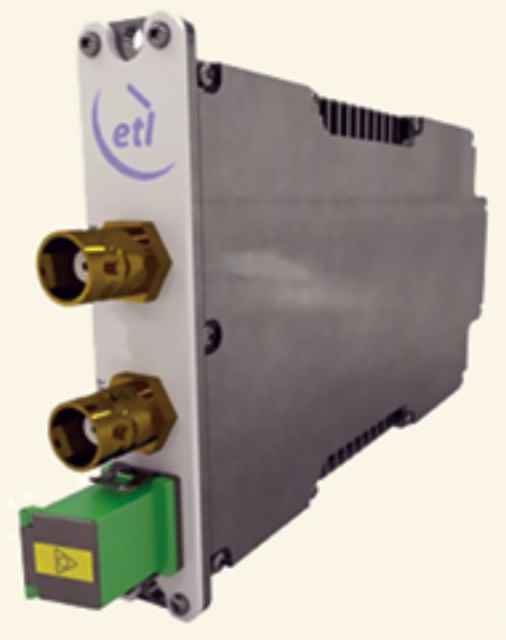
ETL Systems will be launching their StingRay DWDM (Dense Wavelength Division Multiplexing) solution at IBC at booth 1.A33.

The solution enables high-quality distribution between a satellite antenna and a remote control room.

Using DWDM technology, multiple signals can be transmitted and received over distances of up to 100s of kilometers through a single fiber cable and also offers the potential to deliver redundancy by adding an additional fiber connection.

The StingRay DWDM is able to maintain a much finer optical spectrum, enabling it to distribute up to 40 channels through one single fiber cable. It is able to cover much larger distances before suffering any signal loss.

The addition of pre-amp and post-amp Erbium Doped Fiber Amplifiers from ETL Systems further reduces the effects of any potential optical signal loss.



ETL Systems' StingRay200 DWDM AGC L-band Transmit Fiber Converter with Mon port.

ETL Systems will also be demonstrating their existing StingRay CWDM (Coarse Wavelength Division Multiplexing) solution, which combines eight optical signals on a single fiber by using different wavelengths.

Other products on display will include the company's Griffin Redundancy Switch, which provides signal redundancy for satellite modulators, downconverters, or modems, and its Hurricane Matrix, which provides L-band routing for as many as 64 input and output feeds.

Ian Hilditch, CEO, ETL Systems, said that satellite is under increasing pressure to deliver high performance and quality in all environments. This is mainly fueled by growing competition, covering a range of applications, all vying to deliver multiple services across disperse locations.

Both CWDM and DWDM represent great potential for the satellite industry to deliver RF signals much more cost-efficiently and over large distances.

www.etlsystems.com/

InfoBeam

STN has WTA certification

The World Teleport Association (WTA) has announced that STN has achieved provisional certification of their Slovenia Teleport located near Ljubljana under the WTA's Teleport Certification Program.

Since the introduction at IBC 2015, the Certification program has quickly grown in popularity.

Twenty teleports are currently engaged in the quality evaluation process — certifications have already been issued to teleports owned by Eutelsat, du, Signalhorn, Optus, Globecomm, Media Broadcast Satellite, Horizon, Elara Comunicaciones, GlobalSat, Talia, Telenor, Speedcast, Batelco, Planetcast, VIVACOM, Etisalat, CETel, Telstra and Arqiva

To achieve Provisional Certification, a teleport operator completes a +170 item questionnaire and submits it to WTA.

The Association analyzes the data based on standards established by its Certification Committee and issues the Provisional Certification based on the self-reported information.

The teleport then has six months to achieve Full Certification.

To achieve Full Certification under WTA's program, an auditor is dispatched to visit the teleport, provide independent validation of the data submitted in the questionnaire, and identify additional factors that may positively or negatively affect the score.

The WTA's Certified Teleports

Asia

PlanetCast - Noida Teleport
Noida (New Delhi), Uttar Pradesh, India
Telstra - Stanley Teleport

Hong Kong

SAR - China
SingTel - Bukit Timah Teleport - Singapore
SingTel - Seletar Teleport - Singapore

United States

COMSAT - Santa Paula Teleport - Santa Paula, CA
COMSAT - Southbury Teleport - Southbury, CT
Globecomm - New York int'l Teleport - Hauppauge, NY
Hawaii Pacific Teleport - Kapolei, Honolulu, HI
Intelsat - Atlanta Teleport, Atlanta, GA
Intelsat - Mountainside Teleport, Hagerstown, MD
Intelsat - Napa Teleport. Napa (San Francisco), CA
Intelsat - Riverside Teleport, Riverside (Los Angeles), CA

Full Certification is issued at a Tier number from 1 through 4, of which 4 represents the highest degree of excellence, and remains in effect for 3 years.

WTA's Teleport Certification Program serves both teleport operators and their customers by creating an objective, transparent, and internationally accepted method for teleport operators to document the quality of their operations for customers and strategic partners.

WTA also provides a means for customers to select teleport vendors delivering the price-performance level that is appropriate for their applications. Select this link (*worldteleport.site-ym.com/general/custom.asp?page=CertifiedTeleports*) for a list of certified teleports.

Latin America

Elara - Mexico City Teleport - Mexico City, DF, Mexico
GlobalSat - Tijuana Teleport - Tijuana, BC, Mexico

Europe

Arqiva - Chalfont Grove Teleport, Gerrards Cross, UK
CETel - Germany Teleport - Cologne, Germany
Cyta - Makarios Teleport, Cyprus
Eutelsat - Rambouillet Teleport, Rambouillet, France
Horizon Teleports GmbH - Moosburg, Germany
Intelsat - Fuchsstadt Teleport, Germany
Media Broadcast Satellite - Usingen Telepor, Germany
Signalhorn - Backnang Teleport, Germany
Signalhorn - Leuk Teleport, Switzerland
STN - Slovenia Teleport, Ljubljana, Slovenia
Telenor Satellite - Nittedal Teleport, Norway
Telespazio - Fucino Space Centre, Rome, Italy
The Talia Teleport - Raisting, Germany
VIVACOM Plana Teleport, Sofia, Bulgaria

Middle East - Africa

Batelco Ras Abu Jarjur (RJR), Manama, Bahrain
du - Samacom Teleport, Jebel Ali, Dubai, UAE
Etisalat Tawi Al Saman (TAS) Teleport. Sharjah, UAE

Australia, New Zealand - Pacific Island

Telstra - Gnangara Teleport. Perth, Australia
Telstra - Oxford Falls Teleport, Sydney, Australia
Optus - Belrose Teleport, Sydney, Australia
Optus - Oxford Falls Teleport, Sydney, Australia
Optus - Lockridge Teleport, Perth, Australia
Optus - Hume Teleport, Canberra, Australia
SpeedCast- Bayswater Teleport, Perth, Australia
SpeedCast- Henderson Teleport, Perth, Australia
SpeedCast- Mawson Lakes Teleport, Adelaide, Australia

The STN Slovenia teleport.

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The Forrester Report

"We're in the money..."

By Chris Forrester, Senior Contributor

At last we know — on July 12, the FCC Commissioners (via a 4 to 0 vote) backed the proposal by Intelsat and SES (with Intel) to see a restructuring of C-band spectrum over the U.S. to help develop 5G — the firms wish this to occur rapidly and might even extend the concept from an initial 100 MHz to 200 or even 300 MHz.

The plan would see Intelsat, SES (and including Eutelsat) sell some of their C-band frequencies to the USA's cellular operators. However, the FCC enthusiasm needs another vote to finalize the decision, and that vote has yet to be scheduled, as of this writing.

Intelsat and SES, which between them control more than 90 percent of the spectrum under discussion, have benefited from investor enthusiasm for their proposals. Intelsat shares rose 14 percent on July 12 (to $19.78) to a four year 'high.' SES also benefited (by 5.2 percent to 17.06 euros).

"We're going to need a bigger boat," said FCC chairman Ajit Pai, in his comments and referencing the Hollywood movie 'Jaws.' "In our case, more spectrum."

SES, in a statement, said, "The FCC adopted an Order and Notice of Proposed Rulemaking (NPRM) related to the prospective use of the 3,700 – 4,200 MHz spectrum today. We are pleased with the emphasis on the protection of incumbent users from harmful interference and the positioning of our market-based solution as a lead proposal.

"We thank the Commission for the hard work on how to implement our market-based and expedient approach to resolve the challenging regulatory issues confronting the FCC. The FCC's level of interest in our proposal supports our firm belief that it will produce multiple benefits for industry growth and investment and best align incentives to ensure a win-win solution for all stakeholders, as well as the broader public interest. An industry-based solution developed by those who have invested heavily in C-band is essential to avoid disruption of national video and audio broadcasts, emergency services, and military applications in the U.S. that all depend entirely on continued access to C-band. The satellite operators – Intelsat and SES, today joined by Eutelsat – will work hard to demonstrate our ability to efficiently implement our market-based proposal, protecting the C-band services environment from disruptive interference while clearing spectrum to accelerate the era of 5G in the U.S."

The FCC's July 12 meeting stressed that the reallocation of C-band needed to happen speedily, but any reassignment of spectrum also needed to protect existing users.

The good news, but also the challenge, is that the FCC suggests the need to increase the amount of spectrum released from the proposed 100 MHz to "at least" 200 to 300 MHz. Financially this could be extremely beneficial to the satellite operators; however, the challenge would be in the amount of work needed to relocate existing customers.

The reason for this optimism is the world's (and in particular the USA's) thirst for bandwidth. "The coming roll-out of 5G will require more bandwidth," says Kassab. "Among ways to meet this demand is for satellite operators to free up bandwidth by optimizing their C-band spectrum use. SES has estimated it can initially free up 100 MHz of C-band spectrum over the U.S., the bank suggests that 300 MHz could be freed up. This could be spectacularly valuable for SES (and Intelsat in a similar manner), as observers expect the FCC to permit a simple sell-off of the freed-up spectrum to U.S. cellular operators.

The bank noted, "SES has estimated it can initially free up 100 MHz, and this seems to be what consensus models. But our analysis of 1,000+ U.S. C-band transponders shows SES could manage to triple that amount, unlocking 10 euros per share of value. We expect the FCC to support that approach and now factor in this potential, explaining the bulk of our target price hike to 22 from 10 euros."

Sami Kassab, a senior analyst at Exane/BNPP, explained, "We upgrade SES to Outperform from Underperform as we believe the market fails to fully capture the spectrum value associated with its ownership of U.S. C-band rights. Our view of the satellite industry has not changed: we see scope for increased satellite capex efficiency to drive value in video DTH orbital positions, but to put structural long-term pricing pressure on segments with low barriers to entry, namely the connectivity and data markets."

The reason for this optimism is the world's (and in particular the USA's) thirst for bandwidth. "The coming roll-out of 5G will require more bandwidth," says Kassab. "Among ways to meet this demand is for satellite operators to free up bandwidth by optimizing their C-band spectrum use. SES has estimated it can initially free up 100 MHz, and this seems to be what consensus models. But our analysis of 1,000+ U.S. C-band transponders shows SES could manage to triple that amount, unlocking 10 euros per share of value."

July 12 also witnessed Eutelsat join the C-band 'club.' While only a minor player over the U.S. (thanks to the company's ownership of the former SatMex satellites), it was good that there is near-unanimous support for the C-band scheme, with only Telesat of Canada holding out. This move is not a 'zero sum game.' Intelsat and SES (and one presumes Eutelsat Americas) will have to fund the move of their client's Receive Only dishes, and that will be expensive. Moreover, there are some powerful voices firmly against the scheme. The USA's public broadcasters (PBS affiliates) are anxious, while the USA's distributors of content (via C-band) are concerned, and Canada's Telesat, has already said it has reservations as to who would control access to the freed-up spectrum.

Many Asian satellite operators have also expressed their concerns as to whether an FCC ruling in favor of re-using C-band over the USA would place their own C-band services in jeopardy and helped the World Broadcasting Union (WBU) argue strongly against the move.

A detailed analysis from hedge fund Kerrisdale Capital Management, normally seen as a short-seller in Intelsat stock, is firmly behind the proposals. Kerrisdale states that the Intelsat and SES proposal is the best and fastest way to unlock value in this "crucial" spectrum: "If the price is right, Intelsat, SES, and perhaps a few much smaller peers will roll up their sleeves and work with incumbent users to free up the spectrum. This market-based approach not only appeals to the FCC's ideological bent; it's also eminently practical, liberating meaningful amounts of bandwidth in a short period of time and helping the U.S. win the so-called race to 5G. In our view, the Intelsat/SES proposal is by far the leading contender for C-band reform — a high-probability base case, not a long shot."

Indeed, Kerrisdale suggests that Intelsat would see a massive 757 percent upside (of some $151 per share), while SES would gain a 217 percent upside (of 51 euros per share) if their C-band hopes are realized, and perhaps exceeded. The hedge fund suggests that 400 MHz of C-band could be in play, subject to the FCC decision. Kerrisdale values the spectrum at just 50c per MHz (per 'pop', or one MHz of bandwidth passing one person in the coverage area) which suggests a massive $60 billion overall valuation.

As a benchmark, Kerrisdale says the $0.17-$0.38 per MHz (per pop) valuations of recent C-band auctions in the UK, Australia and South Korea could easily mean several multiples of those values for the USA. Kerrisdale said that a value of $1 (per MHz/pop) is easy to argue. "Such a price is probably too high for the carriers to afford, but, even after applying a large discount, the C-band will still generate tens of billions of dollars for Intelsat and SES — a valuation range that T-Mobile, for one, has directly endorsed.

"Only Intelsat and SES are in the right position to understand the nuances of current C-band usage and cost-effectively manage the transition to 5G; without their cooperation, the process will bog down. That's why last week's first step in the rulemaking process prominently featured the Intelsat/SES proposal and former opponents to the consortium's plan keep pre-emptively modifying their own schemes to more closely resemble it: everyone can sense which way the wind is blowing."

Kerrisdale stated bluntly that "Intelsat and SES are dramatically undervalued. With enormous embedded spectrum value than can be extracted at a reasonable cost and in reasonable time, Intelsat and SES should trade toward their fair values of $151 and 51 euros per share, respectively, over the next few years."

Intelsat and SES senior managers (and their ever-patient investors) must certainly hope that is indeed the case.

Senior Contributor Chris Forrester is a well-known broadcast journalist and industry consultant. He reports on all aspects of broadcasting with special emphasis on content, the business of television and emerging applications. 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, Chris was appointed an Associate (professor) of the prestigious Adham Center for Television Journalism, part of the American University in Cairo (AUC).

A Snapshot of the Primary US C-Band Satellites Today

	Intelsat[1]		SES[2]		Eutelsat		Telesat	
	Name	C-Band TPs	Name	C-Band TPs	Name	C-Band TPs	Name	C-Band TPs
1.	Galaxy-15	24	1. AMC-10	24	1. 117 West A	24	1. Anik-F3	24
2.	Galaxy-12	24	2. AMC-11	24	2. 115 West B	12	2. Anik-F2	24
3.	Galaxy-13	24	3. AMC-15	24	3. 113 West A	24	3. Anik-F1R	24
4.	Galaxy-14	24	4. SES-3	24				
5.	Galaxy-18	24	5. SES-1	24				
6.	Galaxy-23	24	6. SES-2	24				
7.	Galaxy-16	24						
8.	Galaxy-19	24						
9.	Galaxy-3C	24						
10.	Galaxy-17	24						
11.	Galaxy-28	24						
	Subtotal	264		144		60		72

Grand totals:

Satellites	23
TPs	540

Source: ACA Exhibit 3, SES website, Intelsat website, Gunter's Space Page, Kerrisdale analysis
Note: "TP" = transponder.
1. Excludes Galaxy-25 given estimated end of service life next year and limited transponder usage. Galaxy-12 serves as designated in-orbit back-up.
2. Excludes AMC-8 which is beyond planned design life and is used primarily for Alaskan data service.
Data: Kerrisdale

UPLINK: INNOVATION — EVERYWHERE COMMUNICATIONS

A conversation with Patrick Shay, company CEO

EVERYWHERE Communications LLC launched in June of 2018. To learn more about this enterprise, Patrick Shay, the founder and CEO of the company, discussed this new endeavor.

***SM:** For starters, would you please give our readers a quick overview of your company, EVERYWHERE Communications?*

Patrick Shay (PS): EVERYWHERE provides dual-mode satellite and cellular safety, security and productivity services for enterprise and government organizations with people and assets deployed globally, including within the 90 percent not covered by terrestrial wireless networks.

Our solution uses intelligent, least-cost-routing to provide a flexible and powerful solution for situational awareness and visibility.

Our products are based on patented field-proven technology with a 10-year track record in mission-critical applications in challenging environments.

***SM:** Is remote worker safety a big part of your business?*

PS: Yes. EVERYWHERE provides a vital communication lifeline to meet duty-of-care obligations and comply with lone-worker safety laws that are being adopted in many countries. The EVERYWHERE personal communication device has an SOS function that sends an immediate distress message to a designated monitoring and safety center. Importantly, unlike one-way emergency beacon systems, EVERYWHERE provides a two-way connection, enabling the safety authorities to determine the nature of the emergency and respond with appropriate resources.

The small, lightweight personal communication device works in standalone mode or via Bluetooth with the user's smartphone app for two-way messaging and data exchange. It has built-in GPS for mapping, navigation and viewing the movements of other individuals and teams on the network.

***SM**: You're also providing a global IoT solution as well, correct?*

PS: True. We offer a complete end-to-end IoT solution for tracking, monitoring and managing assets everywhere — on land, in the air or on the oceans — using our intuitive web-based asset monitoring platform. Whether it is taking readings from a temperature sensor or a pressure valve, or tracking a fleet of vehicles, we provide secure and reliable uninterrupted connectivity as assets move in and out of cellular coverage. Services include real-time position reporting, geofencing, remote query and configuration of assets. We support our own asset tracking devices as well as third-party devices.

***SM**: What market segments are you targeting?*

PS: Our typical customers include national and local government agencies, international governments and NGOs, disaster relief and recovery agencies, law enforcement and private security, scientific exploration and research, forestry, oil/gas, mining and other organizations with remote operations.

***SM**: Can you give us some practical examples?*

PS: Sure, imagine these three scenarios. You are surveying and inspecting fire trails in a national forest. Your truck hits a rock and runs into a tree, and you sustain a badly broken leg. The nearest help is a ranger station 25 miles away, and you are out of range for cellular signals. You simply press a button on your smartphone and immediately an SOS message is transmitted via satellite to an emergency response center. Within minutes a text message pops up on your screen from the rescue center asking about the nature and severity of your injury. You are reassured that help is on the way.

You are a technician with a major oil company, and you've been assigned to inspect a series of pipeline pumping stations. As you drive to the locations, your movements are tracked and monitored at the operations center. As your route changes from a major highway to a rural road and finally to a dirt-track, you are never out of contact, even though the nearest cellular towers are hundreds of miles away. As you leave the vehicle and hike up into the woods to the pipeline, the built-in GPS in your EVERYWHERE device guides you directly to the desired pump. Your movements and status are monitored at the base, while the vehicle itself is also continuously monitored to ensure it is not stolen while you're on foot.

You are a project manager for an organization that has people and assets all over the world, including locations where cellular connections are fragile, overburdened or nonexistent. From your desk, you can view the location, movement, status and other critical information from people and assets automatically on your screen. As they move from cellular to satellite coverage, the transition is seamless and transparent. At a glance, you can see if a lone worker needs help or a bearing in a construction machine is overheating. With geofencing, you'll get an automatic alarm if the person or asset moves unexpectedly. When you leave the office, the screens and alerts are seamlessly transferred to your mobile device.

***SM:** Would you tell our readers about your background and your management team in the mobile satellite industry?*

PS: I've been in the mobile connectivity business more than 30 years, creating and leading businesses connecting vehicles, assets and people, generating over $1 billion in new revenue. I have been fortunate to work with some brilliant people who have changed the industry as we know it. Together, we launched revolutionary businesses and had fun doing it. Our core leadership team at EVERYWHERE consists of long-time industry professionals, most of whom have more than 30 years of direct industry experience. They have been responsible for creating over $2 billion in connected services with companies that have included Motorola, Netxtel, Verizon, SiriusXM, Iridium, Skybitz and DeLorme.

***SM:** Patrick, who are the company's initial investors?*

PS: Gemini Capital LLC, founded by Dan Colussy, former chairman of Iridium, is the lead investment partner in EVERYWHERE. Dan is, of course, well known in the satellite community as the man who successfully purchased Iridium out of bankruptcy and rebuilt it into a global and profitable business that now serves over a million customers worldwide. We have also secured additional capital from other industry leaders and experts.

***SM:** What is your launch strategy? How soon will you begin making deliveries?*

PS: We can supply products now for initial trials, and we expect to move into full production within the coming months. We are developing a tiered pricing structure with very attractive pricing plans for equipment and airtime.

***SM:** Thank you Patrick. In closing, could you just summarize your value proposition in a nutshell?*

PS: We have an unbeatable combination — a strong team with experience and established relationships in this sector, proven patented technology and a compelling value proposition. Our unique global dual-mode satellite and cellular service with automatic least-cost routing fulfills a critical need in an emerging market with enormous growth potential.

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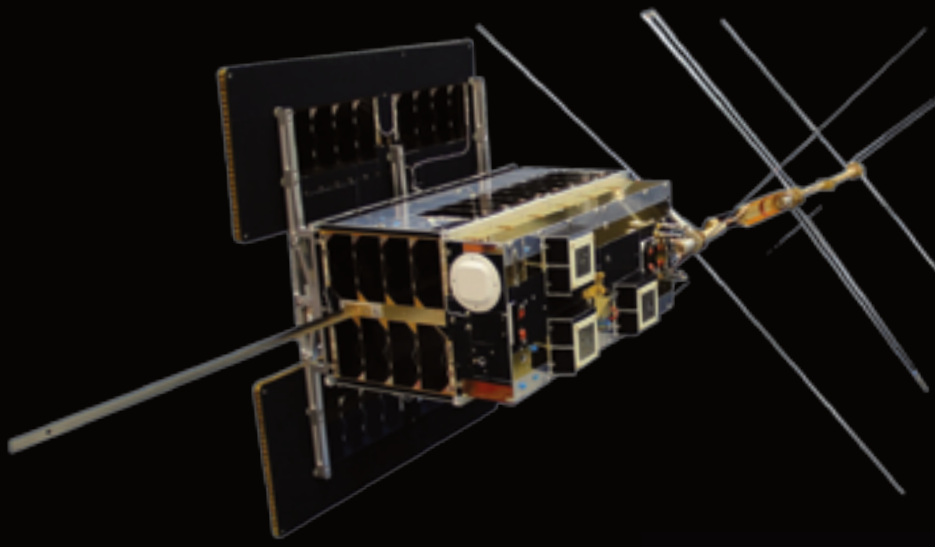

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An area of great concern within SATCOM and MILSATCOM market segments is the constant concern over satellite interference. Innovation is called for in order to negate such problematic challenges for, when encountered, interference impedes crucial communications. Many firms have initiated development of product to offset interference — and one such firm is Glowlink, based in Los Altos, California.

Headed up by founder Jeff Chu, the company provides a variety of system solutions as well as geolocation support that assists users in determining exactly where an interference emitter is located. These services encompass initiating studies to determine the best interference mitigation technique and technology, to an exacting analysis of signal environment to running geolocation as a complete service.

The company's innovative technology is their advanced and patented CSIR™ (Communications Signal Interference Removal) — this technology separates interference from a communications signal before the former ever reaches the receiver — plus, the company licenses the CSIR™ core technology.

According to Jeff, innovation is Glowlink's key to staying ahead of the constantly evolving interference problem.

He said, "*For example, as 5G spreads worldwide, spectrum sharing between the telecom giants and satellite operators is predictably creating interference. Compounding the problem is the bring-up of the meshed LEO satellite-side networks, which will undoubtedly cause the same type of interference for satellite ground stations. Even with planning perfect to the 99 percent, we will need to innovate to solve the 1 percent problem — in our industry, we've learned that 1 percent is the difference between mission success and mission failure.*

"*In the realm of intentional interference, we face ever-changing adversaries. The interference techniques used by our adversaries tomorrow include those of yesterday and whatever schemes they think of today. To stay ahead, we anticipate their developments and iterate on our effective techniques while exploring new algorithmic approaches.*"

As far as innovative projects that the company has underway, Jeff said, "*We are rolling out products and technologies aimed directly at the growing 5G/LTE terrestrial interference problem mentioned above, as well as expanding our GS380 line of mature, high performance interference mitigation products, such as the GS380X, to include things like a wide-band version that is capable of protecting an entire transponder's bandwidth while also delivering next-generation interference mitigation capabilities. We're already getting positive feedback from our users in the field and are looking forward to full-scale deployment of these capabilities. This is an exciting time for the company.*"

The Interference Removal System (GS380X) referred to by Jeff directly addresses noise and interference in a digitally-modulated communications carrier using Glowlink's streaming technology.

Armed with only the most basic information about the primary carrier (center frequency, bandwidth), the GS380X removes — at the digital signal processing level — the signal portion that is not a part of the carrier.

Inserted just prior to the receiver, the GS380X effectively removes all interference, regardless of the type of interference (hopping, burst, modulated, unmodulated, and so on), from the carrier, and restores the carrier to a pristine state that can easily be demodulated despite the ongoing presence of persistent, changing and overwhelming interference on the same frequency.

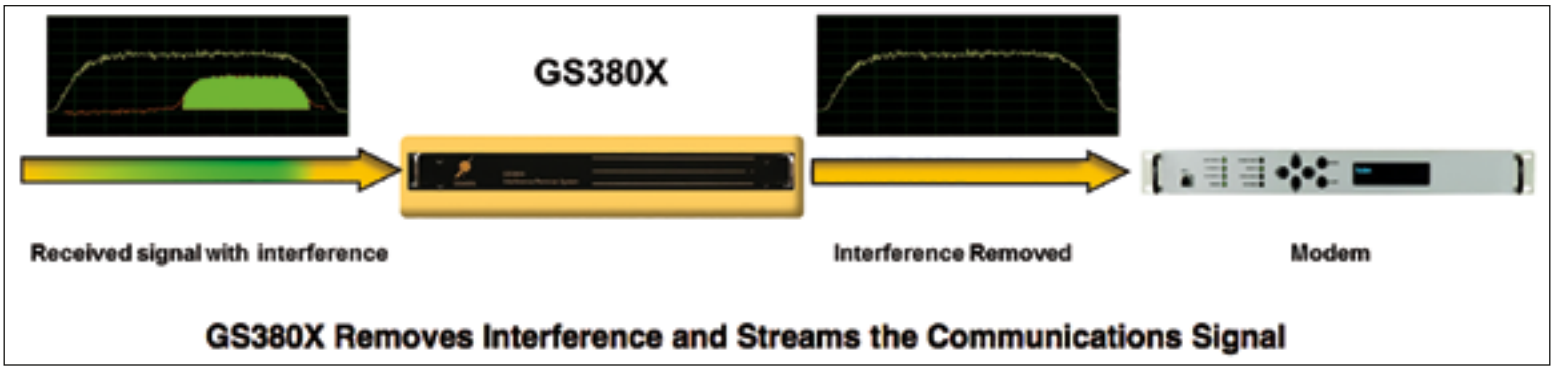
GS380X benefits include the ability to remove interference that changes in strength and characteristics over time, requires no information about the interference to be removed, initiates real-time streaming removal, is plug-and-play with existing comms infrastructure and no changes are required, and offers single chassis construction for ease of transport, maintenance and logistical support.

When asked about the innovative technologies that will drive the space and satellite industry in the next year or so, he said, "*As cheesy of an answer as this may be, I believe that the bring-up of LEOs will, for better or worse, drive innovation. Of course, we'll always have the problem of growing bandwidth demands, but LEOs introduce a paradigm shift in the types of problems that we'll have to engineer around. I'll let others debate whether LEO will be a market success or failure — for me, it carries significance in that it puts a high-wattage spotlight on a whole host of problems central to satellite communications, at any orbit. These are problems that I'm excited to solve with the rest of our community and, particularly, our engineers at Glowlink.*"

Other areas of Glowlink participation include the analysis of a firm's network management requirements in order to recommend solutions to manage SATCOM operations through overall system acquisition and the reduction of operation and maintenance costs.

Additional areas of operation for Glowlink include a variety of maintenance plans, operations and maintenance support, consulting services and demonstrations, comprehensive training courses, system installation and more.

www.glowlink.com



GS380X Removes Interference and Streams the Communications Signal

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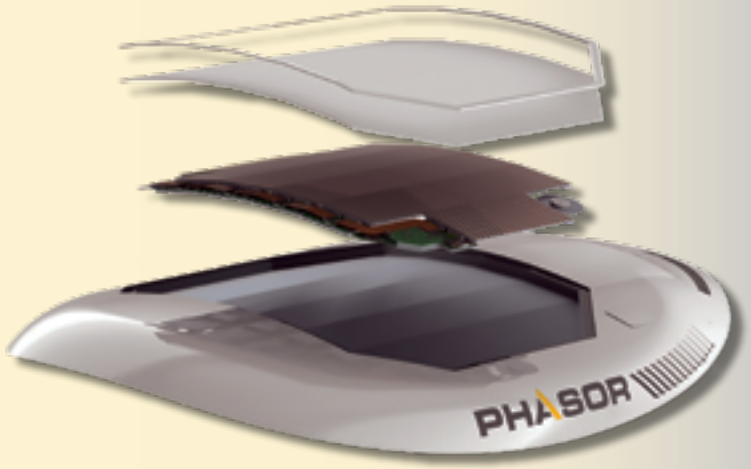
Uplink: Innovation — Phasor

A new era in connectivity

By JP Szczepanik, Chief Technical Officer



A new era in mobility and communications is now being entered — an era that is exciting and challenging and one that has the potential to take connectivity to a entirely new level of access and use.

These changes have been brought about by the rising need for ubiquitous mobile communications, often at broadband speeds. The smartphone, and other mobile devices, have completely transformed the way and "the where" in which we communicate, work and entertain ourselves.

Users are 'always-on', always contactable. Connectivity expectations have completely changed. All wish to use devices everywhere — on a train, on an aircraft or while at sea. However, making this happen is extremely complex and has prompted a revolution within the satellite communications (SATCOM) industry, which is the definitive provider of "connectivity everywhere."

Where GEO satellites were previously the staple for global-reach communications, the global need for data and broadband connectivity is giving rise to the development of High Throughput Satellites (HTS) and also constellations of much smaller satellites in Low Earth Orbit (LEO) and Medium Earth Orbit (MEO); these are all dramatically reducing latency and cost. This is new territory for the SATCOM sector and is pushing the development of next generation access technology and antennas ever faster in order to deliver these new capabilities.

Washington DC and London-based Phasor is a developer of commercial phased array antenna systems, designed to meet the growing wideband mobile broadband market requirements. The company has been working on this system for more than five years and the company is preparing to introduce this technology to the market in the very near future.

The development of the Phasor electronically steered antenna (ESA) has been a study in making the complex simple, and targeting a specific user community — commercial and enterprise mobile broadband market requirements. The team has been tightly focused on the main challenges of enterprise-grade, end-to-end system performance; bringing together a wide range of technical and design disciplines.

Phasor has taken the traditional, parabolic SATCOM antenna and transformed that antenna into a flat, solid-state, electronically steerable antenna (ESA) system that stands just two inches high in comparison to its bulky predecessors. The ESA can be completely flat or conformal to a vehicle due to the unit's modular design, including installation on an aircraft fuselage, a cruise ship or a high-speed train, providing enterprise grade mobile connectivity to passengers and crews alike.

This same technology is well suited to support three different satellite constellation architectures — traditional Geosynchronous Fixed Satellite networks (FSS), High Throughput Satellites (HTS), and Non-Geosynchronous satellite networks, (NGSOs). Moreover, the antenna's modular architecture allows the system to be scaled to virtually any use-case requirement, fixed or mobile. This is the ultimate design for flexibility, yet the ESA also delivers consistently high data rates that support the demanding, bandwidth-hungry applications that are so important to users today.

How Does It Work?

Phasor's system allows users to communicate with satellites anywhere in the sky while on the move using a low profile, solid-state, electronically steered antenna. Phased arrays are active antennas comprised of an interconnected series of very small patch antennas, combined in such a way to extract a specific satellite signal from a noisy background. By controlling in sympathy the signal delay (or phase) and power levels of each of these tiny antennas, the combined signal can be steered in any direction.

Phasor's system is unique — proprietary microchips (or ASICs) control each of these tiny patch antennas — this unique system architecture can combine signals more efficiently and effectively to maximize gain. A dynamic, software-controlled antenna is created that can quickly and robustly track any satellite through a closed-loop feedback algorithm.

How Is It Manufactured?

Phasor's antennas are comprised of a number of standard PCB assemblies. That means that Phasor is able to leverage the industry standard PCB fabrication and assembly lines that are used for mobile phones, IT or cellular base-station equipment, for example. Therefore, production can be ramped-up quite easily to scale (through manufacturing partners), which enables production of the antennas in a matter of weeks.

How Does The Antenna Track Two Satellites Simultaneously?

Phasor's architecture allows for two independent "circuits" that use the same RF aperture area (through the same dual-channel ASICs). The control systems are then able to independently steer these two beams in different directions. These beams are fully independent in frequency, polarization and pointing angle and can be fed to the same, or separate, modems.

This flexibility allows for a entire host of unique benefits; be it interoperability with GEO/MEO/LEO or make-before-break on HTS or LEO constellations.

How Does The System Deliver Consistently High Data Rates?

The final, delivered data-rates are determined by a number of factors and the antenna is in control of an important, but finite, number of these elements. Phasor is highly efficient in processing and combining satellite RF signals, which delivers high fidelity in pointing and tracking accuracy as well as high gain (throughput) capability.

Beyond the ESA electronics, a fundamental driver of data-rate is the effective size of the antenna aperture — it is pure physics that a larger antenna area can deliver proportionally more data. Phasor's scalable modular technology allows it to create a range of different sizes, and uniquely, many modules can be tiled together to create some of the largest flat panel antennas in the industry.

The other important role of the antenna is to robustly track the satellite no matter where, or how fast, the mounted vehicle (or the satellite itself) moves. This consistent tracking results in a reliable data connection. Phasor is able to accomplish feat nearly instantaneously due to closed-loop feedback and fully electronic steering (therefore, no inertia). The antenna does not have to rely on GPS or inertial based sensors or any form of conical scanning/feedback from the Rx signal levels that can be very slow and introduce loss.

Is There A Ka-Band Iteration Of The System?

Phasor is currently focused on delivering products that operate in the Ku-band. However, there are growing demands for a Ka-band solution from Phasor. The good news is that a vast majority of the system is identical between a Ku- or Ka- solution. Due to Phasor's baseband architecture, the translation to a Ka-band solution can be carried out with minimal risk... effectively a new ASIC tuned to the Ka-band frequency.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Phasor is working with a number of partners to kick-start Ka-band development toward the second half of this year and the firm is slated to offer its first Ka- products in approximately 24 months. Currently, Phasor is working on land mobile and maritime data tests — these tests are expected to last several months with the company's first release products.

What Happens On The Ground Is Critical

There has been a significant shift in focus from the satellite, or "space-segment," to the ground segment, as there has been a realization that this is what will enable next generation satellite connectivity. ESAs, such as Phasor's, will be the crucial mode of access technology for future communications and the entire satellite communications and broadband mobility industry is dedicating more time to ground infrastructure, discovering how it will enable next generation satellite networks to work as efficiently as possible.

Phasor has been creative with its design and development of an incredibly compact, low profile, automatic-acquire and tracking ESA , focused on enterprise and commercial markets, where the requirement for "mission critical comms," for very high gain, very high-quality networks is prevalent.

Phasor will carefully complete the test phase and looks forward to the first product release that will enable cruise ships, yachts, buses, airlines government programs, and many more big users of data, to access the bandwidth they require in this new era of connectivity.

Company CEO, ***David Helfgott***, believes, "*The New Space economy is dependent upon innovation — new and creative technologies, new business models, and new kinds of alliances between traditional and nontraditional players.*

"The move to satellite-based wideband/broadband mobility, (GEO HTS or NGSO), is a response to the expanding "connected everywhere" needs of consumers and business travelers alike. Whether that means passengers uploading videos on a cruise while at sea, or receiving files while inflight ahead of an important meeting, or sending operational data and telematics information from a high-speed train… all of this activity requires unique and creative innovation to deliver on the promise of broadband mobility."

Phasor is headquartered in Washington DC, with a technology development subsidiary in London. Phasor's electronically steerable antennas (ESAs) are based on patented innovations in dynamic beam forming technologies and system architecture. Phasor's mission is to enable high-speed broadband communications while in-flight, at sea or traveling over land.

Any surface can be the base for a built-in antenna, thanks to the ESA's very low profile and conformational capabilities. For multiple use cases and markets, those multi-megabit demands for connectivity can be met, as the Phasor antenna can cover the required area without drag, weight or visual impact.

Just recently, Phil Spector joined the firm's Board of Directors, bringing his 30 years of experience in the satellite sector to Phasor. David Helfgoff said the company is delighted to welcome Mr. Spector to the board and his experience and leadership in the various strategic, regulatory and business aspects of SATCOM will be invaluable.

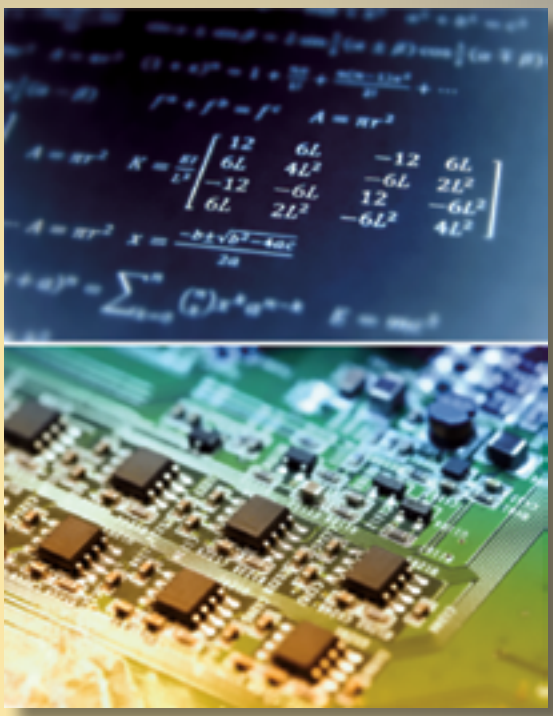
Additionally, Phasor has also recently signed a commercial partnership with Astronics AeroSat, with the two companies engaged in producing a scalable, dual-beam, ESA-based, aeronautical terminal. With the Phasor two-inch high, lightweight and electronically-steerable ESA conforming to the size and shape of an aircraft fuselage, drag-weight will be reduced and bandwidth will be optimized for improved inflight connectivity (IFC).

Astronics Aerosat will meld the Phasor technology into an agile aviation antenna that will operate seamlessly with GEO and non-GEO satellites, such as LEO and MEO constellations currently in development.

Helfgott stated that this agreement will find the companies delivering next-generation flight connectivity across multiple airframe types and SATCOM networks, with ***Matthew Harrah***, the president of Astronics Aerosat, adding the company is working toward certification and commercialization of the dual-beam SATCOM terminal/OAF (Outside Aircraft Equipment).

www.phasorsolutions.com and ***www.astronics.com***

The "Workings"

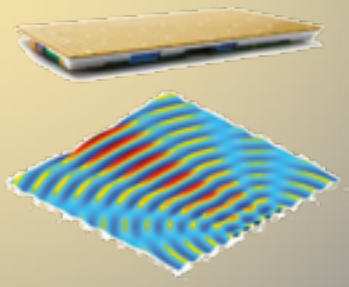


Phased Arrays work by creating this pointing, or beam-steering, from an array of tiny fixed antennas. By electronically changing the relative phase for the signal that each element transmits, the (constructive and destructive) combination of all of these small signals creates a larger focused beam in a particular direction.

As this process is fully electronic, the resulting beam direction can be controlled and directed instantaneously in any direction. It can, therefore, track the movement of any satellite in the sky, no matter how or where you move, without the need for any mechanical moving parts.

The principal and application of Phased Arrays have been around for decades and is well understood. The challenge has been to miniaturize the technology and improve the performance while reducing the manufacturing cost to an economical price point.

Phasor's innovation allows satellite signals to be extracted from very noisy background signals using a large number of ASICs, each directly connected to a small patch antenna. The embedded microprocessors are able to dynamically control the signal phases of each element to combine and steer the transmit (or receive) beams in any direction.



Phasor's antenna systems are compact and have no moving parts. They are manufactured to withstand the vibration and thermal environment on trains, aircraft, land vehicles and ships. The lack of any moving parts means they are robust to harsh environments and can withstand failures or damage without the loss of service through built-in redundancy.

InfoBeam

SSL is Psyche'd out

SSL, a Maxar Technologies company (formerly MacDonald, Dettwiler and Associates Ltd.) (NYSE: MAXR; TSX: MAXR), has been selected by Zin Technologies to build and test the Psyche Compute Element.

This critical flight system component was designed by NASA's Jet Propulsion Laboratory for Psyche, a NASA Discovery Mission, that will investigate a metal asteroid that is expected to offer insight into how our planet formed. The award builds upon a long standing and trusted relationship with NASA and further demonstrates SSL's successful track record of leveraging advanced capabilities for ground-breaking government missions in space exploration and science.

As the main on-board computer, the Psyche Compute Element acts as the brain of the spacecraft, functioning as the coordinating center for command and data handling activity. As previously announced, SSL is working together with Arizona State University's School of Earth and Space Exploration and NASA's Jet Propulsion Laboratory in the first mission to explore what is believed to be an asteroid made of metal rather than rock or ice.

Artistic rendition of the SSL-built Psyche spacecraft is courtesy of Peter Rubin/Caltech-JPL

In addition to the Psyche Compute Element, SSL is providing a high power solar electric propulsion spacecraft chassis based on the SSL 1300 satellite platform. Using SSL's standard commercial spacecraft design helps NASA reduce cost and ensure reliability for this mission to the asteroid belt, which lies between Mars and Jupiter.

Scheduled to launch in 2022, the Psyche mission was selected over four other NASA Discovery Mission candidates. The spacecraft recently completed a comprehensive NASA mission systems review and is on track to meet its next development milestone, called the Preliminary Design Review.

Richard White, the President of SSL Government Systems, said that the company is proud to be playing a major role in NASA's Psyche mission, which will deepen humanity's knowledge of the solar system and accelerate innovation for future exploration missions. The spacecraft's design has been proven on more than 100 missions and leverages SSL's extensive experience in solar electric propulsion, which dates back to 2004. With 87 spacecraft currently on orbit today, SSL is a trusted partner for the most ambitious missions being undertaken in the new space economy.

For more information, visit ***www.nasa.gov/psyche and psyche.asu.edu/.***

Uplink: Innovation — Cloud Constellation

Altering the cybersecurity landscape

By Dennis R. Gatens, Chief Commercial Officer

The new space economy presents an opportunity for game-changing innovation through the evolution of satellite capabilities, from communications and transmission platforms to those with cloud service capabilities such as storage and computer resources.

Due to space commercialization pioneers such as Virgin Orbit, Blue Origin, SpaceX and Nanoracks, along with NASA's strategic initiative for space commercialization, we are witnessing the emergence of a quickly evolving marketplace in space. Low Earth Orbit (LEO), specifically. The result is the emergence of a highly competitive landscape for satellite manufacturing, integration and launch services that has driven the costs down. This emerging marketplace is fostering innovation that will transform the way services will be delivered, in ways not conceivable five years ago.

However, affecting both incumbents and new players, there will ultimately be commoditization and a process of natural selection as the market matures. Therefore, innovation and differentiation that result in higher value and disruptive services for enterprise customers and end-users will determine the winners.

One area of innovation is the intersection of commercial space, cloud services and cybersecurity risk mitigation for a range of applications and services. A company working to establish this intersection is Cloud Constellation Corporation, which is developing a solution that is a combination of secure data storage in space with a secure global managed network service that does not traverse terrestrial networks.

LEO enables the ultimate air gap network security strategy by isolating company and end-users' data, whether it is at rest or in motion, from vulnerable terrestrial networks and the inevitable data breach. This is a significant advantage for the protection of data and is now economically viable.

Cloud Constellation's SpaceBelt™ Data Security as a Service (DSaaS) is a patented, scalable, space-based cloud service for securing high-value and highly sensitive data assets. SpaceBelt services are a paradigm shift in data security that greatly mitigates the risk of a data breach by providing global isolation of a customer's data from inherently vulnerable Earth-bound networks.

- *A constellation of eight satellites in LEO is networked with a redundant, self-healing optical ring for high availability*
- *The SpaceBelt network communicates with secure access points located at enterprise, government and military facilities via connectivity with geosynchronous satellites (GEO)*
- *Individual cloud storage satellites and constellations can be offered to address an organization's storage and/or sovereignty requirements.*

Data breaches are numerous and well documented and have had a significant impact on the affected company's brand equity, leading to bankruptcy in some cases. CISOs are constantly looking for solutions to incorporate into their cybersecurity strategies to stay ahead of the hacker innovation curve.

Cryptocurrencies have experienced numerous, devastating hacks.

For example, cryptocurrencies, a market in its relative infancy, has been significantly impacted by numerous large-scale hacks.

The evolving cybersecurity threat is an unsolvable problem, but it can be greatly mitigated through innovative solutions. And while insurance policies can address a company's liability, they do not repair the harm and loss to a brand's equity, which can sometimes be irreparable.

There are organizations seeking to provide businesses with game-changing and innovative solutions for their cybersecurity strategies that leverage the new space economy and services such as SpaceBelt DSaaS.

SpaceChain is one of them (***www.spacechain.com***). SpaceChain is pursuing an innovative approach that will leverage the advantages of a space-based cloud infrastructure by developing decentralized blockchain applications to be developed and hosted in space.

Just as Linux was a game changer, their SpaceChain OS open source operating system will provide developers with a "blockchain sandbox" to develop, test and deploy decentralized applications, avoiding the cyber vulnerabilities of terrestrial networks. The anticipated community of application developers will ultimately facilitate a robust and secure blockchain-based ecommerce in space.

Working with Cloud Constellation Corporation, SpaceChain and their community of developers can use SpaceBelt services and hosting capabilities for development and deployment of their blockchain applications.

Another company, TokenEx (***www.tokenex.com***), is planning to leverage the benefits of spaced-based cloud services as part of their services portfolio. TokenEx and Cloud Constellation Corporation are jointly designing a space-based data security solution that layers tokenization, secure storage and secure global network services for protecting customer's sensitive data.

The combination of TokenEx's Data Protection Platform and SpaceBelt's Data Security as a Service will enable organizations to secure the sensitive data in space, isolated from terrestrial network vulnerabilities while storing only tokens in their terrestrial systems.

Thirdly, Wasabi (***www.wasabi.com***), a high-performance cloud data storage company and Cloud Constellation Corporation will offer a combined service that will enable enterprise customers to take advantage of Wasabi's high-performance, low-cost data storage. And, where the highest level of cybersecurity risk mitigation is required, SpaceBelt provides the security necessary to protect customers' highly valuable data assets.

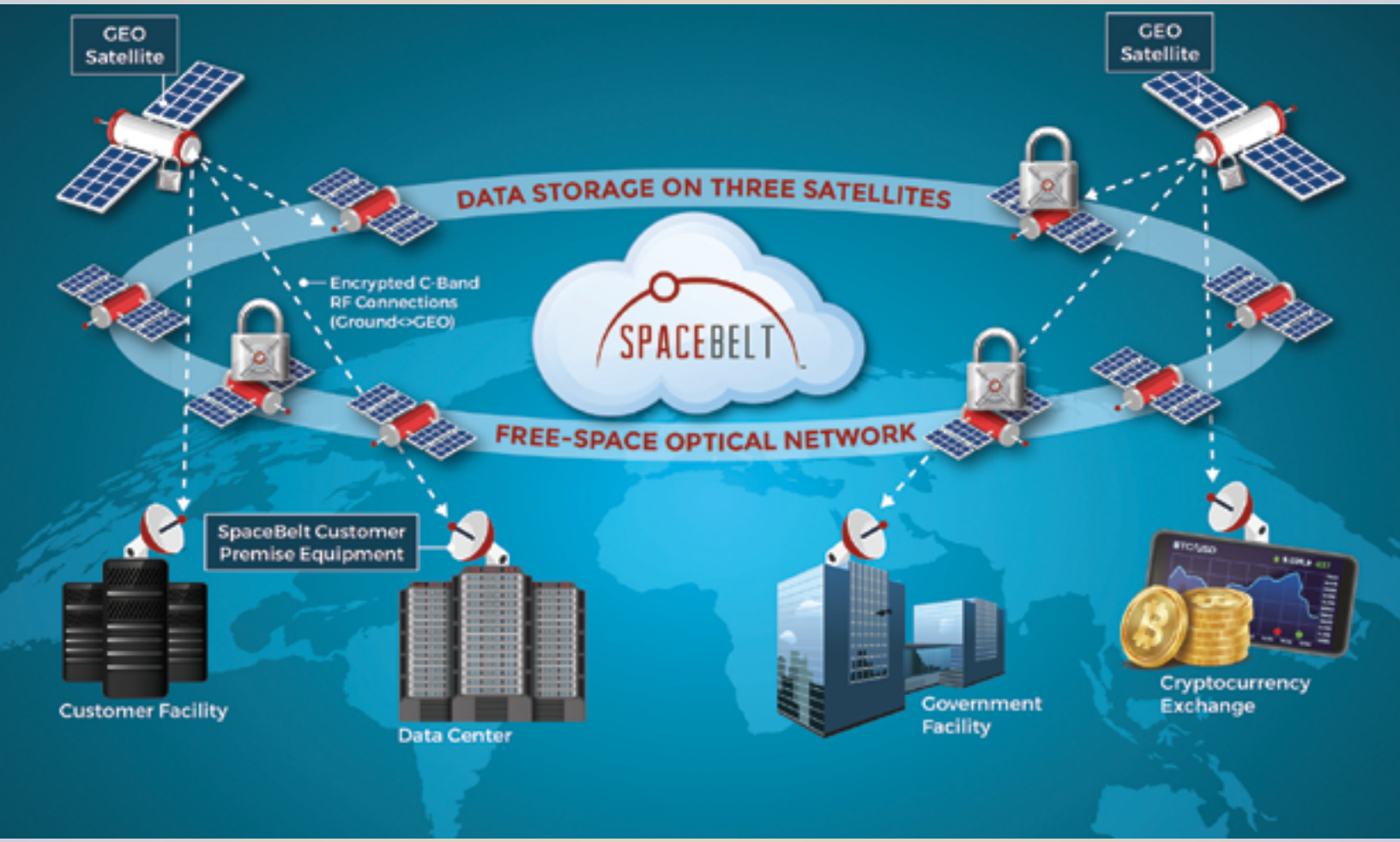
Cryptocurrency exchange operators also recognize the advantages of a space-based infrastructure for secure cold wallet storage requirements, providing a highly secure and globally accessible depository. Coin owners lose their entire investment instantly if their keys are stolen. Having a secure cold wallet storage capability, isolated from the vulnerable internet, is essential to the success of cryptocurrency exchanges.

Where will the new space economy be in five or ten years? Impossible to predict. However, the emerging intersection of the economics, the advantages and the opportunity for innovation are clear indicators that space-based services will be commonplace, and the security of a globally wireless communications and services infrastructure is a real possibility. To learn more, contact Dennis R. Gatens at ***dgatens@spacebelt.com***.

www.spacebelt.com

Dennis R. Gatens joined Cloud Constellation Corporation in 2017. He spent the previous six years as the SVP & GM of OneAccess Networks, NA. Gatens obtained his electrical engineering degree from Virginia Tech in Blacksburg, Virginia, and his MBA from Radford University.

After 12 years as an engineer, engineering manager and product manager at FiberCom developing fiber-based network solutions, he went on to join Carrier Access Corp. as Director of Product Management, then VP & GM of the Converged Access Business Unit.



Uplink: Innovation — Goonhilly Earth Station

Foundations for commercial lunar economy — and Mars

Selling bottled water in space may seem like a giant leap for mankind. However, the news that Surrey Satellite Technology Ltd. (SSTL), Goonhilly Earth Station and Astrobotic have joined forces to design the sophisticated infrastructure required to support a new era of private and public sector lunar endeavors brings this idea into closer orbit.

Almost 50 years after Neil Armstrong and Buzz Aldrin made history by walking on the Moon, the lunar landscape beckons once more — this time as a destination for prospecting and exploration — and, ultimately, as a stepping stone to Mars.

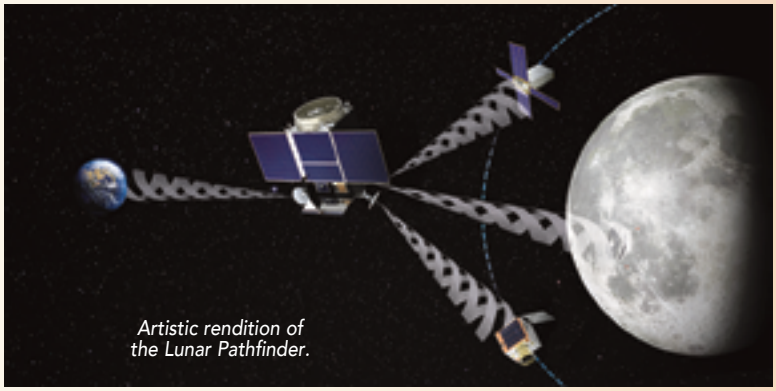
This landmark collaboration sets out a common goal for deploying in-space communication relay services that reach particularly challenging destinations on the Moon, including the far side. These three organizations have a long history of working together, so formalizing the relationship was a natural next step.

According to ***Matthew Cosby***, Chief Scientist at Goonhilly, "*Making every part of the Moon accessible to businesses and universities as well as space agencies and governments is now within touching distance. Working together with Astrobotic and SSTL, our mission is to make space exploration and commerce affordable to any organization with a payload and a vision. Much like the pioneers who laid the first telegraph lines during the California Gold Rush, together we plan to lay the foundations for a thriving commercial lunar economy.*"

Matthew Cosby, Chief Scientist, Goonhilly.

Planetary Partnerships

Partnerships are essential as the industry blasts off toward a new space economy. This particular collaboration comes hot on the heels of the news that Goonhilly has joined forces with SSTL and the European Space Agency (ESA) on the commercial partnerships for space exploration project, Lunar Pathfinder (***buzzstore1.blob.core.windows.net/media/goonhilly/pdf/Flight_Opportunity_Feb_18_II.pdf***). The aim is to develop a European lunar telecommunications and navigation infrastructure, including the delivery of payloads (***http://www.goonhilly.org/lunar***) and cubesat nano-satellites into lunar orbit.

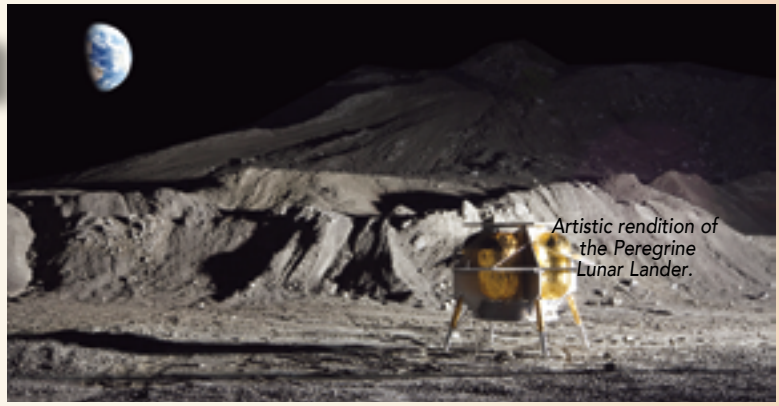


Artistic rendition of the Lunar Pathfinder.

The work being undertaken by Astrobotic, Goonhilly and SSTL provides a perfect pathway to the Lunar Pathfinder project, with the opportunity to gain early flight operations experience and deliver communications and command capabilities to areas of the Moon that were previously considered impenetrable.

A New Frontier

Planning for the first joint Astrobotic/Goonhilly/SSTL mission is already well under way. Flying payloads to the surface of the Moon will be the preserve of lunar logistics company Astrobotic. With plans to deliver a regular manifest of uncrewed payload flights to the Moon from 2020 on its Peregrine Lunar Lander, the firm is actively signing up customers.



Artistic rendition of the Peregrine Lunar Lander.

Photo of the Goonhilly Earth Station and the company's CEO, Ian Jones.

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Rendezvous with the Future

Ariane 5 will deliver Galileo, BepiColombo, and the James Webb Space Telescope, helping humanity to find its way, explore new worlds, and understand the universe.

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Service affordability is key. "*By accommodating multiple customers on a single flight, we can offer unprecedented flexibility at an industry-defining low price. This will open up the market and lay the groundwork for a new space economy — one in which private companies can thrive*," said ***John Thornton***, the CEO of Astrobotic.

Small satellite vendor, and spaceflight pioneer, SSTL is building the first relay spacecraft, and subsequent fleet, that will be launched into lunar orbit to deliver essential data relay services. "*Our relay spacecraft will enhance Astrobotic's offering by making it possible to communicate with parts of the Moon where line of sight from the Earth is limited at certain parts of the lunar day, as well as the far side. Our collaboration with Goonhilly on the design of the mission began about two years ago and we are on target to launch by 2023*," said ***Anita Bernie***, director of exploration missions at SSTL.

Goonhilly's remit is to deliver the communications services for customers. Cosby explained, "*Astrobotic's initial landings from 2020 onwards are likely to be on parts of the Moon where we have a direct line of sight from our ground stations around the world. The missions will venture further afield from 2023 when the relay spacecraft is ready. The spacecraft will be capable of sending and receiving data between customers' assets located in harder to reach areas of the Moon such as the south pole and the far side, and our ground stations. This opens up a galaxy of new opportunities.*"

Readying for Blast Off

The explosion in commercial discussions and endeavors being undertaken by private firms such as Space X and Blue Origin seem to be encouraging national governments to rediscover the value of the Moon as a destination in its own right, and also as a staging post to Mars. This might help explain why the trio's first customers are expected to be institutions such as space agencies and universities — seed-funded by governments — and looking to research the Moon's natural resources. But there are other organizations keen to stamp their mark on the lunar landscape too, most notably those in the deep space and planetary resources sectors.

"*Finding ways of harvesting water from the Moon is a research priority. Being able to produce bottled lunar drinking water would transform our ability to sustain humans in space, while splitting water into oxygen and hydrogen would make it possible to refuel in space, transforming space travel and slashing launch costs*," explained Cosby.

"*The possibilities are many and diverse*," added Bernie, "*asteroid mining, mineral extraction, Moon exploration and power generation are just some of the other opportunities being mooted.*"

"***Cracking the water and fuel challenges on the Moon will also make missions to Mars and beyond more financially viable***," Thornton pointed out.

Profiting from Space

To date, any P&L discussions in relation to space travel have unsurprisingly focused firmly on minimizing losses. However, we are nearing an inflection point where we can realistically consider the other side of the equation for the first time — making profits.

Cosby explained, "*Once the communication, navigation and transportation challenges are resolved, there will be a sustainable lunar ecosystem available for commercial entities to exploit. For example, just as Earth navigation data is now offered by commercial companies — something unthinkable 20 years ago — we see a similar pattern emerging in the lunar economy.*"

Reaching for the Stars

Coming back down to Earth, it's clear there is a strong appetite for a viable space economy that is accessible to many, not just a select few.

Cosby summed up, "*As Captain Jean-Luc Picard once said, 'Things are only impossible until they're not.' We're entering an exciting and important era in which any organization that wants to build a business in space can hitch a ride on one of our missions and send a payload to the Moon. An era which will see commercial lunar endeavors becoming the norm. Captain Picard would surely approve.*"

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Uplink: Innovation — ViaLite

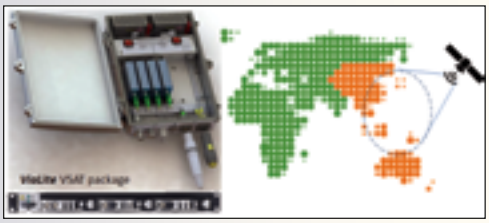
Miniaturization is cool...

By Richard Jacklin, Director

Being born in the 1960's, I've always felt miniaturization is cool. That feeling hasn't always been shared by my three lovely daughters, taking them round a model village on a nice summer's day looking at the amazing miniature railway junction box. Or, closer to their interest, marveling at how many thousands of milliamps per hour they can now squeeze into a smartphone. They just don't get it and look at me like I'm some boggle eyed alien*.

I've also felt that the satellite communications (SATCOM) industry has always been cool, as well; and the demand for miniaturization has pushed a new wave of innovation, particularly in relation to the latest ambitious plans to launch thousands of Low Earth Orbit (LEO) satellites that range in size from the small through to the micro and nanosatellite. This makes total sense — smaller, lighter satellites cost considerably less to launch and maintain in active flight-mode.

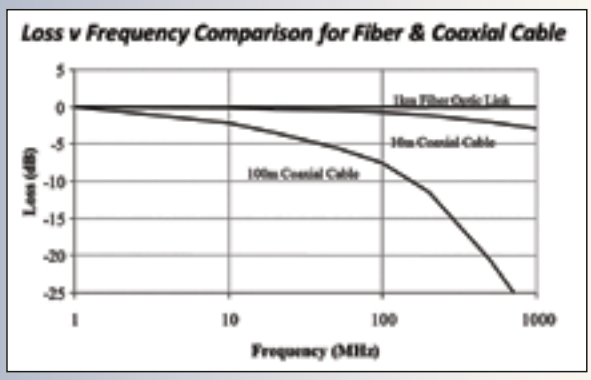
Similarly, on the ground side of the satellite business, miniaturization is a key innovation enabler. Consumer terminals have been dramatically reduced in size — a good example being GPS / GNSS navigation receivers which are now ubiquitous in many handheld and small devices, such as my daughters' smartphones!



The ViaLite VSAT package.

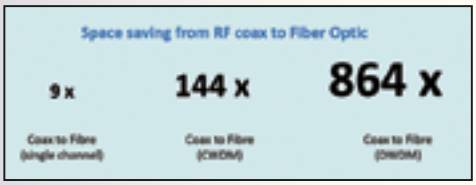
My company develops and manufactures a product which is based on RF-over-Fiber technology, also a ground based application. The RF-over-Fiber technology, in basic terms, is a clever RF coax replacement solution but offers many more additional benefits.

The benefits include: extremely low loss compared to RF coax, inherent immunity to EMI, very wide frequency bandwidth (GHz's), electrical isolation including lightning. These dividends make RF ideal for application into the SATCOM industry, particularly where control stations are connected to a local antenna farm (within one kilometer) or at a diverse remote location, which could be tens or even hundreds of kilometers away. Most teleport operators have moved to this technology for all RF links over 80 meters in length (approximate) or have high throughput-high bandwidth link requirements.



Looking at the miniaturization theme specifically, if a simple fiber optic patch cable is compared to a high frequency coax cable, the fiber optic cable is as much as nine times the cross-sectional area smaller than the coax. Already, savings have been made in space and weight; however, there are more tricks up the RF-over-Fiber sleeve.

RF-over-Fiber can also employ multiplexing technology by using different light colors down the same fiber. The multiplexed channels have high isolation and can be bi-directional. This reduces fiber needs (and leasing costs, if this is long distance) and delivers huge savings on space and weight.



In the ViaLite RF-over-Fiber range, the CWDM products support as many as 16 multiplexed channels and the DWDM product supports up to 96 multiplexed channels. The space saving ratio from a fiber optic patch cable to a high frequency coax cable in cross sectional area goes to 144x for CWDM and 864x for a fully populated DWDM link**.

Another trend in the SATCOM industry has been the move to higher frequency communications, from L- to C- to Ku- and Ka-bands. The trend is to make the antenna dishes physically smaller. Very Small Aperture Terminals (VSAT) typically use dishes less than 4 meters in diameter and are in widespread use today where space is often limited, such as in maritime and mobile transport environments. Many of the new LEO satellite systems, *e.g.*, OneWeb, SpaceX or LeoSat, use Ku- or Ka-bands and need smaller (tracking) or VSAT-type antenna.

ViaLite has also been tracking this move in the market place and has responded with new turnkey solutions that are more appropriate to this application. While the company continues to supply "traditional" 3U, 19 inch rack systems for the larger teleports or broadcast TV gateways, for smaller or temporary deployments, new form factors and outside enclosures have been required.

Particularly in dense urban cities in Asia, VSAT connection packages become a real necessity, often to connect antenna on extremely tall buildings to lower level floors — or even basements. An RF-over-Fiber VSAT package would typically be comprised of an outdoor unit to convert the RF signals near the dish (and provide power for BUC / Downlink converters) and an indoor unit to convert optical back into RF closer to the modem.

The ViaLite VSAT package is made up of the outdoor unit — the ODE-A4, which contains up to 4 channels and LNB powering options, and a slim-line 1U indoor unit, which again handles up to 4 channels with additional options that include dual redundant power supplies, alarms, SNMP, and so on. The complete ODE-A4 and 1U solution packs a lot of features into a small volume, making it appropriate for smaller satellite dish installations.

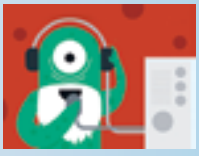
For even smaller or temporary mobile installation — that are popular in the TV and media broadcast industry — the ViaLite Blue2 RF-over-Fiber link was developed as a dual-link solution which can be set up as a dual transmitter (*e.g.*, two downlinks from a dish), dual receivers or a transceiver (transmit and receive). It comes in a small form factor enclosure that is just 350 cubic centimeters. The maximum power used is also 4 watts, so the unit is able to be convention-cooled and does not need ventilation slots or fan assisted cooling. This makes the Blue2 ideal for small or mobile deployment and the product can easily be integrated into another enclosure or as a "throw-down" box. As a complete solution, the Blue2 units can be used in pairs or used in combination with the other ViaLite products.

Finally, coming back to my earlier comments about miniaturization and the younger members of Generation Z (internet users from the early years), while attending conferences and exhibitions this year, I was actually pleasantly impressed with how many universities and graduate teams are developing their own smallsat projects — tiny, almost handheld, satellites weigh somewhere between 1 and 10 kg. Yes, yet another step change in miniaturization that is promoting further innovation in the radio link, in the sky and the ground. Great news for the future and more interesting work to do for ViaLite.

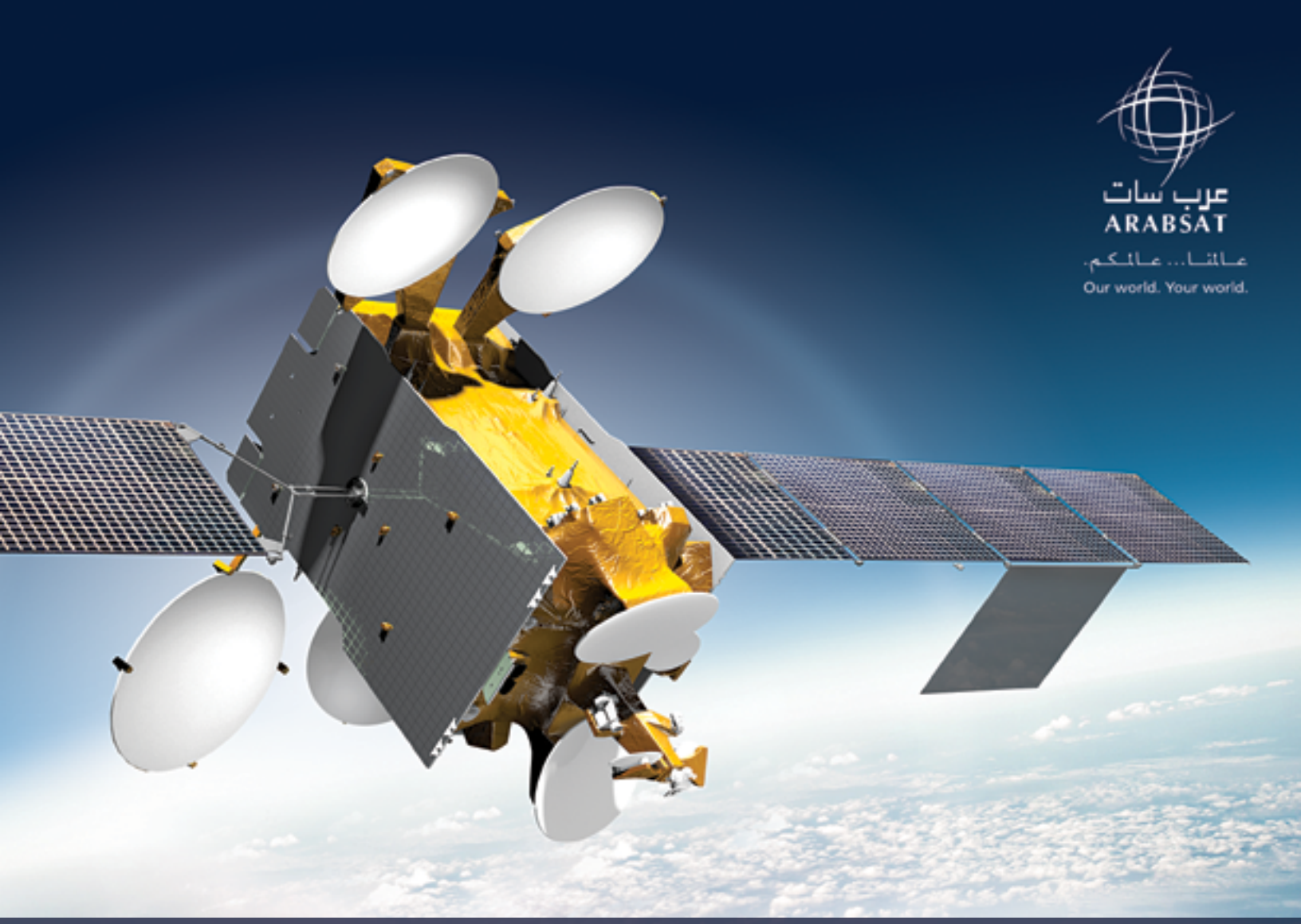
www.vialite.com/

** At ViaLite, we like aliens so much we have our one called Barry; he helps our customers get the most out of RF-over Fiber technology*

*** Based on 2.8 mm diameter Fiber Optic cable and 8.25 mm diameter RG143 RF coax, and the number of CWDM / DWDM channels supported on ViaLite RF-over Fiber solution*



Richard is the Global Director of Sales and Business Development for ViaLite Communications a leading manufacturer of RF-over-Fiber solutions, and has worked more than 30 years in the wireless communications infrastructure, audio and test and measurement markets.



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Insight: Satellite Talent

Candidate experience is key to recruiting success

By Ian Stammers, Founder and Managing Director

The market for top tech talent is highly competitive. To meet recruiting goals, employers need to improve the candidate experience and sharpen their social-recruiting practices.

The manner in which job applicants are treated has a profound effect on a company's ability to hire the most talented professionals. Employers need to make the recruitment experience enjoyable, or at least painless, for every candidate.

Candidate experience captures how they feel about your company once they go through your firm's hiring process. A good candidate experience will make candidates feel better about your company after they see how you treat job applicants. Poor candidate experience negatively impacts your employment brand.

Crafting a good candidate experience involves a mindset shift that focuses on respecting candidates' time. Here are six steps to improve candidate experience at each stage of the hiring process.

1. Make Certain You are Hiring to Fill a Real Need

Disorganization breeds bad candidate experience. Organization and planning breed good candidate experience. Being well-organized starts with planning your hiring strategy by identifying gaps you need to fill, and who would be best suited to fill them. Candidates will have much better-defined job duties and a smoother application experience, as a result. Perform a skills-gap analysis first. Choose a job title second.

2. Write Clear Job Descriptions

Use simple language when describing the job. List must-haves (not nice-to-haves) as requirements. Job descriptions are easier to read if they list the most important information first and are full of bullet points, active verbs and short sentences. Also, keep in mind the importance of creativity when writing your job descriptions. Make the job and your company sound as appealing as possible.

3. Make it Easy for Candidates to Apply for Your Jobs

Make your careers page easy to find. Give clear application instructions. Long, complicated application instructions confuse and turn off candidates. To avoid candidates' dropping out of your application process without completing it, make sure to let them know what they need to submit before they start the process. Keep your application process short and mobile-friendly. The shorter your application, the more user friendly it is. Shorter applications are easier to complete on mobile devices and demonstrate that you respect your candidates' time.

4. Follow Up Early — and Often

Send a confirmation email when candidates' submit their application. Acknowledging candidates' applications is a good practice, even if you send a generic thank you email. Avoid candidate reference numbers, use names instead. Send a rejection email or an interview invite within two days. Getting back to candidates promptly, with either good news or bad, will set you apart and demonstrate that you value your candidates' time.

5. Let Candidates Know What to Expect at In-Person Interviews

Send a calendar invite with the following information: How many interviewers they will be meeting with, who those interviewers are and how they will join the interview; the expected length of the interview; the interview format (*i.e.*, a mock presentation, or structured interview format); your office dress code; and instructions for entering the office building as a visitor.

6. Don't Take Longer Than Four to Six Weeks to Complete the Interview Process.

Taking longer than four to six weeks to complete the interview process will often result in the failure to secure the candidate. More often than not, the candidate you are trying to hire will be interviewing with other companies at the same time. Therefore, if you prolong the interview process, you are likely to lose the candidate.

Effective Social-Recruiting Strategies

The renewed emphasis on candidate experience is one indicator of how recruiting has changed in the past decade. Another indicator is the need to fully implement social-recruiting strategies.

Social recruiting should be viewed as a complement to traditional recruiting methods. Recruiters have found social media allows them to narrow the candidate pool more effectively and quickly find qualified individuals.

When businesses implement social recruiting strategies correctly, they provide potential candidates with an attractive representation of their company culture. Numerous recent studies have shown the overwhelming majority of 18-34 year-olds found their last job through social media. It is important to formulate a concrete plan before posting job openings on social media. Here are five social-recruiting strategies to get you started.

1. Simplify Your Approach

It's easy for companies to get bogged down in connecting with candidates through a variety of platforms. Simplify your approach with the following steps:

- *Visit LinkedIn to learn more about a candidate's professional experience.*
- *Engage candidates on Twitter to learn more about their interests.*
- *Monitor Facebook to see how candidates present themselves to strangers and friends.*
- *Use Pinterest and Instagram to see what candidates are passionate about.*

2. Examine the Various Platforms

To locate well qualified employees, it's important to tap into the correct platform given the role you're trying to fill. While LinkedIn or Twitter might seem like the most obvious place to start your social media recruiting strategy, it's important to profile your ideal candidate and consider where they're most likely to spend their time. For example, a graphic designer might spend more time on visual channels like Instagram or Pinterest. A salesperson will probably be more active on LinkedIn.

Each platform you consider will require a slightly different approach for candidate sourcing. On Twitter you'll want to incorporate hashtags to join the correct conversations and increase your reach beyond your existing followers. On Facebook, it may be appropriate to visit careers pages and job groups to seek out potential employees.

3. Adapt Your Strategy to an Evolving Workforce

When it comes to social recruiting, the modern workplace is constantly evolving. To thrive in this environment, businesses must monitor and frequently update their strategies to adapt to the new ways the incoming generations operate.

Millennials, for the most part, are quite tech savvy. They are drawn more to companies that use the same technologies they access and use daily.

Be sure to leverage social recruiting tools that allow candidates to submit resumes through social channels, or auto-fill contact forms from LinkedIn profiles.

4. Your Online Presence Should Reflect Your Brand

These days, you can be certain that a work environment that's both desirable and reflective of your company brand is high on your future candidates' list of baseline requirements.

In order to develop a more active and positive social media presence, think about your brand statement and how you can highlight the most valuable parts of your company through social media.

For most companies, this means featuring current employees. If you have a strong brand identity, employees will be your biggest advocates. By allowing employees to strongly advocate your company, you give candidates insight into the element they want to learn more about.

5. Strive for Employee Involvement

Studies have shown that people trust people more than brands. This is the single most important reason why it is important to use your employees in your recruitment efforts.

True employee advocates will organically spread the word about your company culture and should be happy to post about a job opening on their own social networks. If your employees are posting and tweeting about how amazing it is to work for you, it will naturally draw a bigger audience to your recruitment effort and to your overall presence online.

Ian Stammers founded Satellite Talent in 2012 — the company is now one of the leading recruitment firms for the global satellite and space industries. He has more than 20 years of tech-industry recruiting experience. He can be reached at ***ian@satellitetalent.com****.*

Uplink: Innovation — SSPI

The Satellite of Things...

It is hard to read anything about business or technology these days without coming across the Internet of Things (IoT). In 2014, for the first time, the number of mobile phones and other devices equaled the number of human beings on Earth, about 7.2 billion. The analyst firm Gartner says that by 2020, there will be 26 billion connected devices — and most of them will be connecting with other devices rather than people.

IoT is rapidly connecting lights and cars, factory equipment and footballs, aircraft engines and thermostats, traffic lights and baby monitors. By monitoring, measuring and managing these billions of things, it will save us time and money, reduce waste, cut pollution, and make the way we live safer, easier and more rewarding. Accenture forecasts that it will add as much as $14 trillion to 20 of the world's largest economies by 2030.

But maybe we should call IoT the Satellite of Things (SoT), instead. Because satellite technology has been connecting important things for decades and will be accomplishing that important task for decades to come.

Connecting Things Before the Internet

For more than 30 years, SoT has connected cash registers in stores with computers at corporate headquarters. Machines talked to machines, and retailers could monitor and inventory hour by hour to discover what was selling and what was not.

SoT has been making the world's energy supply smarter, too, from electricity grids to gas and oil pipelines. Sensors, switches and valves send data and receive commands from space — and the system runs more safely and reliably at lower cost.

Today, advances in information technology are giving the IoT new powers — and satellite is spreading them across the globe.

Keeping the Bananas Cool

Globecomm is a communication solutions provider working on IoT. For one of the world's largest shipping companies, the company found a way to make certain that bananas picked in the field and put into a shipping container reached their destination, ready for sale.

Working with other leading technology firms, Globecomm equipped refrigerated shipping containers with temperature sensors and small computers. Each container keeps track of its temperature and reports it over a wireless link to a central computer aboard ship. Wherever the ship sails, the computer stays connected over the Globecomm satellite network to the shipping company's computers.

The result? An accurate, real-time record of what went on inside the container, from the moment the container was closed on one side of the ocean to the moment it's opened on the other. When a perishable cargo goes bad, somebody has to make good on that load. SoT makes certain the shipper does not pay for problems the firm did not cause — and that can be worth millions every year.

Making Certain the Water Flows

Sometimes the savings is measured in people instead of money.

In 2012, America's Mid-Atlantic states were struck by Hurricane Sandy, which caused more than $62 billion in damage. One victim was a major water utility that served millions of people in the affected region.

The utility used IoT technology to monitor and control their network of valves, pumps, storage tanks and reserve pools that deliver a steady supply of clean water. Those machines talked to other machines over cellular links, the same kind used for mobile phones. However, Sandy's strong winds and severe flooding took down the cellular network in many places.

Suddenly, the control room was blind. The company scrambled to send personnel to facilities across the state. They checked sites, radioed the information to headquarters and manually operated equipment before rushing to the next site. This was an all-hands, around-the-clock exercise that went on for days until cellular service was fully restored.

Those days of crisis taught the utility a lesson. Its IoT platform now includes a satellite backup for all remote sites. Going further, state governments began requiring satellite backup for every network that controls crucial infrastructure. It costs a little more, but the risk of failing systems leaving people high and dry — or much worse, spreading disease — far outweighs the cost.

This is a world of constant change. Things move. Storms rise. Technology improves but makes all more vulnerable at the same time. IoT promises big benefits. However, only SoT can make sure IoT keeps that promise.

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InfoBeam

ICEYE garners Series B funding

Artistic rendition of the ICEYE-X1 satellite.

ICEYE, an Earth Observation (EO) company that provides synthetic-aperture radar (SAR) data, has announced US$34 million Series B funding led by return investor True Ventures and supported by Draper Network VC funds and others.

Building on ICEYE's recent aerospace industry achievements, the Finland-based SAR data company will use the new capital to expand their custom analytics services for its growing customer base, further develop its SAR satellite technology, as well as fund additional launches of ICEYE SAR satellites.

ICEYE's Series B funding round includes financial backing from previous investors True Ventures, Draper Nexus, Draper Associates, Seraphim Capital and Space Angels Network.

The funding round is joined by new ICEYE investors OTB, Tesi, Draper Esprit and Promus Ventures. To date, ICEYE has raised a total of US$53 million, including government financing from Finland and the EU's Horizon 2020 program.

In January of 2018, ICEYE successfully completed a historic landmark in aerospace by becoming the first organization in the world to launch a SAR satellite with a launch mass of under 100 kg.

With darkness or clouds covering two-thirds of the planet at any given time, SAR technology delivers reliable imaging even when optical imaging cannot.

Providing timely imaging data to both governments and commercial entities, ICEYE is helping its customers solve some of the world's toughest challenges in sectors such as the maritime industry, disaster management, insurance, finance, security and intelligence.

Following the January 2018 launch of ICEYE-X1, ICEYE is launching two additional satellites this year. ICEYE is aiming for a total of nine upcoming satellite launches by the end of 2019 and is actively seeking out launch operators to continue the company's rapid acceleration towards the future.

"*This funding secures our goal of deploying the world's largest SAR satellite constellation before the end of next year,*" said Rafal Modrzewski, CEO and Co-founder, ICEYE.

Rohit Sharma, venture partner at True Ventures and ICEYE board member, added that ICEYE is developing and deploying SAR satellite technology that has been dreamed about for decades, but which was thought to be impossible to deliver. The company will accelerate this three-year-old partnership with ICEYE and lead their current round of financing as they continue to change the way EO data is gathered, analyzed, and delivered.

www.iceye.com/

Uplink: Innovation — Satellite Vu

EO can solve the plastics problem...

By Anthony Baker, Chief Executive Officer

The vast amount of plastics produced throughout the world is causing a monumental problem for the governments and organizations that must tackle this growing waste materials crisis.

Plastic is everywhere and is causing a global crisis, particularly for the seas and oceans where plastic is, quite literally, bringing ecosystems to their knees. Plastic is ending up in the bellies of fish and wrapping itself around precious sea life. A critical point has now been reached — if humanity does not act now to solve this problem, the destruction of the Earth's maritime environment will be irreversible.

It is falling to governments to act on the massive wave of plastic that is engulfing the planet. At the end of 2017, more than 200 countries signed a United Nations resolution to eliminate plastic in the sea.

This is an almost overwhelming task. Plastic is used in just about every area of our lives — food and drink is packaged within it — children play with toys made from it — clothes are often manufactured using it. Plastic has permeated our lives to such an extent that ridding the oceans of it is one of the biggest and most complex challenges imaginable.

Monitoring and Quantifying

A key part of the solution resides in the monitoring of plastics — finding out where the plastics in the seas are originating from and where they are ending up.

The World Economic Forum (WEF) identified eight essential steps that need to be taken in order to address the plastics epidemic. One of these priorities is to increase mapping, surveillance and research, as there is still so much that is not known about the plastic problem.

By using mapping and monitoring techniques, better insight and understanding can be gained and, with this knowledge, governments can make more informed decisions on exactly how to take remedial actions. In a 2016 report by the WEF, '*The New Plastics Economy: rethinking the future of plastics*', one of the conclusions drawn was that mankind must, "*Develop insights and build an economic and scientific evidence base. Many of the core aspects of plastics material flows and their economics are still poorly understood.*"

The report also stated that the socio-economic impact of plastics in the ocean should be quantified so here are clear facts to work with in the remediation of the plastics scourge. Also recommended was that a socio-economic value impact model should be developed to enable public and private sectors to factor these costs into their decision making.

If plastics in the marine environment can be constantly monitored, this will facilitate the creation of maps that show global plastic mass. Such mapping could also pinpoint where ecosystems are about to collapse, due to the effects of plastic pollution. Mapping enables users to determine the size and origins of the problem and this knowledge can then be used for clean-up operations and to deter offenders.

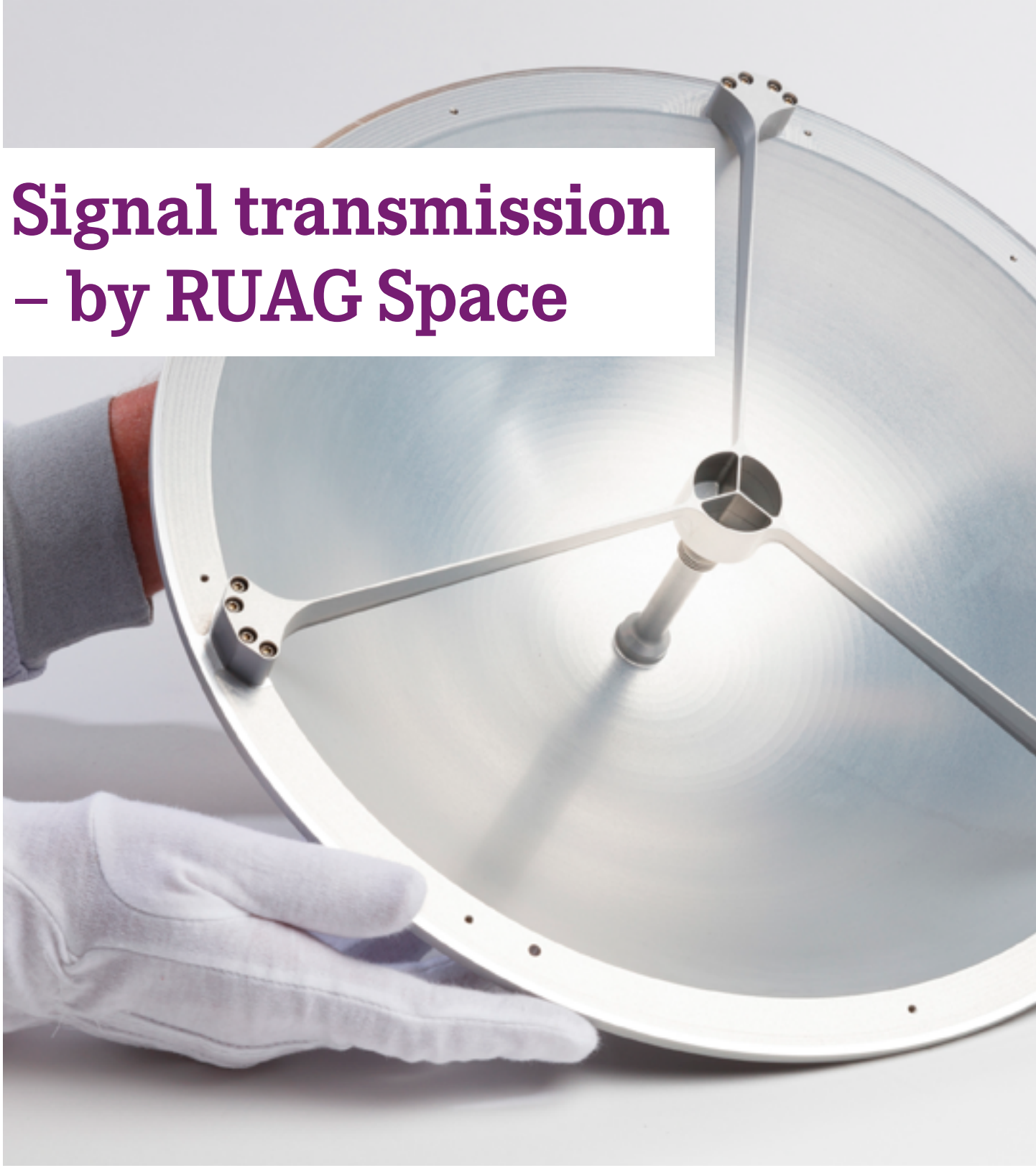
This kind of positive action has been proven to lead to policy changes, to formulation of new regulations and changes in human behavior, much akin to the CO2 regulations that led to carbon reduction targets and economic incentives such as carbon taxes.

A Space-Based Solution

For the 200 plus governments that pledged to rid the world of plastic pollution, a cost-effective means of establishing the extent of plastics in their maritime environment is required. This solution already exists — and it is space-based.

The solution gives countries the power to quickly and efficiently investigate and monitor the problem using satellite Earth Observation (EO) techniques — this is called Satellite Vu.

Signal transmission – by RUAG Space



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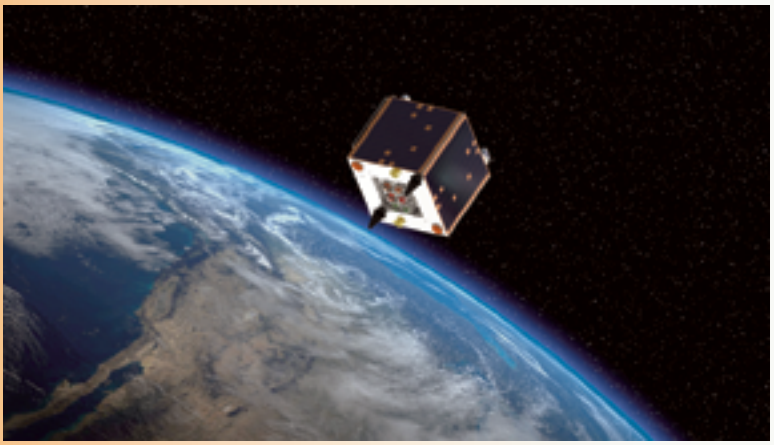
Together ahead. RUAG

EO has long been used to offer a unique perspective of the planet, presenting minute details for examination and analysis. Satellite Vu's unique system is bringing together developments in smallsat technology and cutting-edge software to offer a system that is cost-effective and that can be used by governments to efficiently locate, track and quantify the amount of plastic in the seas, anywhere on Earth.

Fast Track to Knowledge

At present, techniques used to collect data on maritime litter are expensive and time consuming and are carried out either from the air or on the surface or under the sea. Mapping areas in this way can take from months to years and, with the planet in such an urgent situation, this is simply not rapid enough.

EO satellites today, though extremely useful, do not deliver the frequent re-visit times necessary to build a highly accurate picture of what is going on at sea. Governments need timely information to enable them to track in real-time, and they need this data 24 hours, 7 days a week.



Current satellite technology enables just one snapshot of an area, per day, as the satellite will typically re-visit a site just once every 24 hours around mid-morning. For pattern of life analysis and the examination of dynamic, unfolding events, this satellite visitation schedule is simply not enough.

Satellite Vu's specialized satellites will produce very high resolution infrared and optical imagery every hour, which is then interpreted and converted using algorithms into timely information that end-users can readily access. Without the rapid and accurate interpretation of data, the imagery captured is of little use, being only a mass of Big Data.

The system's algorithms apply the science behind the image and the computer recognition that Artificial Intelligence (AI) can deliver. Satellite Vu is completely focused upon the extraction of insightful information within which trends can be identified. When there is a change in these trends, this is flagged and can be looked at in much closer detail to understand what the anomaly means for the end-user.

Satellite Vu's unique data processing is essential for the provision of daily measurements of floating litter, providing a constant stream of real-time, highly detailed, accurate and actionable data that speeds up decision-making and the delivery of meaningful solutions.

As the old saying goes, '*knowledge is power*' and Satellite Vu is offering a tool that will allow governments to access this in-depth information on how plastic pollution is affecting their waters.

This technology is critical, practical and affordable and it is available today to any government that wants to proactively work to eliminate plastics from the Earth's maritime regions.

As Sir David Attenborough said, "***Never before have we had such an awareness of what we are doing to the planet, and never before have we had the power to do something about it.***"

www.satellitevu.com/

Article author Anthony Baker is the Chief Executive Officer of Satellite Vu.

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Uplink: Innovation — Saft

Overcoming the challenges of LEO satellite batteries...

By Yannick Borthomieu, Space and Defense Product Manager

From mission-critical communications to virtual business meetings, advancements in consumer and government communication technologies over the years have driven a rising demand for reliable connectivity around the world via Low Earth Orbit (LEO) satellites.

Batteries are critical to ensuring the satellite's optimum operation and ability to provide uninterrupted coverage. To meet their clients' specifications, today's satellite manufacturers are employing lithium-ion (Li-ion) batteries as a dependable secondary power source.

LEO satellites are equipped with solar panels as the primary power source. When the satellite travels out of the path of direct sunlight in its rotation around Earth, known as an "*eclipse,*" batteries kick in to continue providing power to the satellite. A vital component of a satellite's infrastructure, the batteries provide a secondary power source for seamless, uninterruptable operation.

For satellites on orbit, it is impossible to access the satellite after launch to repair or replace a component, so it's imperative that the batteries are designed and tested for space applications to ensure a successful mission.

Challenges

Designing batteries for satellites presents a unique set of challenges due to customer specifications and harsh space environments. No two space application batteries are identical. Battery designers work closely with satellite manufacturers to customize the batteries to meet the precise parameters set by the customer, in addition to the main space standards directing the project. Some of the biggest challenges for designing batteries for satellites include:

1. Cost/Weight

One of the biggest cost factors of a satellite is the launch. Launching a satellite costs thousands of dollars per kilogram depending on its final orbit, which is why reducing weight is a top priority for satellite manufacturers. Batteries and battery parts alone can comprise 10 to 20 percent of the satellite's total weight. For satellites, weight and cost go hand-in-hand.

2. Lifetime

Once a satellite has been launched into LEO, it's nearly impossible to replace a dead battery. Battery selection is critical for manufacturers to meet a mission's lifetime requirements to ensure the battery will last the length of the satellite's mission, which can last up to 12 years in LEO.

3. Harsh Conditions

Satellite batteries face constant exposure to some of the most severe environments. During the launch, the batteries are subject to vibration and shock. In orbit, the extreme temperature fluctuations, radiation levels and vacuum conditions are unlike anywhere on Earth. These harsh conditions put the batteries at risk of failure.

4. Safety

While Li-ion's high energy density can achieve a smaller size and lower weight, this combined with a flammable material in the batteries can be hazardous. Similarly, the batteries can be a risk if overcharged, improperly balanced, or if they experience a short.

To address these challenges, battery manufacturers must consider factors such as technology choice, cell construction, overall system design (including electronics for safety), reliability and performance.

The Rise of Li-ion Technology in Space Applications

In the past, heavy nickel-cadmium (Ni-Cd) batteries were reliable and sufficient for LEO satellites, but they were unable to keep up with the weight and energy requirements for satellites at higher altitudes. Nickel-hydrogen (Ni-H2) became popular in the 1990s as a higher power, lower weight battery technology for Geosynchronous Earth Orbit (GEO) satellites.

Today, satellite manufacturers are turning to Li-ion batteries to maximize energy for significant weight and size reduction of at least five times less than previous technologies. Li-ion is able to achieve a lower weight and smaller size due to its higher specific energy (or mass energy density) combined with lower thermal dissipation and better charge efficiency. Its benefits in higher-altitude orbit are permeating the LEO market, and satellite manufacturers are incorporating the modern technology into their designs to realize cost/weight savings and longer lifespans.

Driven largely by price, commercially available 18650 Li-ion cells have historically been a relatively popular choice for battery integrators and satellite designers. While 18650 cells are optimized in terms of their small size and energy density, they also create challenges in terms of quality control and, when



compared to Saft's VES16 Li-ion cells, system level content. Furthermore, VES16 batteries are equipped with a balancing system that most 18650 batteries lack.

The VES16 was created by Saft to support the increasing need to reduce weight and save cost. Saft has developed Li-ion batteries allowing for 30 to 50 percent depth of discharge (DoD) for LEO missions and up to 90 percent DoD for GEO missions.

This increased DoD allows satellite manufacturers to incorporate fewer cells in their design. In turn, this cell reduction allows for smaller, lighter batteries, as well as a reduction in associated hardware and potential failure points, while satisfying mission power, size, and weight requirements, with margin.

Li-ion also empowers the battery to operate for a longer lifetime due to its high DoD and number of cycles it can endure. Due to LEO satellites' frequent eclipse periods, the batteries need to be able to endure a high number of charge/discharge cycles. This degrades the battery over time and hinders its ability to store energy. However, Li-ion has no memory effect compared to Ni-Cd and Ni-H2, so its degradation isn't as severe. For example, Saft's space VES16 Li-ion batteries perform at 30 to 50 percent DoD at over 65,000 cycles over 12 years. The typical lifespan for Ni-Cd and Ni-H2 LEO satellite batteries is only 5-7 years and they sustained less than half the number of cycles.

Designing and Testing Battery Operation and Safety

From launch to orbit, satellite batteries are exposed to some of the most intense environments. Batteries for space applications are robustly designed and packaged to withstand vibration and shock levels upon launch, as well as extreme temperatures and vacuum conditions during orbit.

Satellite battery designs are submitted to qualification and endurance testing on ground to reproduce the space environments (vibrations, temperature, vacuum, radiation, cycle life) and ensure the batteries are safe and can withstand the unavoidable strains of space applications.

The initial launch and acceleration into orbit places a great deal of stress on the satellite and its components. To defend the Li-ion cells against vibration and shock, the protective packaging that houses the cells is comprised of material that dampens and absorbs the external stress.

Once a satellite is placed into LEO, external temperatures can range from -150°C to +250°C depending on the sun's position during orbit. Li-ion batteries face irreversible capacity loss, in addition to voltage decreases and delays, when the temperature at which the cells are stored or cycled exceeds or falls below the battery's optimum temperature.

There are several ways battery manufacturers prepare batteries to operate in temperatures outside their normal range. Compared to other battery chemistries, Li-ion has a greater tolerance for extreme temperatures. However, Li-ion batteries still require insulated protection and active thermal management against exposure when the temperature deviates outside of its optimal range. Multi-layer insulation is commonly used on satellites to reduce heat loss, and a modular battery construction aids in further temperature regulation of the cells.

While most of these elements can be found in other applications (*i.e.*, automotive, downhole oil and gas, industrial, etc.), vacuum conditions are unique to the space industry. The low-pressure environment can cause Li-ion batteries to fail if not packaged correctly. Therefore, satellite batteries are hermetically sealed to protect against leakage or opening of the cell, and safety vents incorporated into the battery's infrastructure alleviate pressure buildup.

Satellite batteries are subject to extensive testing to ensure they meet agency standards and are qualified for use in space applications. The batteries are evaluated on their performance under simulated space conditions, which involves tests on the battery's ability to withstand harsh environments, vibration and shock, rigorous cycling and other abuse.

Space agencies, such as NASA (US), ESA (Europe), JAXA (Japan), CAST (China) and ISRO (India), impose stringent standards to ensure batteries operate safely and reliably for the duration of the mission.

Battery manufacturers also conduct extensive testing of battery cell performance under simulated space conditions. For example, Saft's LEO lifetime tests program for the VES16 battery examined the effects of temperature, DoD/charge current, end of charge voltage (EOCV) and radar pulses on cell degradations in LEO cycling and accelerated LEO cycling conditions.

Iridium-NEXT Satellite Constellation Project

The world's largest LEO constellation, Iridium-NEXT is a second-generation global communications system of cross-linked satellites to provide 24/7 coverage for 100 percent of the globe for mobile communications, data transfer, aircraft surveillance, maritime vessel tracking and environmental monitoring.

The system will be comprised of 76 LEO satellites and five on orbit spares following the final launch in late 2018. Iridium-NEXT is the first commercial satellite system to offer spaces on each satellite for hosted payloads in a Public-Private partnership arrangement. The system enables a sizable number of Earth-monitoring payloads to be established at a lower cost.

Iridium-NEXT is replacing, enhancing and extending the mobile communications capabilities of the former Iridium satellites that were launched in the late 1990s. The new constellation has a projected mission life of more than 12 years and will also deliver higher data speeds, enable powerful new services and devices, offer the advantages of IP technology and provide backward compatibility with current handsets, data devices and applications.

Thales Alenia Space was tasked with building the satellites. The previous Iridium satellites were powered with Ni-H2 batteries, but they needed a battery that combined high performance with low weight and reduced volume. The energy/mass advantage and specific energy performance of Li-ion technology was ideal for the specifications of the project.

Thales Alenia Space selected Saft's Li-ion VES 16 batteries for all 81 flight batteries for their combination of robust construction, lightweight design, high performance and long service life.

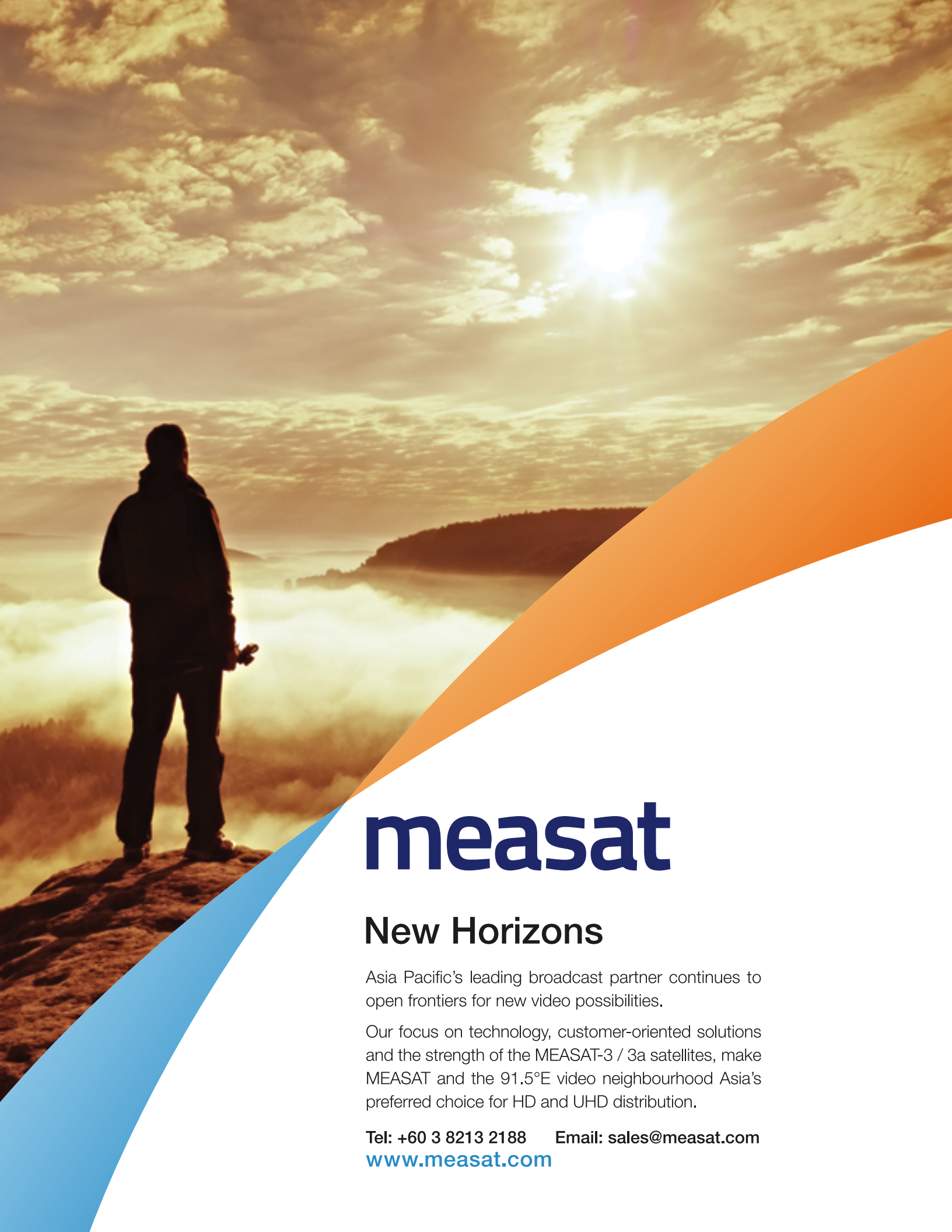
The Future of Satellite Batteries

It is no secret that LEO satellites are becoming more popular for their lower weight and price point. The LEO constellation market is also expected to grow by a factor of ten to twenty over the next year for telecom and internet applications.

Saft's satellite batteries will continue to support this trend through further advancements to increase energy and reduce the number of cells to meet smaller size and lower weight requirements.

www.saftbatteries.com/

Article author Yannick Borthomieu, is the Space & Defense Product Manager for Saft.



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InfoBeam

UrtheCast acquires Geosys

UrtheCast and Land O'Lakes have entered a binding term sheet for the purchase of Geosys Technology Holding LLC, a wholly owned subsidiary of Land O'Lakes, for a purchase price of US$20 million.

This landmark deal is expected to bring value to agribusinesses worldwide through the enhanced relationship between imagery data and geoanalytical solutions.

The closing of the transaction is subject to confirmatory due diligence, entering into definitive agreements, respective board approvals and other conditions customary for transactions of this nature.

Upon the first closing, UrtheCast will take ownership of Geosys' software for accessing, processing, cataloging and the retrieval of images. Land O'Lakes, through its WinField United crop inputs and insights business, will retain ownership of all intellectual property connected to their R7 Tool and farm-gate applications.

Upon the first closing, UrtheCast will continue to provide Land O'Lakes with all the services currently provided by Geosys but with an expanded use of data, once the UrtheDaily constellation is fully operational.

Services would be provided by UrtheCast pursuant to a 13-year agreement with total potential fees payable to UrtheCast over the term of the agreement in excess of U.S. $100 million.

The first closing is expected to occur by November 6, 2018, and full completion of the transaction is expected to occur in approximately 24 months.

Beth Ford, President and CEO of Land O'Lakes, said, that at Land O'Lakes, the firm is looking for the best ways to provide long-term support to member-owners and customers. This transaction will enhance the company's proprietary R7 Tool's ability to identify the correct places for farmers to make incremental in-season input investments to drive yields and profitability — in real-time.

Donald Osborne, CEO of UrtheCast, stated that this important acquisition would bring together the best-in-class imagery capabilities of UrtheCast, with the proven geoanalytics power and deep agribusiness industry relationships of Geosys. By unifying these companies, UrtheCast will be well positioned as the leader in fully integrated geoanalytics solutions for the agribusiness industry.

Osborne added that the expanded capabilities will allow UrtheCast to bring unprecedented capabilities to customers across a global value chain that spans from retailers to insurance companies, banks, and commodity trading houses. By enabling the company to realize an immediate expansion of the firm's capability set, customer footprint and revenue stream, the addition of Geosys will strengthen business while moving UrtheCast another step closer to the launch of the UrtheDaily constellation.

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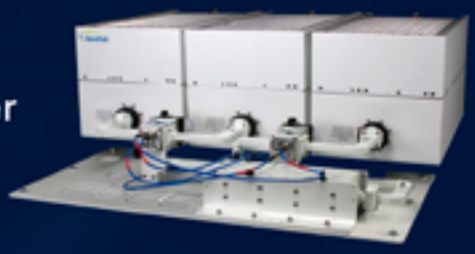

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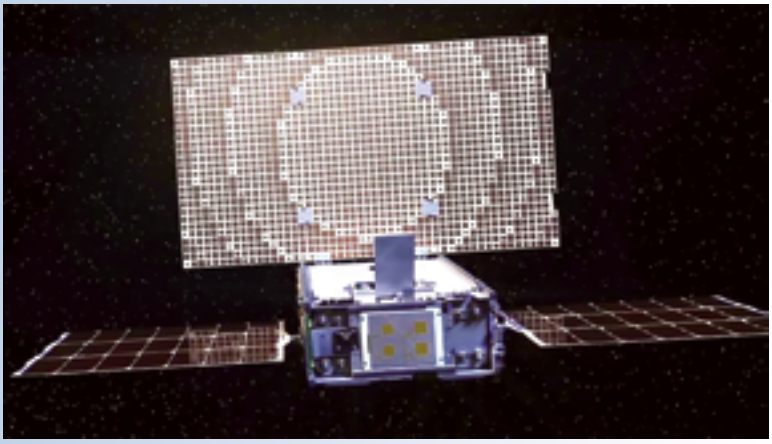
Uplink: Innovation — Omnetics

Smallsats going deeper into space...

By Bob Stanton, Director of Technology



An artist's concept of one of NASA's MarCO CubeSats. The twin MarCOs are the first CubeSats to complete a trajectory correction maneuver, firing their thrusters to guide themselves toward Mars. Image is courtesy of NASA/JPL-Caltech.

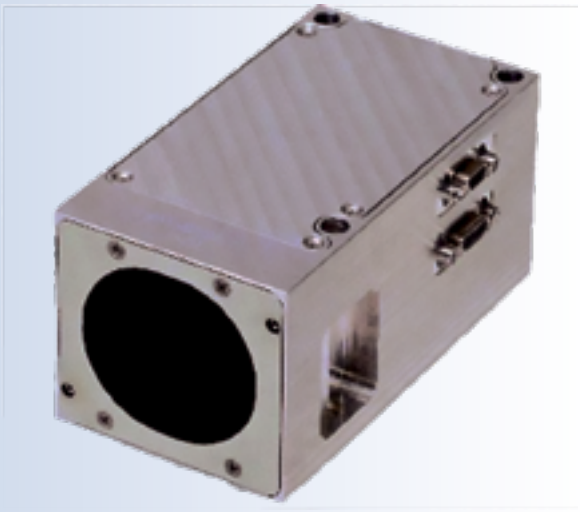
NASA is sending two cubesats to observe Mars — the agency is exhibiting some significant changes and adjustments in the electronics and the design of smallsats with this mission.

With improved packaging, smaller cables and smaller connectors, designers can, indeed, cram more electronics into smaller and lighter weight boxes. This will reduce cost and help the industry prepare for extended smallsat programs on more deep space applications.

To accomplish this, much technology has evolved and is being worked into these smallsat systems. Improved CCD (charge-coupled device) chips continue to offer major advantages, such as lower voltage and reduced current flow. This allows for a much tighter electrical budget and smaller batteries for energy storage. Solar energy collection systems round out the base line for smallsat electronics. Selective digital chips are also offering significantly higher digital processing capabilities as well as dramatically increasing circuit speeds.

Going deeper into space will also include the capability of interconnecting higher speed signals, providing better surveillance data, enhancing temporary data storage, and the sharing images at advanced transmission rates. As smallsats expand their reach from geostationary to polar and onto space exploration, the cube-type design may be a challenge for some current standards.

Internal electronics will be required to meet more stringent reliability and performance capabilities. Cable and connector interconnections focused on "small and light-weight" must also exceed reliability assurances for extended use in deeper space. NASA approved low outgassing materials, construction methods and connector reliability certifications are required in design and construction. Additional attention is also needed on long-term shock and vibration effects, as well as for extended thermal cycling beyond LEO. The internal instrumentation design packages are also going through significant upgrades to serve deeper space smallsat needs and applications. Smaller and lighter weight satellites require significantly improved methods for orbital position management.



BCT Star Tracker.

For years, cubesats struggled with rather limited attitude position measuring equipment. That has now changed. One example comes from Blue Canyon Technologies (BCT) in Boulder, Colorado. BCT has delivered and successfully flown "XACT" turnkey attitude control systems and XB-class spacecraft for a wide array of customers. Both the XACT and XB-class spacecraft leverage the Blue Canyon Technologies Nano Star Tracker, which offers precision attitude determination in a compact package weighing less than 500 grams and contains an on-board catalog of greater than 23,000 stars. High reliable interconnects are used to send position and navigation data to other components within the satellite and back home to the control center.

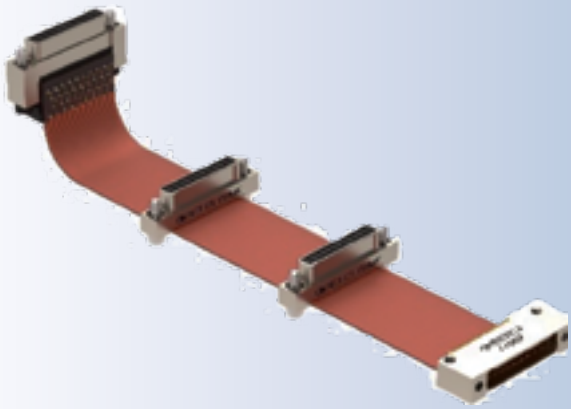
Electron driven smallsat "station keeping" thrusters have been used regularly to maintain satellites in their correct orbit. As smallsat are sent deeper into space, propulsion systems using Xeon based ion thrusters will be employed more and more often.

NASA Evolutionary Xenon Thruster (NEXT) ion thruster in operation. Image is courtesy of NASA.

Smaller solar powered cubesat-sized propulsion thrusters are now proven to be reliable and effective and are offered by a number of manufacturers, such as Busek Propulsion systems. Ion propulsion spray comes from CCD like micro-chips that separate electrons temporarily and accelerate positive ions out the back of an ejection nozzle. Though the strength of ion sprays is quite low, there is plenty to push the satellite in a direction desired. Deep space may require multiple micro-chips, but the size and weight are negligible. Miniature cable and interconnects supply needed triggering and solar power control elements to the propulsion system.

Modular stacking design is a standard for compacting electronics into small satellite packages. One key, however, is how well interconnections are made from one printed circuit to the next layer in the stack. Low profile Micro-D and Nano-D connectors allow for higher density, while still supporting current levels needed to run up and down the stack. Low Profile Micro-D and Nano-D connectors come with options for horizontal mount, vertical stacking, and wired to route signals from board to board. Voltage protections are included inside the connector designs using cable with high quality insulation extruded over the wires.

Connector design and materials are focused on low weight, high density and rugged



Omnetics Flex to Nano Connectors.

Screening Level	Special Screening	Outgassing.
Level 1 Mission Critical	SPT 1	Less than 1% TML
Level 2 High Rel.	SPT 2	Less than 1% TML
Level 3 Standard Rel.	Standard Reliability	Less than 1% TML

Figure 1.

	Micro (.050" Center)		Nano (.025" Center)	
	Sample Size(Allowable Failures)			
Inspection/Test	**Level 1 Com'l/SCD**	**Level 2 Com'l/SCD**	**Level 1 Com'l/SCD**	**Level 2 Com'l/SCD**
Visual	100%	100%	100%	100%
Mechanical	2 (0)	2 (0)	2 (0)	2 (0)
Voltage Rating (DWV)	100%	2 (0)	100%	2 (0)
Insulation Resistance	2 (0)	2 (0)	100%	100%
Temperature Cycling	2 (0)	2 (0)	2 (0)	-
Low Level Contact Resistance	2 (0)	2 (0)	2 (0)	2 (0)
Mating/Unmating Force	2 (0)	-	2 (0)	-
Solderability/Resistance to heat (SMT & Thru-Hole only)	2 (0)	-	2 (0)	-
Note: NASA screening requirements from Table 2C & 2J of EEE-INST-002				

Figure 2.

superiority to meet the extreme reliability demands during launch through deep space operations. Special "rugged-mount" designs can be made to system configurations. Materials have been selected for thermal-expansion match to sustain continued performance from launch pad through geo-thermal orbit conditions.

With increased densification of cable diameter and reduced connector size, Nano-interconnect systems offer significantly reduced weight and lower payload costs. EMI, cross-talk and high speed requirements are evolving rapidly. Satellite designers may need to specify details and work with solid models offered by connector companies to optimize connectors for new instruments. Circuit board to board jumper systems using wire and or flex cable with Micro and or Nano connectors can be rapidly designed to support linking and offer power to each board level.

Omnetics Mixed Signal Micro nd Nano connectors.

Many miniaturized connectors achieve high reliability in satellite connectors using a specialized design that employs a spring pin and socket system with proven reliability over wide ranges of shock, vibration, and thermal changes. Made of BeCu (beryllium copper) with high tensile strength (17,200ksi), assuring they withstand the rigors of use and physical abuse experienced in lift off and space flight.

Pin and socket elements that are selected must also pass plating tests specified in Mil. B488-type II, Code C class 1.27. This requires a strong nickel plate barrier that is then coated with 50 micro-inches of gold. When placed into miniature insulator housings molded from LCP (Liquid Crystal Polymer), the connector remains at the highest level of reliability testing in medical, military and aerospace industries.

The assembly often consists of Teflon® insulated wiring that is carefully "laser-stripped" to avoid nicking miniature wiring and crimped into the back section of the pin system. The pin-and-wire set are then inserted into the LCP insulator and fixed with space qualified epoxy. Metal shells can be customized to the designer's criteria, completing the assembly. To reduce cyber interference, cable can be shielded and shroud connected to a metal back-shell on the connector.

Many of the newer interconnections being employed also reduce size and weight by mixing power, coax, and digital signals within one cable and connector system. Mixed single wiring also allows special routing from a main control module during complex assembly to multiple subsystems. Interconnections are designed to levels set by international space agencies including ESA, NASA, and CSA, among others.

To specify cable and connectors for deep space, the system designer should follow some simple steps in ***Figure 1*** for selecting a correct screening level: ***Figure 2*** offers a screening level check list showing sample size and number of acceptable failures.

The era of deep space smallsat systems has arrived and new systems are positioned to serve those needs. Star tracker positioning technology, ion propulsion systems and new CCD chip capabilities can collect and send data beyond our dreams of just a few years ago.

Omnetics offers connector and cable technologies for deep space and the company is able to rapidly provide application specific interconnections as systems evolve. Most importantly, the company can now accomplish these tasks at lower cost and can provide new information that is not easily collected from larger, single satellites with multiple orbital instruments.

www.omnetics.com/

The author is Bob Stanton, who is the Director of Technology at Omnetics Connector Corporation.

Uplink: Innovation — Accion Systems

The near future of in-space propulsion...

By Natalya Bailey, Chief Executive Officer

The current state of the art for interplanetary space travel is essentially unchanged from the techniques that were used to send Mariner 10 to Venus and Mercury in 1973. Once in space, a satellite's chemical rocket engine provides high thrust for a very brief period, starting a long coast phase that takes advantage of as many gravity assist maneuvers as possible. Many months or years are then required to travel anywhere interesting — even maximizing propellant efficiency in this way, there are still significant limitations placed on spacecraft mass and payload.

Solving this problem has not been particularly urgent while spacecraft remain unmanned and space agencies remain patient. But as human exploration of the solar system increases, we'll need engines to speed things up. For space travel, better engines aren't necessarily more powerful; instead, these engines are more efficient and able to rely on less propellant, and significantly safer to manufacture and launch. There are an array of promising new propulsion technologies at various levels of technological readiness, all of which have the potential to make an enormous difference in the very near future as we send humans to Mars and beyond.

Maximizing Payloads

Fundamentally, space travel is about transporting useful mass from one place to another, ideally as quickly as you can. Moving mass requires engines and fuel, and the more mass you need to move, the more fuel is required — don't forget that fuel adds even more mass that also needs to be moved.

The Space Shuttle, for example, required on the order of 20 times its own mass in fuel [*ed note*: ***coolcosmos.ipac.caltech.edu/ask/268-How-much-did-the-Space-Shuttle-weigh-***] to reach orbit. In general, rockets that launch payloads into space have payload fractions [*ed note*: ***en.wikipedia.org/wiki/Payload_fraction***] of between 2 and 5 percent, meaning that more than 95 percent of the launch mass consists of things that are necessary but not ultimately useful.

Compare current space travel to early automobiles. Due to a number of factors — emerging standards, technological advancements, and the oil economy, to name but a few — fuel efficiency of automobiles has increased about 80 percent since 1975 [*ed note*: ***www.washingtonpost.com/news/wonk/wp/2013/12/13/cars-in-the-u-s-are-more-fuel-efficient-than-ever-heres-how-it-happened/?noredirect=on&utm_term=.a11f7e4a6895***]. As the automobile industry grew, funding and research supported this rise in efficiency, and as access to and interest in commercial space increases, the same pattern of efficiency gains seems likely.

Within the limitations of conventional rocket technology, there are a few different ways of maximizing the payload that can be sent to an interplanetary destination by reducing the mass devoted to propulsion. This is accomplished primarily by using as little fuel as possible to transfer from one orbit to another.

The goal with planning an efficient transfer is to minimize velocity changes, or Δv (pronounced "*delta-vee*,"): that is, minimizing the amount of acceleration and deceleration necessary, each of which burns fuel. A spacecraft propulsion system has a fixed amount of Δv, defined by its own efficiency and the mass of the payload that it's attached to, and that Δv is "*spent*" whenever thrust is used.

Transfer Orbits

The most efficient way of traveling more or less directly to another planet (the transfer that uses the least amount of Δv) is through a Hohmann transfer orbit. From LEO, entering a Hohmann transfer orbit to Mars takes a Δv *(acceleration)* of about 3.5 km/s. Entering low Mars orbit from the transfer orbit takes a Δv (*deceleration*) of about 2 km/s, meaning that a spacecraft needs a total Δv of around 5.5 km/s to travel in this way from an Earth orbit to a Mars orbit.

An ideal Hohmann transfer orbit between two planets depends on a specific orbital alignment. For Earth and Mars, that window happens once every 26 months, with a minimum travel time of about nine months. Unfortunately, these ideal transfer windows only work in one direction and a return trip from Mars to Earth will either need to spend significantly more time in transit, or wait for a new window.

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Most proposals for sending humans to Mars and back include stays of about 500 days, time to accommodate entry and exit windows. Beyond Mars, Hohmann transfer orbits start to take an impractically long time — optimally, it takes about 36 to reach Jupiter and more than six years to reach Saturn. While these are the most efficient direct transfer orbits, traveling beyond Mars still requires an amount of Δv that is often beyond the capability of the current generation of launch systems.

Gravity Assists

To reduce Δv requirements even further, most spacecraft traveling to the outer planets use gravity assist maneuvers to increase velocity without expending propellant. Gravity assists leverage planetary motion to change both speed and direction — as a spacecraft passes close to a planet, the planet's gravitational pull speeds the spacecraft up on the way in, and slows it down on the way out. However, since the planet is also moving in its orbit relative to the sun, the spacecraft gets pulled along, affecting its velocity. The spacecraft can either be accelerated or decelerated, depending on whether it approaches the planet towards or against the orbital direction.

To get to Saturn, for example, the Cassini spacecraft used two gravity assist maneuvers around Venus twice, as well as one from Earth and one from Jupiter. While Cassini's total travel time was about the same as a Hohmann transfer, the Δv needed was just 2 km/s, rather than the 15 km/s that a Hohmann transfer orbit from Earth to Saturn would have required. This allowed Cassini to carry a much larger scientific payload than it would have been able to otherwise. The disadvantage of gravity assist maneuvers is that their usefulness is dependent on planets being in a specific alignment, which makes relying on them for frequent transfers impractical.

Although these techniques for maximizing efficiency are certainly important, as we think about what it will take to send humans to Mars and beyond, it becomes necessary to increase the payload fraction itself — spending mass budgets on the transport of useful cargo rather than fuel. The best way to do this is by significantly increasing the propulsive efficiency of the engine, such that the same amount of fuel can impart more Δv.

Specific Impulse

The efficiency of rocket engines is measured through their specific impulse (abbreviated Isp). Specific impulse quantifies how effectively the propellant of a rocket gets turned into useful thrust — higher specific impulse means more Δv per unit of propellant. In practice, engines with higher specific impulse have higher exhaust velocities. This is where the efficiency increase comes from: since the mass of the propellant exiting the engine is constant, making it exit faster will give the engine more thrust without increasing propellant consumption

Specific impulse is conventionally measured in seconds, although this unit is not particularly meaningful. In practical terms, specific impulse is the number of seconds that a unit of propellant will last while the engine that's using it produces an identical unit of thrust — an engine with an Isp of 200 seconds will use 1 kg. of propellant to provide 1 kg. of thrust for that amount of time, and an engine with an Isp of 400 seconds (which is twice as efficient) will produce either twice as much thrust with the same amount of propellant, or the same amount of thrust for twice as long.

To put specific impulse in context, the solid rocket boosters on the Space Shuttle had an Isp of 286 seconds and its main engines had an Isp of 453 seconds. The Centaur upper stage, commonly used to send spacecraft on interplanetary missions, has an Isp of 450 seconds, and the R-4D engine (the main engine for the Cassini space probe to Saturn) has an Isp of 312 seconds. Chemical propellants max out their specific impulse at somewhere between 500 and 600 seconds [*ed note*: ***https://archive.org/details/nasa_techdoc_19700018655***], meaning that completely different technologies are required to substantially improve engine efficiency.

Near-Term Advanced Propulsion Systems

With chemical propulsion hitting efficiency limits, electrical propulsion is a critical next step towards our expansion beyond Earth's orbit. Again, this is a comparable adoption curve to the automobile industry, which is experiencing rising popularity of electric vehicles.

Rather than energizing mass through a chemical reaction, electrical propulsion relies on electromagnetic fields for the direct acceleration of ionized particles (atoms or molecules with a net charge) to very high exhaust velocities. As electricity can be continuously generated by relatively low-mass systems (such as solar panels), the majority of the propellant is converted directly into thrust, offering order of magnitude increases in efficiency. The amount of thrust generated is usually much lower than chemical rockets, but by thrusting continuously for weeks or months rather than seconds or minutes like a conventional rocket engine does, ion engines can efficiently reach much higher speeds.

Gridded Ion Thrusters

There are a variety of ways of building electrically powered ion engines.

One of the first types of ion engines to be developed was the gridded ion thruster. In this design, a high mass, electrically neutral propellant (like xenon, argon, or iodine) is injected into a chamber, where it's bombarded with electrons, ionizing the atoms with a positive charge and forming a plasma. At the other end of the chamber, a positively charged grid and a negatively charged grid create an electric potential. As the positive ions diffuse out of the plasma and through the first grid, they're accelerated by the second grid to very high velocities, generally several tens of kilometers per second.

With these high exhaust velocities comes a high specific impulse of between 2000 and 4000 seconds [*ed note*: ***www.mdpi.com/2226-4310/4/4/58***], nearly ten times better than a conventional rocket engine, at thrust levels of a few Millinewtons. In practice, this massive improvement in specific impulse translates into a spacecraft that can execute a mission while needing to carry just 16 percent of its mass in propellant rather than 82 percent. This means that the same overall mass budget results in a spacecraft that can carry more payload, travel farther and faster, or both.

Hall Thrusters

While gridded ion thrusters offer high specific impulse and high efficiency, they tend to be complex, requiring a substantial amount of power to operate relative to their output. A mechanically simpler variant (and one of the most successful electrical propulsion designs to date) is a Hall-effect thruster, several hundred of which have flown in space over the last few decades.

Instead of charged grids, a Hall thruster uses an electron plasma to both ionize and accelerate propellant via electrostatic potential. The overall efficiency and specific impulse of Hall thrusters is somewhat lower than that of a gridded ion thruster (a typical Hall thruster Isp is 1500 seconds), but they're usually physically smaller and more robust, and tend to be more efficient with the use of power (producing a few tens of Millinewtons), which is often a limitation on smallsats.

MPD Thrusters

For larger spacecraft that need more thrust, or that require a focused amount of thrust over a short period of time (for orbital capture), magnetoplasmadynamic (MPD) thrusters are able to deliver tens or even hundreds of Newtons of force, limited primarily by how much power is delivered to them.

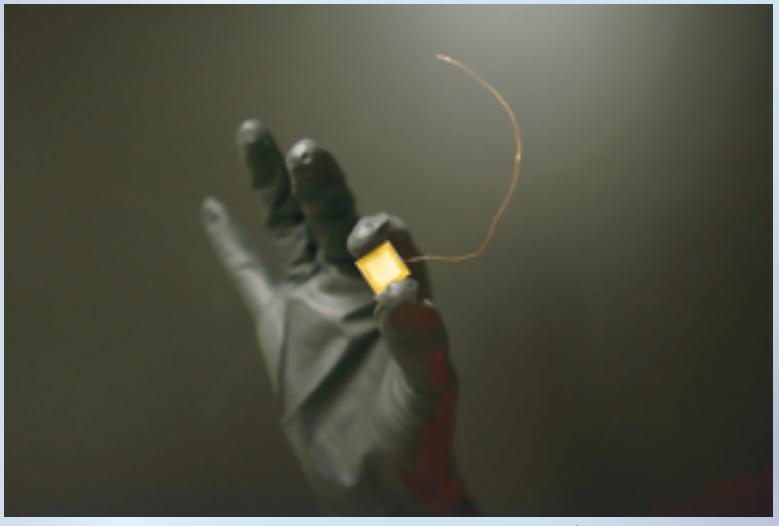
MPD thrusters generate a high-current electric arc between an anode and cathode, and a propellant is ionized by the cathode and accelerated by Lorentz forces. In testing [*ed note*: ***https://www.nasa.gov/centers/glenn/about/fs22grc.html***], MPD thrusters have demonstrated exhaust velocities approaching 100 km/s, providing 100 Newtons of thrust from an input power of 1 mW, although only one has flown in space to date and at much lower power.

VASIMR

VASIMR (Variable Specific Impulse Magnetoplasma Rocket) is another experimental and potentially very high thrust plasma engine. VASIMR uses radio waves to turn gaseous propellant into a plasma, followed by ion cyclotron heating to further energize the plasma.

A magnetic nozzle accelerates the ions in the plasma out of the engine at 50 km/s. With an input power of 200 kW, the first flight-suitable generation of VASIMR is estimated produce 5 Newtons of thrust with a specific impulse of 5000 seconds. The "variable" in VASIMR's name refers to its ability to trade efficiency for power by varying its exhaust parameters, providing a versatile engine that can meet different mission requirements.

Electrospray in-situ. Image is courtesy of Accion.



Tiled Ionic Liquid Electrospray. Image is courtesy of Accion.

Electrospray Thrusters

While most of the above thruster designs can be scaled up, they don't scale down well, which prevents them from being useful for the rapidly expanding smallsat market.

A much different type of ion thruster, called an electrospray thruster, is ideal for smallsats while also maintaining utility for larger spacecraft and payloads. Electrospray thrusters still rely on ionized propellant, but they don't need to generate a plasma. Instead, an unpressurized liquid salt is extracted from microscopic emitters and accelerated to 30 km/s by the electric fields generated in an extractor grid.

Each thruster is a cube just a few centimeters on a size, with an Isp of 2000 seconds and 1000 m/s of Δv for typical 1U cubesats. For larger spacecraft, electrospray thrusters also have a clear path towards increased thrust density: while the current technology produces 1.6N of thrust per square meter of thruster, the theoretical limit is 10 Kilonewtons, at which point a pair of centimeter-sized thrusters would be able to provide orbital station keeping for the International Space Station.

Power in Space

The amount of thrust that EP engines are able to provide depends on the amount of power that they're able to use to accelerate their propellant. At the moment, the demands of high thrust ion engines are far beyond the capabilities of the current generation of spacecraft power supplies. There are no systems in space right now that are able to generate megawatts, or even hundreds of kilowatts, of electricity— to put this amount of power in context, the four pairs of thirty-five meter long solar panels that provide power to the ISS generate a maximum output of 120 kilowatts [*ed note*: ***www.nasa.gov/mission_pages/station/structure/elements/solar_arrays-about.html***].

As solar power density decreases as the distance to the sun increases, solar arrays are not practical for providing significant amounts of power beyond the orbit of Mars. Instead, spacecraft have been relying on nuclear power, in the form of small radioisotope thermoelectric generators (RTGs). RTG designs vary, but in general, a few kilograms of uranium or plutonium can produce several thousand watts of heat, which is converted to several hundred watts of electricity. The RTG will continue to function for decades, although its output will degrade over time.

Hundreds of watts is not nearly enough electricity to power a high-thrust ion engine, which can demand megawatts (or more) per engine. Nuclear power is the only current practical solution for this, but there hasn't been a substantial amount of recent progress towards the kind of high output, low mass nuclear reactors that would be necessary for space flight.

NASA has been working on small reactors designed for space intermittently since the 1950s, and the Soviet Union successfully operated a series of 3kW reactors in space in the 1970s and 1980s [*ed note*: ***https://en.wikipedia.org/wiki/BES-5***]. NASA's new Kilopower reactor is scalable up to 10 kW (and could operate in space, although it was designed for planetary surfaces), and private space companies are also getting involved, with Atomos targeting 1 MW [*ed note*: ***youtu.be/tDWPLF3DuXM?t=467***] for its in-space reactor. When these new innovations come online, doors are opened for electric engines to efficiently move spacecraft to our farthest destinations.

What's Next for Ion Engines

Gridded ion thrusters and Hall thrusters have proven themselves in space, but newer technologies such as MPD thrusters, VASIMR, and electrospray thrusters promise to be less expensive, more robust, more scalable, more efficient, and more powerful all at the same time.

While NASA is working on its own MPD thrusters, VASIMR and electrospray thrusters are being commercially developed by Ad Astra and Accion Systems respectively. Accion plans to fly its first thrusters on three different missions in 2019 [*ed note*: No date yet for first VASIMR flight — ***https://www.reddit.com/r/space/comments/8zw7ph/we_are_scientists_at_ad_astra_rocket_company/e2m6tfa/***].

Initially, electric propulsion is likely to see the most use in low power, long duration applications in near Earth orbit, including gradual orbit changes, drag compensation, orientation and station keeping, and de-orbiting. Until now, small and efficient thrusters have not been available for smallsats, severely limiting their usefulness — with the maneuvering capability that ion thrusters enable, space will soon be more accessible than ever.

As the technology matures and additional power sources become available, more powerful ion thrusters could be used on space tugs that perform significant orbital adjustments to large satellites, moving them into geostationary orbits after launch or even performing refueling and repairs. Long term, electric propulsion will come into its own once we have enough in-space power to take advantage of high thrust applications. At that point missions to Mars that take weeks instead of months become a reality. Human exploration of the solar system requires reliability, speed, and above all efficiency, and electric propulsion is the way to make it happen.

www.accion-systems.com/

Natalya Bailey is the CEO and a co-founder of Accion Systems. Natalya earned her doctorate in space propulsion from MIT where she helped invent the first working prototype that made use of an ion propulsion technology for small satellites, which then became Accion Systems. Prior to MIT, she invented a new chemical rocket technology that she turned into a space startup. At Accion, she has developed an electric rocket system that can work at a smaller scale than the alternatives, and is cheaper and easier to manufacture. She was named to the Forbes' 30 Under 30 list in 2015. During graduate school, Natalya was a National Science Foundation Fellow and a NASA Ambassador to the U.S. at the International Aeronautical Congress.

Perspective: mu Space

The Wild Boars are finally going home...

By Philip Nalangan, a communications and media author

"The Wild Boars are finally going home!"

That was mu Space Corp CEO and founder James Yenbamroong's reaction as he witnessed the final mission to rescue the remaining four teenage players of the football team known as the Wild Boars and their coach, all of whom were trapped in Tham Luang cave in Chiang Rai, a province in the northern part of Thailand.

James Yenbamroong, CEO and Founder of mu Space Corp.

The final rescue occurred at 7:00 p.m. local time on Tuesday, July 10, 2018.

"*Many people have been waiting for this day for a long time,*" James said. "*We're glad to see them out safe and thrilled that they're finally going home.*"

Thailand-based satellite and space company mu Space sent five of their staff engineers to assist in the rescue mission of 12 football players, ages 11 to 16, and their 25-year-old coach who were trapped inside Tham Luang cave.

On June 23, the football team went exploring in the cave after a practice game and were reported missing following a heavy rain downpour. They were found alive by search teams only after over a week being stranded without food and clean water.

News of their discovery sparked jubilation across Thailand; however, that joy was cut short by the news that the football team couldn't exit their location due to the cave being flooded by the rain storm.

"*When we heard the news that they were still trapped after two weeks, we quickly assembled a team of engineers to arrive in the area to give support to the rescuers,*" said James. "*We collaborated with several private companies and universities who wanted to help in the rescue. Google provided useful data and Weather Decision Technologies aided the rescuers with weather forecast models. U.S.-based aerospace manufacturer SpaceX, who also offered support, contacted us to help them connect to the Thai government.*"

The final rescue mission on July 10 brought to the end to an 18 day long ordeal.

"*The Thai Navy SEALs, divers, water pumping and drilling teams, professional climbers, and K9 units played a big role in the search and rescue of the 12 boys and their football coach,*" said James, adding that "*foreign individuals and teams from Australia, Belgium, China, Japan, Laos, Myanmar, Sweden, UK and USA also extended support to the operations.*"

Confirming the completion of the rescue operation, the Thai Navy SEALs on their Facebook page posted, "*We are not sure if this is a miracle, a science, or what. The 13 Wild Boars are now out of the cave.*"

Meanwhile, the eight boys who had been rescued earlier on Sunday and Monday the 8th and 9th of July were treated in a hospital in Chiang Rai.

"*They're healthy, fever-free, mentally fit and seem to be in high spirits,*" CNN reported. "*They'll mostly be eating a food similar to milk and rich in proteins and nutrients.*"

"*Finally, they're out of the cave and going home. We wish the 12 brave boys and their coach a speedy recovery,*" concluded James.

Established in August of 2017, mu Space delivers satellite-based broadband, mobile and broadcasting solutions for telcos and businesses throughout Thailand, with plans to extend their services across APAC by launching their own HTS and GEO satellites. A full suite of connectivity solutions are offered for smart cities, energy and transportation sectors and the firm is also engaged in various digital transformation activities throughout Asia. mu Space is also introducing commercial space travel in Asia via their ***everyOne Project***.

www.muspacecorp.com/

Philip Nalangan is a communications and media expert who directly works with CEOs, company founders and executives to grow their personal and professional brands. He has spent a decade working in public relations for telcos, charities and startups and he has worked in the Philippines, Thailand, Cambodia and Ghana. In addition to his extensive communications and media experience, Philip is a trained staff coach. He holds a bachelor's degree in computer engineering and masters degree in development communication.

Rescuers inside the flooded cave. Photo is courtesy of Thai Navy SEALs.

Uplink: Innovation Mission Microwave

It's all about the terminals... the power of RF...

By Steve Richeson, Vice President, Sales and Marketing

In the satellite communications (SATCOM) industry, the word "innovation" captures both the excitement and the frustration of successful business as they struggle with the question of "*How do we grow from here?*"

Companies spend a great deal of effort to encourage and inspire innovation and then struggle to turn it into something that can earn a profit. Navigating the perilous passage between the need to change and the need to deliver the next quarter's performance is a journey that few can complete. The companies that can and do complete this journey sometimes transform into companies that are scarcely recognizable from their pre-innovation selves.

Necessity is the Mother of Innovation

Why innovate? Companies will claim they need to innovate or die — that's partially true, but many of them die anyway, even after spending their earnings on innovative efforts when they could have just returned that money to shareholders. Choreographed innovation seldom works — innovation inspired by the fear of imminent failure usually works pretty well. Innovations that solve problems tend to stick around and evolve into new business models. Companies may or may not include the innovator in their success.

Kodak innovated by making photography available to the mass market — Kodak made it so people could do something they could not do before — that's innovation. However, when was the last time you purchased a camera? Was Kodak successful? I'd argue they were; let's see how many folks remember Apple on their 130th anniversary in 2106. Remember Webvan? You probably do not. It turns out that the problem they solved (online ordering and quick delivery of groceries) didn't need to be solved.

In the satellite industry, it's easy to find examples of these extremes. Innovative companies solve problems and enable new long-term businesses transformations and audacious bold initiatives that offer a better way of doing what we already do pretty well today. Of course, they all claim to be innovators — you don't see a lot of investment or marketing claims around "Same old stuff."

It's All About the Terminals

A speaker at a June 2018 industry conference pointed out that the cost of a satellite network over its lifetime was dominated not by the initial investment in the satellite and launching, but by the ground terminals needed over the life of the satellites. Moreover, the ability of users to find terminals that fit within their financial and operational constraints determined if the network was successful or not. There are very costly examples of networks that have failed to meet their mobile user's objectives due to a failure to plan and include ground terminals.

Mission Microwave's thesis is that innovation happens faster on ground terminals than it does in spacecraft. Hardly an earth shattering revelation, but one that merits a thoughtful analysis, lest we run willy-nilly in the wrong direction by rushing into innovation on orbit before have we innovated on the ground.

There are two reasons for this difference in innovation: the equipment life cycle differences between ground and space, and disaggregated "structure" of the industry supporting the ground terminal business.

Life Cycles Define Innovation Timelines

In an earlier article in *SatMagazine*, the value difference between the different parts of a ground terminal were detailed. Each component in a ground terminal evolves in terms of price and performance on its own life cycle, depending on demand, supply chain, and technology maturity.

A spacecraft in a geostationary satellite network typically has a design life of 15 years and a service life well beyond that (some are still active at 20 years). Ground terminal equipment, on the other hand, gets replaced every 5-10 years. Large Earth station antennas routinely last well over 20 years, but the electronics that support them are replaced multiple times during the antenna's service life.

Spacecraft design is also conservative — for obvious reasons. The environment is harsh and failures cannot be repaired in situ. When you couple the design time, planning time and service life of a spacecraft, you get to some fairly slow evolutionary timelines. By the time an innovation is proven to be commercially viable (worth the risk), it can easily be a 20 year old idea.

On the ground, the quicker life cycles support experimentation and adoption of the "fail fast" way of innovating. "Let's try this," is a phrase seldom heard in the clean rooms and high bays of satellite manufacturers — it's in common usage in the ground terminal business where the cost of failure is relatively low and the means of recovery are generally at hand. Furthermore, in the ground segment, there are always multiple competitors eager to innovate faster and take more risk.

Competitive Environment

The satellite spacecraft business and the ground terminal business are competitive — however, completion looks a little different when you have four to six main players (each aligned with a particular nation or region) with high barriers to entry and well defined anchor customers (the spacecraft business) versus the relative free-for-all of the ground segment business.

Mission Microwave tracks the company's competitive environment closely. In some product categories, there are more than 15 direct competitors. New entrants appear frequently — although many are just working with the same building blocks from Asia and repackaging them under some surprisingly patriotic facades. These competitors constantly try new things to meet customer requirements.

The innovation cycle is fast, on the order of months versus the years required in the spacecraft business. Mission Microwave has established a top tier position in the market by offering combinations of efficiency and design that exceed the market's expectations. In some cases, the firm offered solutions that are a quarter of the weight of existing products and more than twice as efficient in power utilization — all at a competitive price. This has enabled ground terminal manufacturers to bring new capabilities to the market. That's an innovation that supports the increase in capacity in orbit and enables new mobile applications within a tight size, weight and power budget.

Mission Microwave Innovations in RF Power

The mobility market has made a necessity of low SWaP (Size, weight and power) along with increased energy efficiency and reliability. At Mission Microwave, there are two core deign philosophies that satisfy all of these needs and drive the company's innovation in Block Up Converters (BUC) and Solid State Amplifier (SSPA) designs. ***Figures 1*** and ***2*** on the following page show a portion of the product range produced by Mission Microwave using innovative design and technology.

Premise I — Efficiency and Reliability Are the Same Thing

RF Power efficiency is how much of the prime power gets translated into RF energy. Typical Ku-band BUCs at 100 Watts of saturated power operate in the range of 11 to 17 percent efficiency — most are below 15 percent.

Mission Microwave's 100 Watt Ku-Band Javelin BUC has 25 percent efficiency. RF engineers realize that the difference between 15 and 25 percent isn't 10 percent - it's 66 percent, and 66 percent more efficiency is a big deal.

Efficiency equates directly to reliability as well. That 66 percent more energy that the old style BUCs use can only go to one place — heat. Prime power draw gets turned into RF power or it is turned into heat. Heat is the opposite of reliability. Electronics that run cooler run longer and provide a greater "thermal margin" for operation in harsh environments where ambient temperatures can rapid reach 60 degrees C.

How does one make RF power more efficiently? The secret sauce here is in the ability to get signals from the semiconductor devices and into the waveguide with minimal loss. This is largely a manufacturing problem — to design a system such that it can routinely (and affordably) be produced.

The second aspect is the efficient combining of RF signals. The Gallium Nitride (GaN) devices used in SSPA's have limited output power. Multiple devices must be combined to reach higher power levels. Mission Microwave's team leads the BUC industry in the commercial combining of RF signals at Ku- and Ka-band.

Figure 1. Ka-band Solid State BUCs 200 to 25 Watts.

Figure 2. Ku-band Solid State BUCs 200 to 55 Watts.

Efficient RF designs generate a lot less heat that typical SSPA designs. They still generate a considerable amount of it, and how you manage this heat is the key to the second design imperative we use.

Premise II — Running Cool and Looking Cool

At Mission Microwave, the firm's efficient RF designs generate less heat per watt of RF power than any other BUCs on the market. The company, then, has less heat to manage. However, that doesn't mean traditional techniques are used to manage it — Mission Microwave has innovated on that front, as well. ***Figure 3*** shows an example thermal analysis that demonstrated the optimal use of airflow resulting in Mission Microwave's patented cylindrical design.

Mission Microwave has developed and patented intellectual property on the thermal management of RF amplifiers. The elegant design of the company's BUCs is derived from an efficiency of thermal design. Designs of thermal conductors and airflow are designed to minimize the amount of size and weight of the products — and the result is the signature cylindrical shaped BUCs and SSPAs with remarkable SWaP characteristics. Example — a 200 Watt Ka-band BCU weights only 22 lbs. (*20 lbs .lighter and 15 percent more efficient than its closest competitor*).

Terminal Designs Continue to Evolve

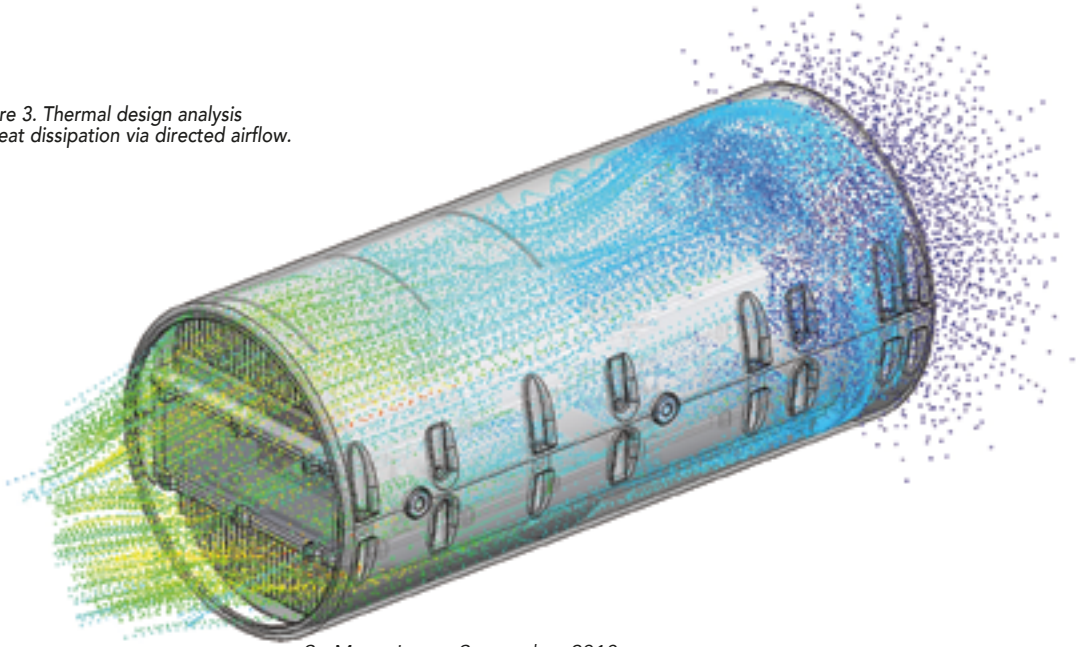
Mission Microwave BUCs have made it possible for terminal designers to bring unheard of savings in SWaP to their platform designs. The company has witnessed new, lightweight terminals with integrated BUCs, where previously, the BUC was a separate device that weighed more than the rest of the terminal. The firm's lightweight products enable new mission profiles as the reduced SWaP required for the BUC can be used for other essential items.

The satellite industry has recognized Mission Microwave as an innovator in BUC and SSPA design. Mission Microwave has shown that is still plenty of room for innovation in a mature market, such as satellite terminals. This innovation has been driven by the demand for mobility in satellite terminals and the continual need for efficiency and elegance in design. Mission Microwave is proud to carry the banner of innovation in the company's segment of the satellite terminals market as "***The New Shape of Solid State***."

Steve Richeson joined Mission Microwave in 2017 and is responsible for sales and marketing. He possesses 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, SATCOM Technologies and Schlumberger. Steve is a Senior Member of the IEEE and a Registered Professional Engineer. He earned his engineering degree at Georgia Tech and an MBA at Georgia State University. Contact Steve at...

steve.richeson@missionmicrowave.com.

Figure 3. Thermal design analysis showing heat dissipation via directed airflow.



An MSUA Executive Leadership Interview

With Erwan Emilian, Executive Vice President, Speedcast

By Catherine Melquist, President

Catherine Melquist (CM)
We appreciate you taking time for an interview — let's talk about the company's refinancing plus the Harris CapRock and UltiSat acquisitions. What do these mean to you and your mission at Speedcast to further the development of the enterprise and other emerging markets?

Erwan Emilian (EE)

The Harris CapRock and UltiSat acquisitions really helped us diversify our strengths in multiple industries while improving our ability to invest in new technologies. We already have a presence in more than 40 countries and experience working in nearly every country in the world. These acquisitions will allow us to cement our role as the largest global provider for remote communications.

Now, we can scale our efforts and use our global infrastructure to develop leading solutions for enterprise customers and emerging markets wherever they need us. Our recent refinancing also supports these developments because it increases our operational and financial flexibility, allowing us to focus on growth in these additional markets without disrupting our progress in our three other major verticals: Maritime, Energy and Government.

CM
Have you prioritized segments to focus on within the enterprise and emerging markets?

EE
There are many sub-segments within enterprise and emerging markets in which we see opportunity for sure. With that being said, cellular backhaul, humanitarian/NGO, and media and broadcast will be the key areas that my team and I will focus on this year. However, we also employ specialists to help us build our offerings, serve customers and support growth in industries such as utilities, plantations, mining, transportation and aero.

CM
Before we continue, I'd like to learn more about your professional background. How did you find your way into the satellite industry and Speedcast?

EE
I was a 3D CAD/CAM pioneer when I joined the first French startup to focus on technology in 1986 — maybe you remember the Intel 386 PC or Apple Macintosh? My role was to create 3D objects from 2D plans on an Intel 386 processor — fun challenges!

I then became an IBM'er and re-entered the world of startups in the late 90s, developing various innovations and applications for PCs and cellular phones. I joined the satellite communications industry in 2007, where I spent some time investing in M2M, IoT and IP technologies and solutions. In 2008, I met PJ Beylier for the first time and eventually joined Speedcast in October 2017.

CM
How does the satellite industry compare with the other industries you've worked in?

EE
The satellite industry is a uniquely small, tight-knit community that allows for building great relationships and strategic partnerships with other suppliers. We're able to leverage each other's strengths and innovations to provide the best solutions for our customers, and we're all working toward the same goal of providing the best available connectivity using the latest technologies for our customers anywhere the world.

With that being said, I feel the biggest challenge we have in satellite compared to other technology sectors is the distribution chain. Many providers have a hand in multiple channels, which can sometimes lead to overlap, forcing competition between companies who are also trusted partners.

CM
As you know, there's a lot of disruption unfolding in the satellite market, how do you see the enterprise and other emerging markets iterating during this time of industry change? And, what growth drivers (e.g., HTS connectivity, terminal innovations, other) are you and your customers most about this service?

EE
Speedcast has become the sole supplier of satellite communications to the Casey community in Antarctica. The company has been able to make a significant improvement in the reliability and accessibility of connectivity provided to the area, communicating with servers located in Kingston, and cutting down congestion on the satellite link, thus improving response times.

A wide range of applications are used by local medical, commerce and trade organizations to run daily operations and keep in touch with the rest of the world. Scientists also use the service to collaborate with local and worldwide educational institutions, gaining access to information in order to conduct experiments and research as well as share findings and data in their fields of expertise. Explorers and vacationers now have easy access to keep in touch with family and friends as well as ensure their safety while out on excursions.

CM
Erwan, thank you again for taking time for this interview and for being a great addition to the MSUA Board of Directors. We look forward to watching future successes unfold from Speedcast's Enterprise Division.

www.msua.org

President of the Mobile Satellite Users Association, Catherine spearheads the group's mission to promote mobility market development and mobility innovation. With over 25 corporate and small business members representing all levels of the satellite value chain as well as end-users, MSUA collaborates with conference organizers around the world to facilitate panels and keynote speakers that decipher mobility market dynamics including: growth opportunities, strategic partnership, barriers to progress, application aspirations, adjacent market influences and more.

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Downlink: Point Of View — Global Teleports

Why the promise of 10Mbit/s is an empty one..

By Roger Boddy, Founding Director

There are a number of points to consider in any conversation concerning the broadband issues that the United Kingdom (UK) currently faces. The promise of 10Mbit/s for everyone in the country is an empty one, at least in a world where the government refuses to consider satellite connection for rural areas or considers allowing thousands of satellites to be launched into space by multiple companies.

The USO (*Universal Service Obligation*) that has been introduced by Ofcom (*the UK's Office of Communications*) is claiming that this service can be offered by fixed line or wireless providers by 2020. Well, this is now 2018, and yet more than 1 million 'forgotten homes' in the UK do not have fast enough broadband (***www.theguardian.com/technology/2017/dec/15/internet-speeds-uk-broadband-forgotten-homes-ofcom-report***). In fact, there is a town in the UK that has a worse internet connection than Mount Everest (***www.theguardian.com/technology/shortcuts/2016/mar/06/miserden-cotswolds-village-worse-internet-mount-everest***) — imagine that...

The Problem with Fixed Line Broadband

The main problem with the government's well-meaning plans is the sheer lack of understanding of wired internet. Just because it is delivered directly to the home doesn't mean that it isn't being sucked up by hundreds of other people on the way to the user. The internet is similar to a water supply, with a big pipe at the supply branching out to smaller pipes in the main streets that feed even smaller pipes going into estates' serving pipes that are even smaller. It only requires a neighbor to leave a tap running (or a burst pipe) and the supply becomes but a dribble.

"End of the line? Sorry, sir, you can't access Netflix today, because you need a stout internet connection — perhaps you could blame your neighbor's son or daughter who has been streaming YouTube all day."

UK Prime Minister David Cameron's vision of "Digital Britain" has certainly never quite reached it's "Digital by default" ambition. In fact, his plans left an unrequited demand for digital connectivity across 70 percent of the UK. Deadlines are coming and going, much like the promise of funding, and yet rural areas in the UK are left up the creek without a paddle, completely unable to gain any usable internet, isolating them from the current digital landscape.

Meanwhile, the convergence of technologies has been marching on, with fourth and fifth generation cellular networks (4G, 5G) serving ever more sophisticated smart phones and Digital TV available on PCs, smart phones and pads — the internet is becoming increasingly available on a new breed of smart televisions.

No matter where you are, the expectation of a broadband service being available is inescapable, and yet the average UK broadband speed falls to 31st in the world. The reason? Providers stuck in the mindset of monopolizing the industry aren't capable of understanding that, even with the alternative rollout of fiber to street cabinets, the service must be then extended to the front door on copper wires on which service degrades with distance. The further away from the cabinet, the more the service is degraded and, for a broadband service, that means a reduction in deliverable transmission speed.

The UK network infrastructure managed by Open Reach has a fiber backbone that serves approximately 40 percent of the UK geography and focuses the service on the most densely populated areas. The remaining 60 percent of the UK geography is quite challenging to serve — other than by satellite.

Why Satellite?

Since 1964, satellites in geostationary orbit above the equator have offered viable services, which are profitable and provide up to 55 percent of international connectivity, with point to point and multi-point to multi-point topography.

Satellites in geostationary orbit have always suffered from latency issues and concerns about rain fade. Initially, satellites used C-band (4 to 6 GHz) frequencies to optimize signal to noise ratios and to make it easiest to differentiate required services from sky noise. In the mid1980s, the Ku-band (11 to 14 GHz) was adopted using smaller antennas and, in 2010, Ka-band offered the frequencies of choice (18 to 30 GHz).

Ever higher frequencies that were once deemed impractical because of higher noise levels associated with increasing frequency are now being used, with technology having been developed to accommodate and overcome the noise problem. Not only that, but the impact of latency has been minimized and is now more widely understood. In fact, because it can provide service anywhere at any time, in many use cases, satellite offers a much faster broadband connection.

With VipNet, Global Teleports is now offering stable service via satellite with speeds of 20 MBit/s in Ka-band for less than the cost of a landline rental (and without the need for a land line) with customer equipment available for a few hundred pounds for outright purchase. Equipment may also be rented, which makes the service applicable for any network usage, whether it be an event for a short period or seasonal lodging in the sticks — satellite can provide where cable cannot deliver support.

The ability of satellites to provide services to any home is evidenced through the successful implementation of satellite TV services. Even the most rural of homes can access satellite TV. To compete, terrestrial providers are now implementing an online TV service where in the consumer can 'do away' with their satellite TV dishes. However, this loads the already heavily laden terrestrial network and adversely impacts the availability of service to those more distant users — for the majority of whom copper wire is the only means of terrestrial access to their home.

A large percentage of the country is still not provided with an internet service that matches the levels perceived by the Ofcom proposal and it is probably for this reason that the proposer isn't 'doing away' with the satellite service, simply adding an terrestrial facility to run alongside it (which won't be coming to the UK until 2019 — maybe waiting for the government to catch up?), most likely because it is aware of the state of the internet in the UK.

What is the Answer?

The fact is that current broadband providers, as big as they are, are not meeting the requirements of the country because of their outdated belief in their monopoly and a sheer inability to accept the failings of wired internet for rural communities.

Additionally, the new players entering the game with plans to launch thousands of satellites into space to provide broadband services are not looking at the greater picture. They focus only on their own target market and seem to ignore the fact that they are one of many competitors for that market share. Standing alone, they can justify the cost to compete, but when the competition reduces their realizable share of the target market (as they certainly will), their business plan will require funding — if they don't get that funding, all that will remain is a metal bubble surrounding the Earth, which can only cause chaos if the venture is abandoned. There must be an ability to compromise and to agree that the market is a singular one, one that cannot be fought for by multiple companies without resulting in the disbanding of all of them.

The promise of a faster internet is one that has been left empty in the past and, without the proper implementation of broadband by providers, it is one that is set to fall flat on its face when confronting the first hurdle.

Without using the capabilities of satellite, while respecting the importance of maintaining accuracy and responsibility in the space environment, the Ofcom plan is yet another promise that will fall short.

www.globalteleports.com/

The author, Roger Boddy, is the Founding Director of Global Teleports.

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Uplink: Innovation — AsiaSat

Wet antenna attenuation?

AsiaSat has investigated C-band's exceptionally high rain fade attenuation reported by uplink stations during monsoon seasons in South East Asia — techniques for uplink station operators to mitigate against these issues, to improve their service level availability, are presented in this article.

Three methods are demonstrated to mitigate high rain fade:

1) Replace new feed Teflon coated diaphragm regularly (yearly) to prevent rain water staying on the feed aperture. This is because the waterproof capability of old diaphragm can be degraded after long time operation.

2) Increase the rain blower wind speed as it may help reduce the accumulation of water in front of the feed aperture.

3) Increase the uplink power by 3 dB in advance, an hour before heavy rain begins to compensate resulting decreased power.

Overview of Uplink Propagation Losses

In satellite transmission modeling, the path loss is the reduction in the power density of an electromagnetic (EM) wave as it propagates through space. The path loss includes free space loss which depends on frequency and distance, and propagation loss as a result of refraction, diffraction, reflection and absorption when the EM wave propagates through the medium between transmitter and receiver. International Telecommunication Union (ITU) provides a model to estimate the propagation loss between earth and space, and is generally used by network engineers to determine the rain margins in the corresponding link budget analysis for different geographical sites.

However, AsiaSat has observed and received reports of higher than expected C-band uplink propagation loss during heavy rain (typically 50mm/h rainfall rate) from some uplink stations. By tracking the performance differences between the satellite telemetry and the rain attenuation prediction data, insight can be gathered for more detailed investigations.

For example, it is observed that the uplink propagation loss is about 8 to 11dB through the telemetry for an uplink in Singapore during heavy rain, however the ITU rain model prediction can account for only part of the observed losses based on the reported rainfall rate from Meteorological Service Singapore.

Investigation shows the additional and unexpected loss is a combination of the antenna loss due to the water film formed on the surface of the feed aperture, and the water pool accumulated on the main reflector, resulting in wet antenna attenuation (WAA). Wet antenna attenuation is an additional contributor to the overall signal fading during rain events along the communication link path.

The company performed extensive tests to measure the losses under different water film thickness on the feed aperture. In addition, antenna gain degradation due to the water accumulated on the main reflector surface has been measured. Based on these measurement results, the effect of the wet antenna attenuation from the propagation loss is better understood, and the required transmitting power capability for uplink power control during heavy rain can be estimated.

Wet Antenna Attenuation

The coastal region of China and South East Asia are located within the ITU wet zone. Heavy rain is expected, especially in monsoon seasons. Based on the ITU rain model, the predicted rain loss depends on rainfall rate, antenna elevation, frequency and rain path length. The rain loss is about 4 dB at 6 GHz during severe rain when rainfall rate is greater than 120mm/h. The estimated rain loss of Singapore at 6 GHz versus rainfall rate is shown in ***Figure 1***.

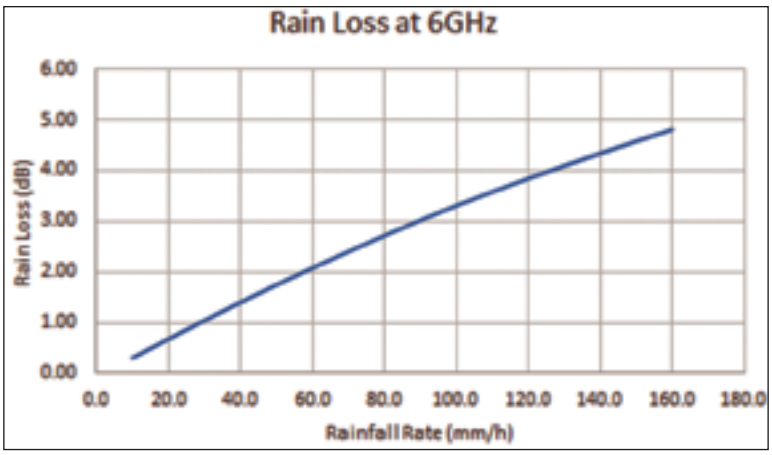

Figure 1. Rain loss versus rainfall rate.

For some advanced satellites, as in AsiaSat's fleet, uplink power data can be retrieved from satellite telemetry data which measures the input power to the high power amplifier (which is TWTA in AsiaSat's fleet). By trending the telemetry, the delta of incoming power between clear sky and adverse weather condition from the uplink station can be determined. Based on the trending of the collected data, the uplink rain attenuation was about 8 to 11 dB in Singapore and Hong Kong during heavy rain condition at C-band. By cross correlating it with the ITU data, there is an unexpected additional loss of approximate 6 dB.

AsiaSat knows that wet antenna attenuation can be up to 8 dB for a 0.4 mm water sheet formed on the feed aperture [1]. Wet antenna attenuation could be a function of frequency, antenna structure, material used for the antenna reflector and feed, and the rainfall rate on the antenna. It will affect the antenna efficiency, changes in directivity and variation in antenna feed port reflectivity. The company conducted extensive testing to measure the signal level degradation on antennas with different water film thickness, and different strengths and structures of antenna wetting conditions on the feed aperture and main reflector: the three types are discussed below:

1. Wet feed attenuation with different water film thickness on the feed aperture by using a broadwall coupler.

To investigate the output power degradation on feed aperture with different water film thickness, a broadwall coupler was used to conduct the forward and reflected power measurements. The output signal degradation versus different water film thickness was characterized, and the test setup is shown in ***Figure 2***.

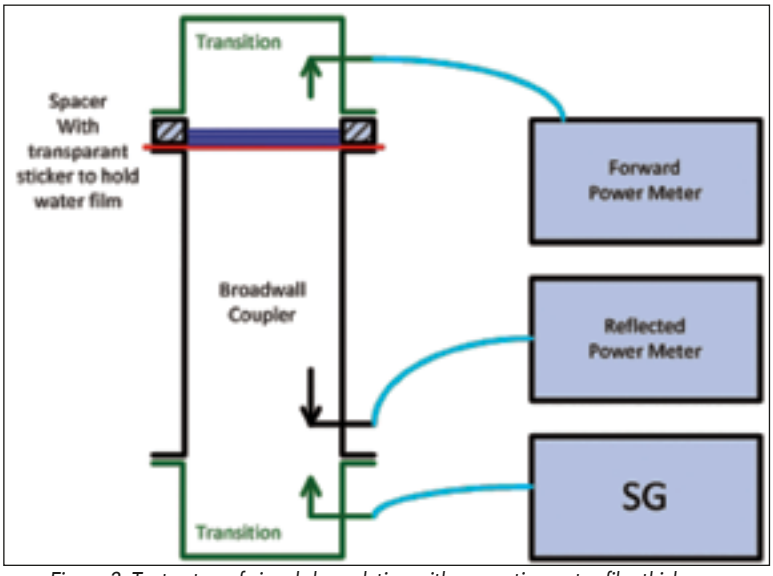

Figure 2. Test setup of signal degradation with respective water film thickness.

The test results show that the output signal degradation at 6 GHz will worsen when the water film thickness increases. The output signal degradation will be about 2 dB when the water film thickness on the feed aperture is about 0.1mm, but when the thickness reaches 0.2 mm, the output signal degradation will increase significantly to about 7 dB.

The output signal degradation can exceed 11 dB if the water film thickness is more than 0.3 mm. The signal degradation looks higher than the predicted number mentioned in the literature [1] because the assumptions of materials like dielectric constant and conductivity of feed horn radome and permittivity of water used for prediction are different from the actual measurement, particularly when an accurate measurement of the complex permittivity of water is not a trivial effort.

Degradation is caused by part of the transmitting power being reflected back to the transmitter, thus reducing the total output power. The water film on feed will distort the electric field distribution of the feed, and as a result creating a high perturbation on the feed standing wave ratio (SWR) which means more power is reflected. The reflected power will increase as the water film thickness on the feed aperture increases. The relationship between the output signal power degradation and the water film thickness from the measurement data is shown in *Figure 3*.

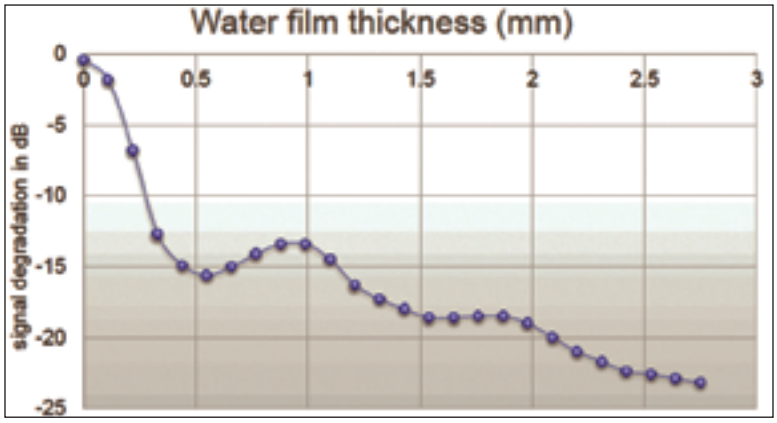

Figure 3. Signal degradation versus water film thickness on a feed aperture at 6 GHz.

2. Signal level drop with different wetting conditions at antenna feed aperture

The wetting conditions on the feed aperture will change from time to time during heavy rain. The water film can fully, partially or thinly cover the feed aperture resulting in different magnitude of degradation. To investigate the corresponding degradation, a wet tissue, a wet towel and a bag of water were placed on the feed aperture to measure the respective degradation. The degradation is obtained by observing the delta of receiving C/N change on a SCPC carrier with detailed test configuration described as follows:

- *A modulated carrier was transmitted to our advanced satellite, AsiaSat 7, by a 5m antenna dish under nominal configuration on the antenna feed and the transponder drive is linear.*
- *The carrier was received by a 9m antenna and an IRD receiver. The receiving carrier C/N can be obtained by IRD receiver and the spectrum analyzer. By observing the changes of receiving carrier C/N with different wetting conditions on the aperture, a better understanding of the wet antenna attenuation was achieved.*
- *The weather condition under test was clear sky.*

Dry and wet tissue case (*Figure 4a.*)

- *A dry tissue was placed on the feed aperture, the receiving C/N was about 19.3 dB, IRD margin 5.2 dB and HPA reflected power 1W*
- *A wet tissue was placed on the feed aperture, the receiving C/N was reduced to 16.9 dB, IRD margin 2.9 dB and HPA reflected power 3W.*
- *By comparing the dry and wet issue case, 2.3 dB signal loss from C/N and 3W HPA reflected power were observed.*

Test Condition (Case 1)	DL C/N by 9m (dB)	HPA O/P (W)	HPA reflected power (W)	IRD C/N Margin (dB)
Dry tissue on feed aperture	19.25	180	1	5.2
Wet tissue on feed aperture	16.92	179	3	2.9
Signal Drop (dB)	2.3			

Figure 4a. A wet tissue on feed aperture.

Dry and wet towel case (*Figure 4b.*)

- *A dry towel was placed on the feed aperture, the receiving C/N was about 18.8 dB, IRD margin 5 dB and HPA reflected power 1W*
- *A wet towel was placed on the feed aperture, the receiving C/N was reduced to 9.1 dB, IRD margin became unlock and HPA reflected power 19W*
- *Results show significant signal degradation (i.e., 9.8 dB)*

Test Condition (Case 2)	DL C/N by 9m (dB)	HPA O/P (W)	HPA reflected power (W)	IRD C/N Margin (dB)
Dry towel on feed aperture	18.83	177	1	5.0
Wet towel on feed aperture	9.08	185	19	Unlock
Signal Drop (dB)	9.8			

Figure 4b. A wet towel on feed aperture

Plastic bag case (*Figure 4c*)

- *A plastic bag was wrapped around the feed, the receiving C/N was about 19.5 dB, IRD margin 5.1 dB and HPA reflected power 2W*
- *A bag of water was placed on the feed aperture which was wrapped with plastic bag, the receiving C/N was about 12.4 dB, IRD margin in unlock state and HPA reflected power 3W*
- *Results show about 7.1 dB signal degradation from the spectrum. The smaller degradation than the wet towel case is because the bag of water is smaller than the feed aperture thus the feed aperture is not entirely covered by the water.*

Test Condition (Case 3)	DL C/N by 9m (dB)	HPA O/P (W)	HPA reflected power (W)	IRD C/N Margin (dB)
Plastic bag covered the feed aperture	19.5	181	2	5.1
A bag of water on the feed aperture covered by plastic bag	12.42	180	3	Unlock
Signal Drop (dB)	7.1			

Figure 4c. A bag of water on feed aperture

Results show that there is about 2 dB output signal degradation if the water film is as thin as a wet tissue and fully covers the feed aperture. If the water film is like a wet towel and fully covers the feed aperture, it will cause significant degradation on output signal. If the water film does not fully cover the feed aperture, the degradation is less severe so the rain blower does help to mitigate the degradation because it can prevent the water film from staying on the surface of the aperture.

3. Signal level degradation with water pool on main reflector

The antenna gain degrades if water accumulates on the main reflector. To investigate the corresponding loss, a test has been conducted with results in line with our prediction. The antenna elevation look angle toward AsiaSat 7 is about 60 degrees in Hong Kong so the rain water may accumulate on the main reflector.

For a 7.3 meter antenna, the maximum area of water accumulated on the main reflector surface is about 2.6 meters in diameter, which is about 13 percent of the surface area of the antenna. The water pool will affect the total energy toward the target satellite due to scattering, and as a result degrading the antenna efficiency. The estimated worst case gain degradation is about 0.6 dB. The test case has the same test setup as outlined in (2).

A plastic sheet was placed on the main reflector and the receiving C/N was about 19 dB, IRD margin 5.2 dB and HPA reflected power 1W. Water was sprayed on the sub-reflector, with water accumulating on the plastic sheet to form a pool on the 5m antenna.

The observed receiving C/N is about 18.58 dB, IRD margin 4.6 dB and HPA reflected power 2W. It shows about 0.6 dB degradation by comparing the delta of IRD C/N margin which is in line with our prediction. The test setup on feed aperture is shown in ***Figure 5***.

Results and Recommendations

Water film and water pools formed on the feed aperture and on the main reflector due to rain can cause significant output power degradation. The water film on the feed aperture will distort the electric field distribution and cause severe reflected power back to the HPA which degrades the total output power, or may even trip the HPA if the reflected power is larger than the threshold trip point of the HPA. If the water film thickness is 0.2 mm, it will cause 7 dB degradation.

If the water film thickness is greater than 0.3 mm, it will cause more than 11 dB degradation in output power. In addition, the water pool accumulated on the main reflector will affect the antenna efficiency and degrade the antenna gain.

High elevation look angle of the antenna may accumulate even more water on the main reflector and cause more degradation in antenna gain. This explains the extremely high rain attenuation observed during heavy rain in Singapore, the propagation losses include rain loss and additional loss due to water film effect on feed aperture and main reflector. To mitigate the wet antenna attenuation, the following techniques are recommended:

1. *Replace new feed Teflon coated diaphragm regularly (yearly) to prevent rain water staying on the feed aperture. This is because the waterproof capability of old diaphragm can be degraded after long time operation.*
2. *Increase the rain blower wind speed as it may help reduce the accumulation of water in front of the feed aperture.*
3. *Increase the uplink power by 3 dB in advance, an hour before heavy rain begins to compensate resulting decreased power.*

www.asiasat.com

Reference

[1] "Wet Antenna Effect on VSAT Rain Margin" by Jonathan Y.C. Cheah Aug 1993 IEEE

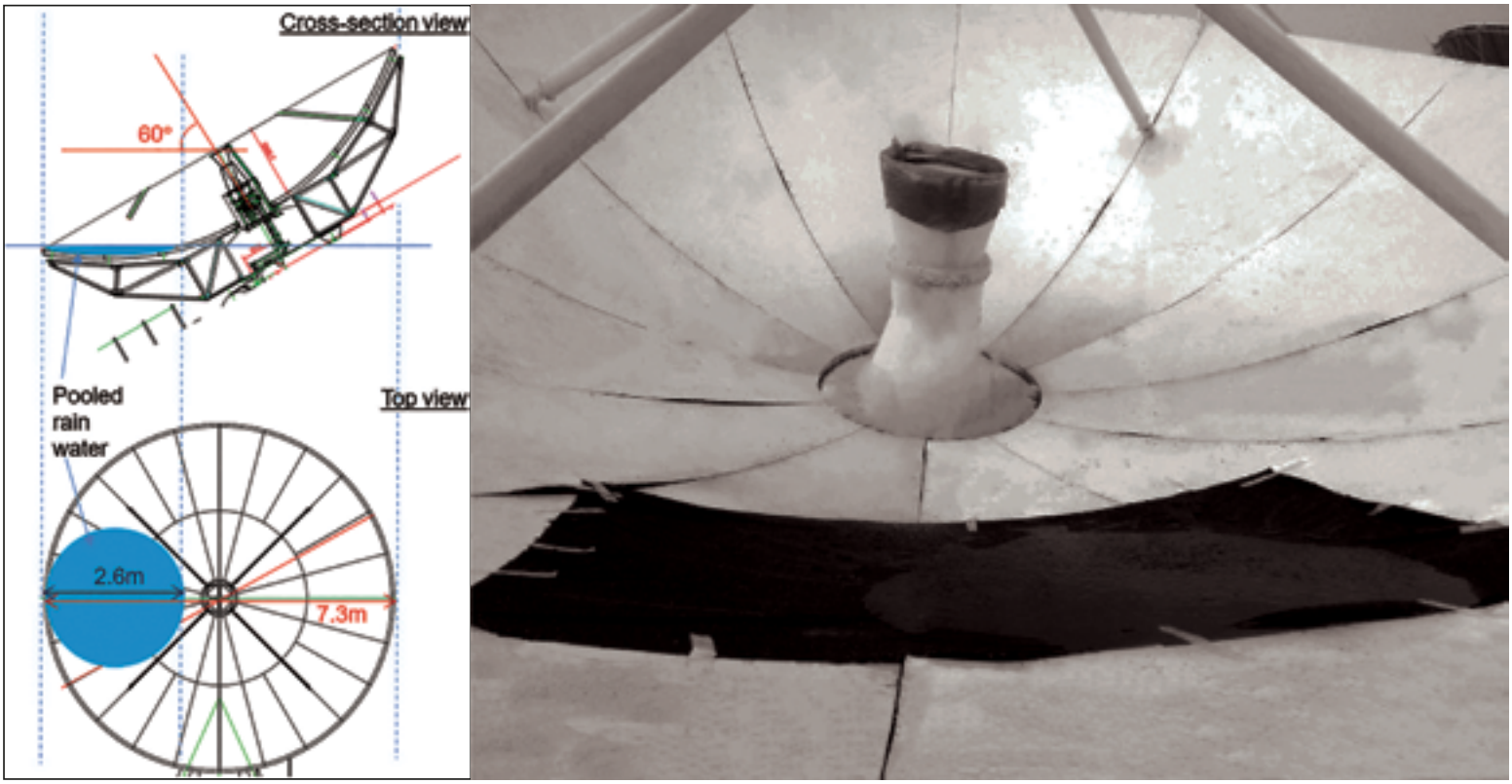

Figure 5. Water pool on main reflector

Uplink: Innovation — ADCOLE Maryland Aerospace

It's a small satellite world...

By Darko Filipi, Director of Business Development

Big space had small beginnings — Sputnik, the world's first man-made satellite, was 58 cm (23 inches) in diameter and would fit into the trunk of a family sedan. The first successful U.S. satellite, Explorer I, weighed only 14 kg. (30.66 lb.) and was 203 cm. (80 inches) long by 15.9 cm. (6.25 inches) in diameter and could easily be hoisted aloft by four people — without a crane!

Explorer-1 model being held aloft by the spacecraft's creators.

From those modest beginnings, spacecraft have grown ever larger, heavier, more sophisticated, and significantly more costly. The highly complex satellites produced by today's prime, space-faring nations are routinely the size of a city bus.

The development cycles that lead to these modern behemoths are attributable to ever-increasing technology demands and shrinking risk postures. The cost of building and launching current, state-of-the-art satellites demands that these technological marvels become ever more reliable and long-lived to justify the cost of placing them into orbit. As this vicious cycle has played out, current generations of U.S. Government spacecraft increasingly include aggregated payloads that meet the demands of multiple users within a single spacecraft.

Unfortunately, as this approach has led to increasingly larger, more sophisticated, and more expensive space assets, the U.S. finds its technological lead in space challenged, not only by traditional rivals, but also by emerging space powers. The historically evolved approach to spacecraft development is not aligned with internet-age technology advances, and the U.S. space enterprise has found that the space environment is increasingly congested, contested, and competitive. With all of the incredible sophistication built into recent prime space assets, these monolithic and aggregated satellites have such long development cycles that by the time they are deployed, their capabilities may be outdated in light of emerging needs, threats, and insight.

The great irony is that part of the solution to these troubling trends is to go back in time — to smaller, less complex spacecraft — to get to the future. As it happens, while major government and commercial developers have been focused on ever larger and more expensive satellites, innovative forces have been at work on the fringes of the space industry to meet these unfolding challenges head-on — with ever smaller and less expensive satellites.

Cubesats (built and launched in "units" of 10x10x10 cm.) emerged originally as educational projects for university students. Some of these smallsats, being inexpensive to deploy as "rideshare" payloads, have proven to be extremely well suited as testbeds of transformative technologies. These technologies can then be rapidly scaled or further developed based upon lessons learned — inexpensively — from on orbit operations.

With this boot-strap approach, some of the newest and latest space technology is now in the hands of widely varied and non-traditional users. The payload builders and spacecraft bus technology manufacturers benefit from this approach. These emerging space industry pioneers can rapidly improve their products over short cycle times, including capabilities such as advanced electric propulsion, increasing computer capacity, or laser-based intersatellite communication - all while improving product reliability and driving down costs from operational and manufacturing experience.

Cubesats are quickly growing in capability — and size. Whereas early units were a single 1U cube, these prototypical and educational models were quickly augmented by the addition of 3U cubesats and are now being followed up with 6U and 12U cubesats. The success of these smallsats has also further increased the U.S. Government appetite for other smallsat classes, including 180+ kg. satellites being launched on EELV Secondary Payload Adaptor (ESPA) launch opportunities.

These smallsats will never replace the exquisite behemoths that are the backbone of the nation's current space enterprise; however, augmenting current assets with a wide range of smaller spacecraft may be exactly the tool needed to increase resiliency in today's contested space environment. While the current crop of large platforms routinely achieve capabilities that are well beyond anything a single smallsat will ever be able to deliver, it is possible that clusters of smallsats flying in controlled formations will someday deliver capabilities that single monolithic satellites simply cannot achieve.

Large constellations of inexpensive smallsats also provide other unique advantages — for example, the ability to gather large, spatially and temporally diverse data sets due to frequent revisit times. Another attractive feature of smallsats is the ability to achieve rapid operational deployment (and replenishment), especially if built in advance and stored on the ground to be quickly pulled from a magazine and responsively launched to replace damaged or lost operational units — either partially or completely. With advancements in launch capability, replacement smallsats could be rapidly deployed when and where they are needed to provide responsive intelligence, surveillance, and reconnaissance — or other capabilities.

The scientific community has also quickly realized benefits on par with the military utility of smallsats. An entire generation of scientists and engineers is emerging that have not only built a satellite with their own hands, but have witnessed those satellites launched and they have then received their own data from the orbital operations of these satellites — an incredibly valuable education hitherto unavailable to aspiring space explorers.

Furthermore, maturing Principal Investigators have begun to rely on publications from previous smallsat projects to secure funding for new projects. As the trend of satellites becoming larger and more expensive has begun to reverse, access to smallsats is increasing the number of investigators with credentials to lead such missions — a virtuous cycle that is creating the next cadre of Principal Investigators to enhance and eventually replace the existing cohort of space scientists.

Perhaps even more surprisingly, commercial ventures have rapidly embraced the smallsat revolution to provide services that were previously only available to governments from space-faring nations. In the past, when a government organization needed data, they would develop a mission concept, finance the design and manufacture of the space assets, and obtain the data they needed — putting such ventures out of the reach of disadvantaged users.

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With commercial providers (sometimes funded by Venture Capital), the data or information is the product — a product that can be shared with many customers, within and outside of space-faring governments, reducing overall mission cost and releasing hardware providers to do what they know best. To maximize the utility of the aforementioned benefits of smallsats for government users, procurement approaches and mindsets need to realign with the evolving space enterprise. NASA and the U.S. Air Force have successfully used Other Transactional Authorities (OTAs) to develop and set the stage for acquisition of capabilities that would have otherwise never materialized.

A highly successful example is NASA's International Space Station (ISS) resupply program, known as Cargo Resupply Services. This development program was known as Commercial Orbital Transportation Services (COTS). Within a period of less than five years, NASA's COTS program resulted in two companies that deployed two dissimilar end-to-end systems — including two new launch facilities (at the Wallops Flight Facility and Kennedy Space Center); two new launch vehicles (Antares and Falcon 9); and two new space vehicles capable of autonomous travel to the space station without the need for onboard human pilots (Cygnus and Dragon).

If the Department of Defense and other U.S. Government agencies can harness the creativity and efficiency of today's commercial space industry using similarly flexible procurement strategies, the future for small satellite space could be breathtaking. (ed note: see NASA Critical Knowledge captured from the COTS procurement and execution, ***www.nasa.gov/content/cots-critical-knowledge-0***)

Such procurement approaches could match the innovative potential of small satellites, unleashing a wave of space exploration. Correctly and carefully applied regulations, domestic and international, can help foster the burgeoning smallsat industry.

There will be many challenges. Congestion is a common concern in the industry due to both physical conjunctions and radio frequency allocations. Some challenges can be ameliorated with technology, such as improved space situational awareness (reducing conjunction false positives) or laser-based communication, but the cooperation of existing operators in established orbits with new entrants seeking access to space is essential for the success of the industry.

Companies, such as Adcole Maryland Aerospace (AMA), have been on the front line for this new generation of smallsats. AMA built the first self-contained attitude control system for CubeSats and recently delivered the Kestrel Eye tactical imaging satellite to the US Army Space and Missile Defense Command. The experience of such companies has vastly improved and rapidly grown over a short period of time.

Smallsats will provide the capability for evolving concepts, such as responsive imagery direct to the warfighter, monitoring of deforestation, Maritime Domain Awareness — and perhaps, someday, lunar or Mars communication infrastructures, dissimilar spacecraft-borne sensors orbiting Europa, and many others... **large dreams can fit into compact packages**.

Adcole Maryland Aerospace was formed in April 2017 through the merger of Maryland Aerospace, Inc. (MAI) and the Adcole Corporation's aerospace division. MAI has long been a leading provider of Small Satellite and CubeSat components as well as end-to-end space systems. Adcole Corporation, now in its 60th year, has been the trusted supplier of radiation hardened and high reliability sun sensors for hundreds of LEO, GEO, and interplanetary space missions. More information about the company is available at www.adcolemai.com.

Darko Filipi is the Director of Business Development for Adcole Maryland Aerospace, LLC. In this position, he leads business development across all sectors. Before joining Adcole Maryland Aerospace, Mr. Filipi was the Deputy Director of Operations and Engagement Program Manager for the ARES Corporation in Vienna, Virginia. While with ARES, he planned and executed project tasks, and managed customer relations for the office and programs within NASA Headquarters OCT, OSMA, HEOMD, and OCE.

Mr. Filipi also worked at Orbital ATK/Orbital Sciences Corporation, in Dulles, Virginia, as a Systems Engineering for eight years. There, Mr. Filipi lead human rating efforts for two key elements of the NASA Orion Launch Abort System. As part of the Orbital ISS Commercial Resupply Services (CRS & COTS) programs, he supported the Program VP for Operation, Chief Engineer, Lead Systems Engineer in implementing incremental changes to the program, based on internal and customer direction. For the Stratolaunch Orbital Launch Vehicle, Mr. Filipi organized key reviews, including a PDR, and established the Risk Process for the program.

Photo of the ISS deployment of Kestrel Eye smallsat.

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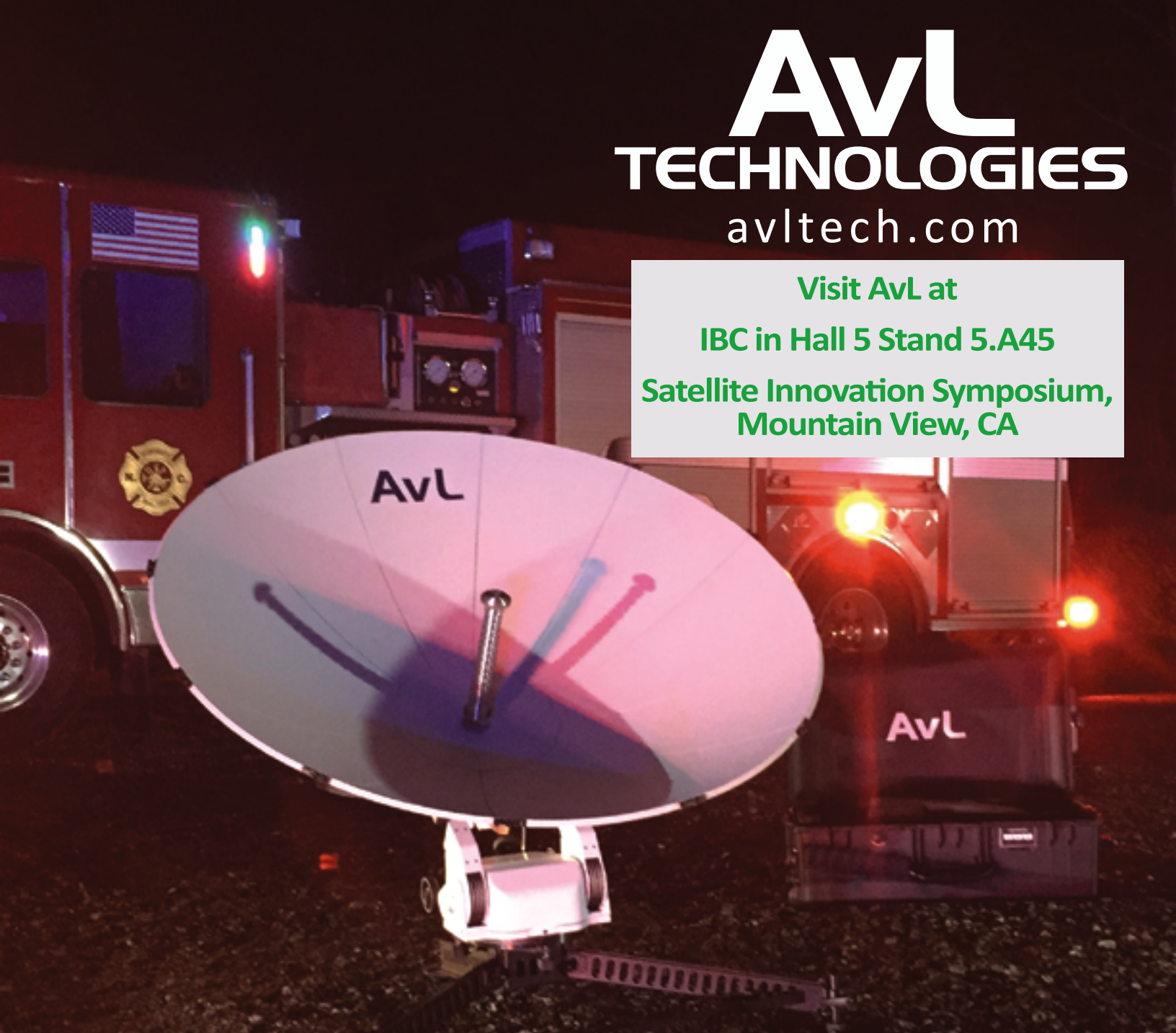

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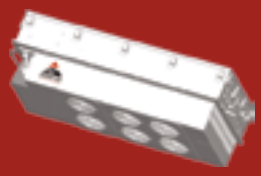

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