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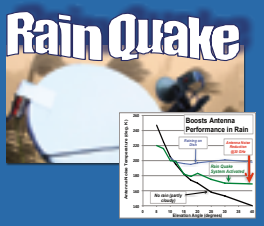


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## FEATURES





# AN NSR ANALYSIS: 2018 — A YEAR OF OPTIMISM IN GOVERNMENT AND MILITARY SATCOM MARKETS

*By Brad Grady, Senior Analyst*

**According to NSR's Government & Military Satellite Communications, 15th edition report, the outlook for Government and Military SATCOM Markets will exceed $71 billion in retail revenues over the next ten years.**

With 2018 posting a net-positive gain in revenues over 2017, there are a lot of reasons to be optimistic about the prospects of this market, finally. Setting aside conversations around "***Space Force,***" or the unexpected allotment of funds toward ***WGS 11/12***, or the additional MILSATCOM procurement happening in Europe, or... well, the list can go on and on and 2018 was the year where a lot happened.

Among all these events, which in isolation could move the needle by themselves, is a changing landscape of macro-economic events.

Defense spending is on the rise, across the globe. Not only is U.S. defense spending guidance up over previous levels set under the rules commonly called '*sequestration,*' but NATO saw more countries reach their 2 percent GDP targets and additional spending activities are occurring in the Middle East and Asia-Pacific.

This defense spending is just a simple reallocation of funds toward current operations but is focused on the acquisition of new capabilities — all of which will be '*state of the art*' technologies developed among the landscape of the data-focused era. Combined with a new, data-driven approach to combat operations which relies heavily on distributing information across all levels of military forces, and there is a strong need for robust, reliable communications infrastructure in next-generation doctrine.

Today, land-mobile and unmanned platforms drive the market by nearly any measure from capacity demand to revenues generated. That will largely remain true as we look towards the next few years.


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What continues to change is under that curve – a market rapidly adopting HTS-based architectures across a variety of frequencies and orbits. New ground terminals are helping rewrite some of the complexities of choice that end-users face, multi-band terminals are becoming a fiscally-reasonable option.

Network designs are becoming more complex, while the integration with military networks is shifting from the RF to IP layer. Simply, investments are being made on the ground from both commercial and government sides of the market to leverage the changing infrastructure in space.
Programs aimed at addressing these complex networks are already underway.

The Flexible Model Interface program is only one such example. However, with complex networks comes an even larger task in securing the RF and IP layers. Already, commercial players are investing significantly in cybersecurity programs, and some requirements by commercial players such as Oil & Gas, electrical Utilities, Banks, and other critical commercial industries are higher than Gov & Mil customers. To address the security layer, Protected Tactical Waveform and other link/RF-layer encryption developments will continue to be pursued over the next few years – and provide additional opportunities for commercial providers.

Yet, as we look forward to future growth opportunities in HTS from GEO to MEO to LEO, FSS Ku-band will still be a significant source of revenues for the commercial industry. As the U.S. Government and Industry discovered during the Wideband Analysis of Alternatives process, which is helping to shape future broadband satellite communications procurement for the U.S. Government, there are a significant number of terminals out there in the field. And, it costs a lot of money to replace them. A lot of money. As such, FSS Ku-band will generate $3.1 billion in retail revenues by 2027, the largest chunk of the current and future market opportunity.

With legacy FSS Ku-band being a significant source of revenues for commercial providers, 'gov-like' frequencies will be one of the growth-drivers. FSS X-band is projected to go from around $890 million today, to more than $2.2 billion by 2027. Driven by renewed spending on MILSATCOM networks (and subsequently terminals), interoperability with and augmentation of sovereign MILSATCOM capabilities are key. Moreover, the acquisition of commercial networks and capabilities is being '*baked-in*' from day-one, with nearly all major operators of MILSATCOM networks having commercially-provided communications featured in their next-gen roadmaps.

Alongside X-band, GEO-HTS Ka-band offered by the likes of Inmarsat, ViaSat, and others will yield $6.6 billion in cumulative revenues over the next ten years. With nearly all gov-owned SATCOM networks having some flavor of Ka-band capacity and expanding commercial coverage in Ka-band across GEO/MEO/LEO, the capacity continues to be a bright-spot

of emerging growth opportunities. Overall, the digitalization of warfighting all point to the needs for more connectivity in more places across more frequencies and orbits.

However, not all waters of Gov & Mil markets are rosy – narrowband applications will be an area of challenges – with higher throughput options available to similar terminal form factors.

FSS C-band will also be a market of issues, as the terrestrial wireless seems almost certain to gain some usage of the frequency in major markets.

Bulk leasing will be a positive-gain of retail revenues over the next ten years, but the number of those opportunities are only expected decrease as additional capacity is procured via a managed service offer.

***Bottom Line***

While the industry is focused on the resurgence of proprietary MILSATCOM capacity, there are a lot of reasons for optimism. Networks are becoming more complex, the terminal landscape is changing, and there is a renewed focus on defense spending across the globe.

The role of the commercial sector will be to help stitch together these '*networks of networks*', just as they do for cruise ships, airlines, and other sectors across the world.

If the WGS program is any indication, additional MILSATCOM supply only means one thing — the higher requirement for data at the tactical edge of the network. And, with that higher demand for data will come the greater need for commercial providers to build, deploy, and operate these more complex networks.

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*Brad Grady is the Lead Author of NSR's Government and Military Satellite Communications reports, in it's 15th Edition. Focused on the opportunity for SATCOM players in the Gov & Mil market, the report focuses on tracking the capacity, segments, and regions driving growth over the next ten years. Based in Washington DC, Brad also leads NSR's research on the Maritime and Energy markets, bringing commercial insights and best-practices across both Gov & Mil, and Commercial Mobility markets. Brad can be reached by emailing* ***info@nsr.com****.*

# TAKING SIGNIFICANT STEPS TOWARD A NEW PATH OF UNIFIED SATCOM

*By Rebecca Cowen-Hirsch, Senior Vice President of Government Strategy and Policy, Inmarsat Governemnt*

**Taken as a whole, space-related actions in 2018 have signified the promise of a sea change in the way the U.S. government acquires critical satellite communication capabilities. Overall, we should be greatly encouraged by the achievements and ideas set forth by military and industry leaders over the past year. Expectations all around are high, and it is time to deliver on the path forward in which a lasting, productive U.S. government-commercial partnership prevails.**

Indeed, in reflecting upon the building momentum established so far, General *Jay Raymond*, Commander of both the **Air Force Space Command** and J**oint Force Space Component** stated, "*I am convinced that when historians look back at 2017 and 2018, they will look back on this as one of the most critical times in our national security space history. It will be seen, in my opinion, as a strategic inflection point for national security space and a bold shift towards warfighting and space superiority.*"

Specifically, I believe the following developments speak to what we all, government and commercial SATCOM operators alike, ultimately hope will be viewed as major steps toward realizing a fully integrated, capable, resilient and global SATCOM architecture:

***The signing of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2018.*** With the NDAA, the U.S. government is recognizing the criticality of space resilience and the importance of consistent, consolidated and strategic leadership in space through the support of commercial SATCOM (COMSATCOM).

Among the key provisions for national security space programs are changes in the space organization and management to include the establishment of a separate combatant command responsible for the national security space activities of the *Department of Defense* (DoD). This is a clear recognition that SATCOM has emerged as an area requiring extremely senior-level strength and focus.

With the space environment growing increasingly contested and operationally challenged, the NDAA provides a framework for, and marks the first step toward, the crucial reorganization and consolidation of space capabilities. It presents a clear opportunity for COMSATCOM to become an integral part of the SATCOM architecture.

***The National Defense Strategy.*** Published in January, the strategy highlights the need to build up space-based threat awareness and safeguard military and commercial space assets from adversaries. Announcing a prioritization of investments in resilience, reconstitution and operations to assure space capabilities, it articulates a strategy to "*…compete, deter, and win in this environment. The reemergence of long-term strategic competition, rapid dispersion of technologies, and new concepts of warfare and competition that span the entire spectrum of conflict require a Joint Force structured to match this reality.*"

This new strategy shifts focus onto highly mobile mission sets to support advancements in intelligence, surveillance and reconnaissance, demanding resilient SATCOM, inclusive of COMSATCOM. Consequently, the space industry's focus must be on the broadest areas of support for ***Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance*** (C4ISR), for both military and commercially-supplied SATCOM.

This means continued investment into wideband and additional tactical protected communications, network diversification, backhaul performance, overhead persistent infrared technologies and enhanced augmentation for *Global Positioning System* (GPS).

***The transition of the Joint Space Operations Center (JSpOC) to the Combined Space Operations Center (CSpOC).*** This initiative further integrates critical allied and U.S. capabilities. An industry consortium is driving a key component, the open architecture Enterprise Space Battle Management Command and Control system. "*The progress on this system to date has been nothing short of remarkable and I am extremely excited for the transformational capabilities it will deliver,*" General Raymond said.

The establishment of the ***Commercial Integration Cell*** within the CSpOC has enabled the government to explore ways of sharing technology and information, as well as an increase in integration, space situational awareness and collaborative operations with commercial partners.

From the Pentagon's release of some of its conclusions from the AoA in June, we learned that there are opportunities to expand the use of commercial communications satellites. However, there was also a major perceived obstacle revealed – that some 17,000 military satellite terminals are not currently compatible with modern SATCOM technology. And yet, this is not an insurmountable challenge given the wide commercially available of modular and adaptive terminals, which should immediately be considered to replace vertically-integrated systems, enabling the expected integrated architecture.

Rather than view the sunk cost as an inhibitor to modern capabilities, following the commercial model of embedding terminals in the service, modifying existing terminals and intentionally planning for multi-mode and multi-band is the

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right path to take. It is time to "*go fast*" toward modernizing this critical infrastructure so essential to mission success.

The U.S. Air Force's now "final" ***Wideband Communication System Analysis of Alternatives*** (AoA) enlisted unprecedented industry and allied participation to offer seemingly limitless possibilities for new space, air and ground layer communications. This effort underscores the urgency for a strong, forward-looking partnership between government and the satellite industry, to ensure that available COMSATCOM solutions are fully considered as part of any recapitalization process.

***The establishment of a "Program of Record."*** Also in June, the Congress appropriated $49.5 million in funding for FY 2019 U.S. Air Force budget to create a new program of record for commercial satellite communications. The program is intended to pursue a wideband and narrowband communication architecture and acquisition strategy that include both government and commercial space systems. The Committee and DoD officials have indicated that they are seeking a better long-term plan to buy COMSATCOM via a more seamless, integrated network structure, and that meaningful changes in SATCOM procurement are required to make this happen.

Through this and the other significant steps, the government is recognizing the importance of consistent, consolidated and strategic leadership in space where COMSATCOM is an integral part of a unified architecture.

***The Final Report on Organizational and Management Structure for the National Security Space Components of the Department of Defense***. In August, this report extended the vision of the National Defense Strategy, while elaborating upon key action details. In its powerfully worded "DoD Space Vision" statement, the report reveals that the DoD will "usher in a new age of space technology and field new multi-domain systems in order to deter and if necessary degrade, deny, disrupt, destroy, and manipulate adversary capabilities to protect U.S. interests, assets, and way of life.

This new age will unlock growth in the U.S. industrial base, expand the commercial space economy, and strengthen cooperation with our allies and partners. To accomplish these goals, the Department will harness a blend of commercial and government technology, rapid prototyping, experimentation, collaboration with key allies and partners, and enhanced government-commercial relationships."

Then, to further accelerate warfighting capabilities, the President's administration announced a plan to usher in a new "Space Force" as the sixth branch of the military by 2020.

These enhanced government-commercial relationships will help open the door to enriched technology innovation. From aspirational proposals to well-established resilient global networks, new, flexible and affordable sophisticated technologies and business models — such as ***SATCOM as a Service*** — overshadow the legacy technology and greatly enhance efficiencies and responsiveness to meet DoD and other national security and federal government requirements.

Throughout the year, government and industry leaders have constantly emphasized the need to make greater use of available commercial expertise and resources. As General Hyten noted, the DoD must "go fast" and ***take risks to accomplish advancements more swiftly than our adversaries***.

To illustrate the point, General Hyten said that if a commercial company was unable to build and deliver a large wideband commercial satellite in less than three years, it would be out of business. "*Why are we [DoD] even buying wideband satellites?*" he asked. "*Why don't we have the commercial side that already built them in three years go ahead and buy them for us, and we'll just lease it back or come up with some other arrangement in order to do that?*"

Similar remarks were echoed by other government/DoD leaders at a number of public speaking events, and in interviews: Deputy Assistant Secretary of Defense for Space Policy, ***Stephen Kitay***, described an immediate focus at the DoD to improve space asset resiliency and said, "*When we talk about resilience, we're talking about the ability of an architecture to support the functions necessary for mission success with a higher probability, shorter periods of reduced capability, and across a wider range of scenarios, conditions, and threats, in spite of hostile actions or adverse conditions.*"

These statements – along with the overarching, approved policies and proposals of the past year, as summarized here – are encouraging and demonstrate a path forward to innovative, impactful, complementary SATCOM capabilities that our servicemen and women must have to operate where ever their mission takes them.

Yes, there is much more work to do, and some of it will be difficult. However, as President ***John F. Kennedy*** famously and eloquently spoke about the moon mission in 1962, we choose to do these things "*not because they are easy, but because they are hard.*"

While there are diverse perspectives about how to proceed, we all know where we need to go and that bodes very well for SATCOM in 2019 and the indefinite future.

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*Rebecca M. Cowen-Hirsch is Senior Vice President for Government Strategy and Policy of Inmarsat's Government Business Unit and she is also a leading Senior Contributor to MilsatMagazine.*

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# TRANSFORMING COMMAND AND CONTROL IN THE DIGITAL AGE

*By Marc Melviez, Chief Strategy Officer, Geospatial Division, Hexagon Digital*

**Confronted with asymmetric warfare since the end of the cold war, NATO Allies have maintained an edge over potential enemies thanks to their advanced Command and Control (C2) systems. Moreover, dominance in the air and in space has allowed almost unimpeded Intelligence Surveillance and Reconnaissance (ISR) coverage of threat areas.**

Today's C2 systems, and their rich intelligence information sources, have allowed forces to execute missions better and faster than ever before, but potential enemies have similarly made technological advances.

There are now near-peer adversaries with capabilities spread across the air, land, sea, space, and cyber domains that demand a new approach to C2. The ability to prosecute high-tempo joint coalition operations simultaneously across all domains is now seen as essential, but there are many issues to overcome.

The concept of Multi-Domain C2 (MDC2) is emerging as a key enabling capability to counter adversaries that increasingly demonstrate their ability to bring about asymmetric effects.

Many of today's C2 systems are based upon outdated legacy technology, are rarely interoperable, and certainly incapable of the rapid agile development required to meet emerging challenges. Even the current ISR advantage brings with it a dilemma that must be overcome — how to exploit the vast amount of rich intelligence data from many sources and spread across the network of networks that is typical of the *Federated Mission Network* (FMN)?

There are many new capabilities coming online that can help and the *NATO Allied Ground Surveillance* (AGS) system is one such example that will improve ISR data sharing: but the C2 systems it will feed are stove-piped, and service specific, with little dynamic data shared across domains.

If MDC2 goals are to be achieved, then our military forces need the ability to rapidly switch from one course of action to another across all domains and environments — to be able to coordinate operations, and to make informed decisions based upon exceptional *Shared Situational Awareness* (SSA).

The *Common Operating Picture* (COP) has been a traditional provider of SSA but it has all too often been limited by the detail that can be shared. Tactical and Operational level Pictures have differed hugely in content and the ability to coordinate across the services, and especially between nations of a coalition, has all too often been the limiting factor.

How can we do better? Industry has not stood still and enabling network capability, even between disadvantaged forces limited by network bandwidth, can now enable that cross-network robust sharing of intelligence data.

This can only work if systems are based upon standards, can allow the military staff officer to view any data in-context and can be used without a burden of specialist training. We risk being swamped by the amount of data now available, whether *Open-Source Intelligence* (OSINT) or based upon more traditional ISR products.

In 2017, the NGA director, ***Robert Cardillo***, forecast that there may be a million times more data in just five years. He went on to highlight that NGA alone would need eight million analysts.

Even with an increasing use of reach-back capability, to HQs out of theatre, this problem needs another approach, and once again technology can help. Novel techniques to visualize data, to allow a user to exploit what is available, and generally to better understand and exploit what is available are all ready to use.

We cannot create the analysts required but these new techniques, as well as emerging AI capabilities, can become real force multipliers. Military staff with minimal training can now delve into their data and perform their own Visual Analytics.

GPU-powered performance and the stunning visual displays of modern geospatial capability can now offer such ability: and it can be done, without compromise, alongside rich dynamic feeds and multiple data sources as a true Multi-Domain Agile COP — space, and cyber alongside intel and the more traditional operating pictures.

The '*Need to Share*' has now been widely accepted as the new mantra and, as we aspire to transform C2, these powerful new enabling technologies must be embraced if the challenges of big and ever-growing data, and the need to inform and maintain SSA are to be met.

Industry can support the Multi-Domain C2 objectives; however, military forces must be willing to embrace the technology, to manage the risk alongside the real benefits, and to develop the doctrine that can help to remove the often stove-piped single service C2 systems in favor of modern agile capability.

***www.hexagongeospatial.com***

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# SPACE WARFARE: TRAIN LIKE YOU FIGHT.

*By Adam Krause, Analytical Graphics, Inc. (AGI)*

**Why should we care about space threats? Isn't space peaceful? Unfortunately, no.**

Space is no longer a benign environment. Modern threats exist, whether they are obvious kinetic threats such as a Chinese direct ascent anti-satellite missile, or less observable and more subtle stratagems, such as close proximity maneuver operations.

China, Russia, and others are rapidly increasing their proficiency in this new warfighting domain. Moreover, the impact of these threats is growing ever more significant as modern societies, and modern warfare, increasingly depend on space-based capabilities. Whether it is loss of a space platform or a loss of service, modern cultures and their security depend on satellites.

To counter the menace, we first have to understand the threat. Classic strategy starts first with knowing your enemy and then extends to knowing yourself.

Space threats and space warfare are no different. You cannot defeat a threat if you don't see it coming or you don't understand what you are seeing. Is it a hostile maneuver or is it just routine station-keeping? What could you do if you did recognize the threat? How would you maneuver? Which maneuver would result in the greatest tactical advantage?

To answer these questions, training is required. Training is the lifeblood of the military and should be no different as the threat extends into space. Space operators must be trained to respond to potential threats in ways that are practiced and accurately account for their own capabilities and limitations.

The U.S. Air Force recognizes this challenge and has started to address it. Recently Brigadier General ***DeAnna Burt***, Director of Operations and Communications for ***Air Force Space Command*** (**AFSPC**), discussed numerous improvements her organization is making to better prepare operators for the space threats of tomorrow.

Key areas include increasing the scope and classification level of Undergraduate Space Training conducted at Vandenberg Air Force Base, increasing the number of coalition partners who train in U.S.-lead space exercises, such as the recent "*Schriever War Games*," and potentially instituting new training courses for enlisted 1C6 space systems operators.

However, even with these initiatives, we still need better training tools. The U.S. outspends China 4:1 in space, yet China is closing the performance gap. In the age of **Google** and **SpaceX**, relying on 20 year old software and white card exercises is not a tenable strategy to defend our critical national assets.

A military cornerstone is "*Train like you fight and fight as you train.*" As a former Naval Flight Officer, I can attest that this is the way it is done in the air community. If I didn't stay current, I didn't fly — if I didn't fly, I was back in the simulators.

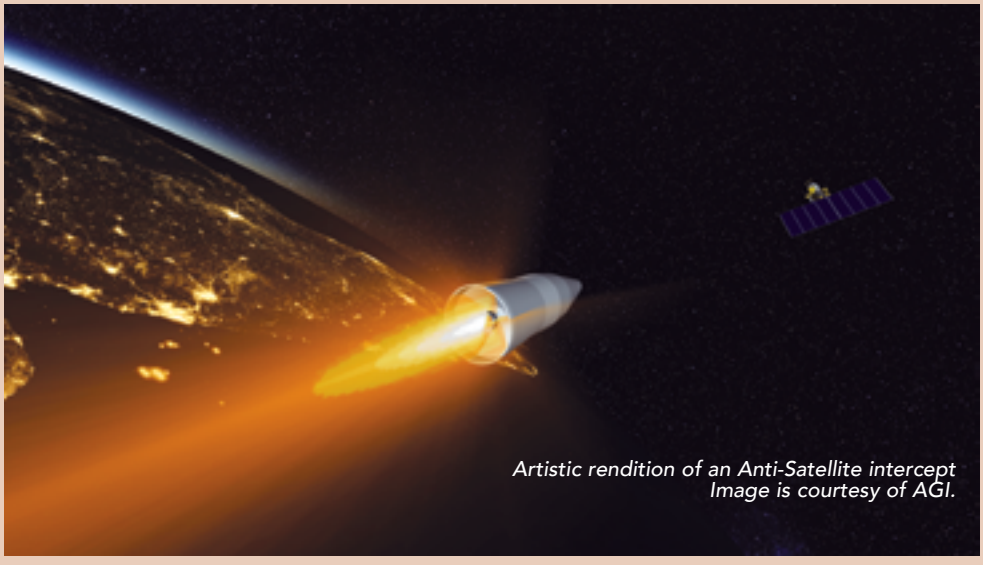
We had the tools to ensure we were prepared to fight: We trained in the aircraft that we fought in and our simulators were functionally, mirror images of the real aircraft. This is where we need to get in space.

AFSPC is actively studying the air, land, maritime, and cyber domains to better understand their processes for instituting operationally relevant training, developing tactics, and determining rules of engagement. Additionally, they recognize the need for better space operations simulation tools.

Brigadier General Burt, in fact, called out simulators as the biggest issue in space operations training and exercise effectiveness today and noted that AFSPC is increasing their budgets in this area to directly address this deficiency.

*Brig. Gen. Burt of AFSPC.*

The General's concerns are reflected in many of the conversations AGI has had with customers across the market and during the exercises we



*Artistic rendition of an Anti-Satellite intercept Image is courtesy of AGI.*

have supported. Throughout these, we have identified two main challenges in the area of space exercises and training.

The first issue is the training timeline, and its impact on currency and readiness. Air Force Group Commanders are doing the best they can with the tools available, but these tools can take operators and expert contractors weeks to months of work to generate the data needed to support an exercise. This extra time costs more and leads to lower readiness levels.

If you are only training monthly instead of weekly, you can't stay current. It also means you can't keep up with evolving threats. Moreover, these slow tempos are not viable if you are trying to rapidly execute potential, what-if scenarios, which are critical to tactics development. Frequent and agile training and simulation capability is critical, but is currently inhibited by today's underperforming tools and extended timelines.

The second significant challenge is accuracy. Any pilot walking into a simulator expects it to behave like the real aircraft. Yet today's space software simulators use simplistic representations of the real thing; they often model only a portion of the catalog or of the total mission.

Typical exercises include only ten to 50 objects and often the associated ephemeris is based on an assumption of persistent sensors and perfect orbit determination. In reality, orbit determination is regularly quite imperfect, operators have to deal with up to 20,000 different background objects and sensor data is almost always noisy and sporadic. This kind of unrealistic training without real-world fidelity and difficulties leads to poor preparedness.

With these two primary challenges in mind, AGI embarked to define a test, training, exercise support tool for the modern space threat environment.

First, we determined that any viable capability required sufficient scope. It had to be able to model a majority of the regular threats and space events experienced today.

Next, it had to be realistic, employing full fidelity force modeling in a physics-based environment. Simulated objects need to move as real threats would.

Third, it had to be quick. You can't model what-if scenarios and expect to make progress if you are waiting days or weeks between runs. We wanted to be able to create a scenario, run it, learn from it, change it, and run it again within minutes. And not for one object, but in a scenario of multiple, linked space events, intermixed with a fully representative background catalog.

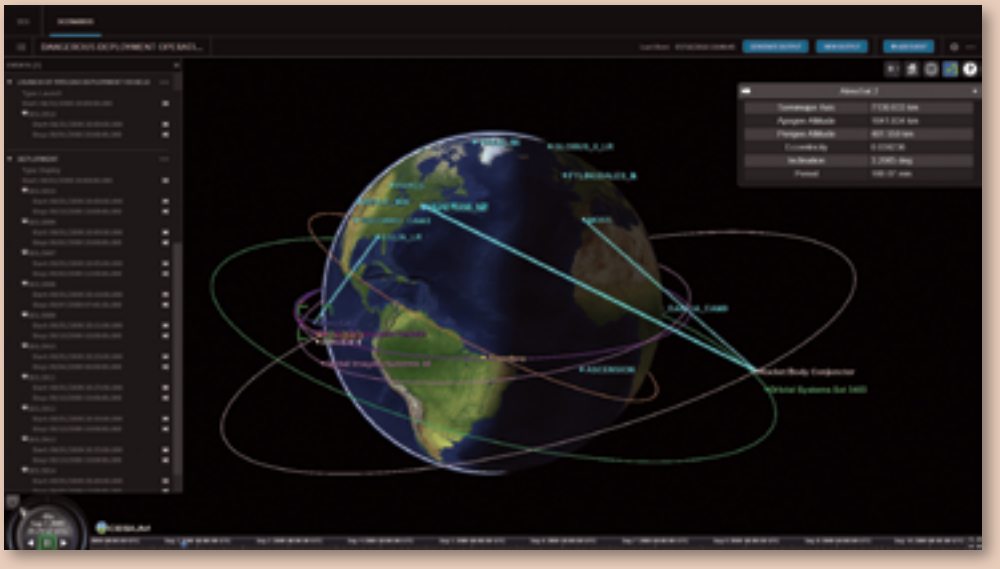
To accomplish this, it had to be highly automated. Why do manually what can be automated with modern programming architectures? Additionally, it had to be operator friendly.

We envisioned a tool that didn't require an astrodynamics Ph.D. or even a contractor to run it. We wanted something with simple interfaces and constructs to enable operators to use the tool effectively and independently.

Finally, interoperability was vital. No single tool can do it all. AGI envisioned a simulation platform that could additionally leverage an ecosystem of external tools, each with their different strengths, and bring them all together in a coherent simulated scenario.

These requirements led AGI to develop the ***Space Event Generator*** (**SEG**), commercial software aimed at meeting the modern space threat training challenge. SEG allows operators to rapidly create accurate, space event simulations with full 3D visualization, outputting ephemeris, sensor observations, and access in-views.

Additionally, SEG is extensible and interoperable with AGI's complementary applications, such as ***STK***, ***Space Object Threat Assessment*** (**SOTA**), and ***Voyager*** (AGI's detailed RPO modeling tool), as well as third party applications.



AGI aims to help space operators better simulate realistic space events, better visualize the space battlefield, enable enhanced and more effective space operations exercises, and develop more in-depth tactics for space operations and reactions.

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# ADVANTECH WIRELESS TECHNOLOGIES

*By Cristi Damian, Vice President, Business Development*

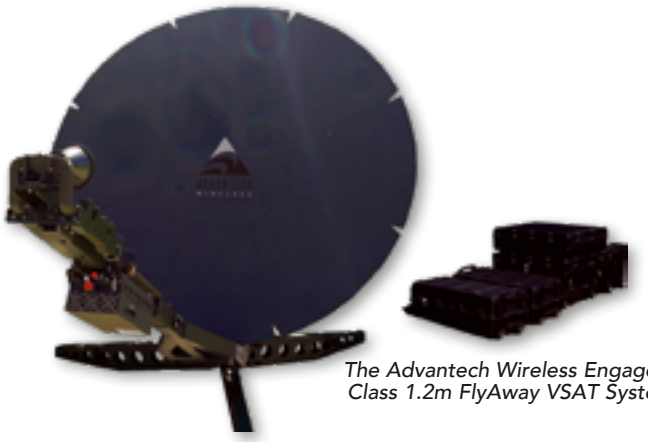
**If you asked the question: "*What do SATCOM communications, Tropo scattering links and new advanced RADAR design concepts have in common*?", Advantech would unequivocally answer: Gallium Nitride (GaN) Solid State Technology.**

Advantech was an early believer in GaN technology and after more than ten years of intense engineering development, the company has built this advanced engineering into all three, rather distinct, military classes of equipment.

For Advantech, 2018 witnessed increased military demand and spending for advanced SATCOM, TROPO (*Tropospheric Scatter Communications*), and RADARs. Almost all military grade SATCOM terminals today use GaN technology.

The exceptional improvement in efficiency, linearity and reliability, combined with drastically reduced weight and size, make this technology the preferred choice for mobile applications.

Throughout 2018, Advantech manufactured and delivered thousands of low form factor SSPAs (*Solid State Power Amplifiers*) designed for portable Mil Grade SATCOM terminals. These are now **ARSTRAT** or **XTAR** certified and part of all major NATO MODs (*Ministry of Defense*).



*The Advantech Wireless Engage™ Class 1.2m FlyAway VSAT System*

The **Engage** class of military grade flyaway antenna terminals, designed and manufactured by Advantech, saw significant sales. Ranging from 60 centimeters to 2.4 meters, these antenna terminals are fully integrated with C-, X-, Ku- or Ka- GaN RF and are able to deliver more than 50 Mbps in harsh environments.

The antenna terminals bring innovative ideas into practice. Each terminal can sustain two separate encrypted communication links, allowing simultaneous communication between the remote terminal and the command center or between two remotes.

With the fragility of today's GPS systems, these antenna terminals offer anti GPS jamming capabilities and are able to cancel several jammers simultaneously.

These terminals have now been adopted by various NATO MODs and the company has won multiyear supply agreements from them. The large SATCOM teleports used by NATO are now also deploying GaN technology.

In 2018, Advantech won several major contracts with power levels in the range of 6kW. Products with GaN Solid State in C-, X-, or Ku-band are regularly installed worldwide. These powerful systems have built-in redundancy, extremely high linearity and are replacing multiple aging klystrons and TWTS.

The OPEX cost savings are also remarkable, with the entire initial investment usually being recouped in less than 2 years from electrical savings alone. By using these products, NATO avoids the cost of transporting diesel fuel to keep electrical generators running in combat zones.

2018 has seen a TROPO comeback. With previous technology, TROPO's were limited to low data rates and required large TWTs or Klystrons to close the link.

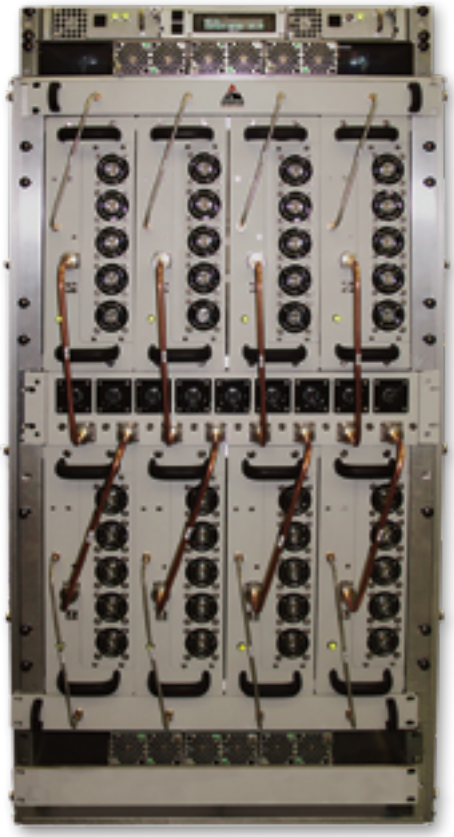
*The Advantech Wireless 2.5kW TROPO C-band Modular GaN based Solid State Power Amplifier*

Today, Advantech's GaN SSPA designs for TROPO links resurrects the old TROPO.

Small SSPAs are now available to replace the large TWTAS and are drastically reducing the cost and complexity of the TROPO terminal.

In early 2018, Advantech successfully demonstrated data rates of up to 100 Mbps using these very high linearity GaN SSPAs. While TROPO benefits from "*Free Bandwidth*," the terminal cost was historically high and the data rates low. With the introduction of Advantech TROPO GaN Technology, such concerns are now eliminated.

Advanced **RADAR** systems for military markets require a vast amount of R&D. Advantech introduced some of the world's first 10kW GaN modular SSPA systems for large defense RADAR in 2016. Now, when you hear the word RADAR, it is generally accompanied by the term GaN.



*The Advantech Wireless 12kW L-band Solid State Pulse Amplifier MODEL APRA-L12000A*

In 2018, Advantech expanded its GaN SSPA portfolio for RADARs with power ranges from 500W to 20kW in L-, S-, and X-bands. These systems have built-in redundancy and offer increased reliability. Due to the low jitter capabilities and pulse sharpness, these SSPAs are now allowing a longer detection range, while using a fraction of the power.

An older generation 1 MW Magnetron can easily be replaced by an Advantech 10kW GaN SSPA while achieving the same or better performance at a fraction of the cost. Portable RADARs also benefit from small and powerful GaN SSPAs designed by Advantech.

Point-to-Point microwave links were popular selling products in 2018. The Advantech **T800** line of MW radios gained acceptance by the military community.
The Army requires high data rates for IP data, video links and voice and the T800 delivers. Advantech's T800 MW class of point-to-point radios is a very attractive choice for secure tactical communication networks due to their reliability, ability to multiplex IP traffic with video traffic directly from video encoders, and have integrated IP routing and redundancy.

In 2018, initial trials using the T800 technology in drones were performed successfully. The ability to carry both video and IP traffic are of critical importance for any drone application and Advantech has been successfully incorporated this into the T800 product line.

For Advantech, Military Grade R&D in 2018 was important. A new generation of GaN based SSPAs, with higher power and higher linearity, will be released during 2019.

Sustained R&D is now taking place in order to release a Ka-band GaN High Power SSPA as well as a monopulse antenna controller for delivery in early 2019. This Monopulse ACU will work in dual mode, offering either the Advantech proprietary ***INTRAC ACU*** mode, or ***Monopulse Mode***, depending on the application requirements.

*The Advantech Wireless INTRAC 605 Antenna Controller Unit Monopulse Antenna Tracking Controller for Antennas up to 35 meters*

As the military industry continues to demand better and more reliable products, Advantech is making a strong commitment to support the firm's customers. In order to execute on the increased market demand, as well as deliver large R&D initiatives, Advantech has invested in a brand new, state-of-the-art design and manufacturing facility which will be fully operational by the end of calendar 2018.

The company is working diligently to ensure the continued delivery of quality cutting edge global solutions in 2019 and beyond.

***www.advantechwireless.com***

*Mr. Cristi Damian joined Advantech Wireless in 1995 and has held various positions in operations, manufacturing, sales, engineering and customer support. Prior to working at Advantech, Cristi was employed as a hardware engineer in various high-tech companies. He holds a Master's degree in Electrical Engineering from Concordia University.*

# ATLAS SPACE OPERATIONS

*By Mike Carey, Co-Founder*

**2018 was a sensational year for ATLAS Space Operations Inc. as the company completed their Series-A round of investments as well as captured multiple government contracts while more than doubling in size to meet demand for its services — 2019 is projected to be an even bigger year for the company.**

In 2018, ATLAS looked to the company's four founding members industry know-how to pave the way for a successful year in the government sector. Led by ***Sean McDaniel***, the original four members of ATLAS provide the company 100+ years of U.S. military and government experience. As a Bronze Michigan Veteran-Friendly Employer, this experience has proven to be invaluable as the company continues global expansion.

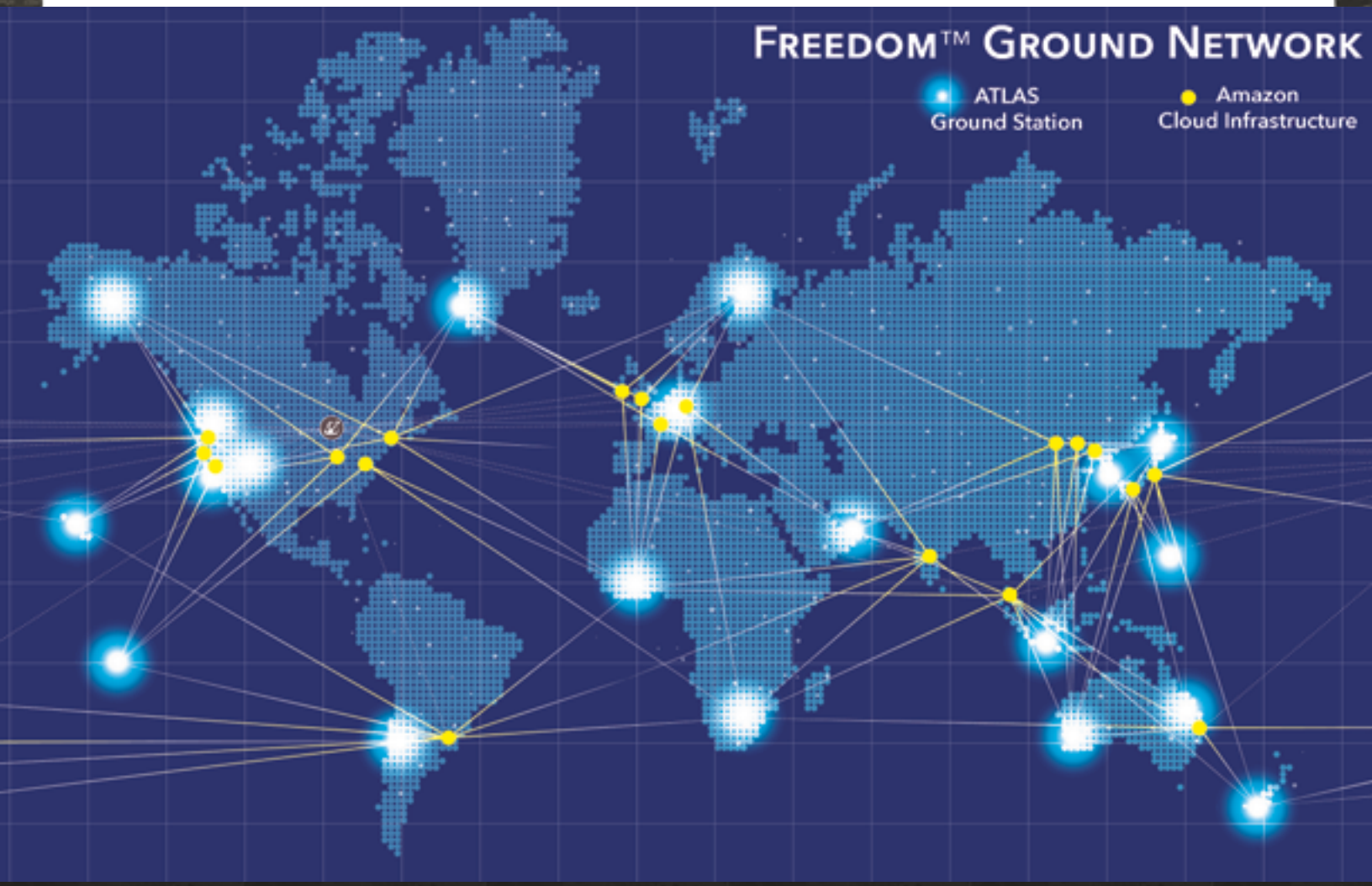
"*Our collective experience serving the DoD has armed us with experience and discipline to deliver excellence in our product,*" said ATLAS co-founder, ***Mike Carey***. "*The qualities of military service translate directly to our work ethic and security mindedness, with first order effects on ATLAS' performance. It's a true differentiator in our market.*"

ATLAS was awarded multiple U.S. government contracts in 2018.

Highlighting this success is an **Air Force Research Laboratory** (AFRL) *Cooperative Research and Development Agreement* (CRADA), aligning ATLAS to further strengthen the resiliency of the **U.S. Department of Defense** (DoD) space and satellite control networks.

ATLAS additionally won the contract to support the **United States Air Force Academy**'s ***FalconSat-6*** and ***FalconODE*** (***Orbital Debris Experiment***) spacecraft, providing uplink and downlink communications services from the ATLAS 3.0 meter S-band ground station located in Sunyani, Ghana, and UHF ground station in Cedar, Michigan.

During the past year, ATLAS grew its ***Freedom™ Network*** of ground stations, bringing U.S. antenna locations in California, New Mexico, and Washington online, as well as others overseas in Ghana, Finland and New Zealand.
Most significant of these antennas is the array located in



Albuquerque, New Mexico; it is ***LINKS***™, the world's first commercially available, mobile, and rapidly deployable *Electronically Steered Array* (ESA).
LINKS is one of the key pieces of game-changing


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

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

The fully completed Freedom Ground Network of antenna will consist of no-less-than 30 ground stations, all strategically dispersed across the globe.

These ground stations will provide connectivity for a broad range of missions including launch support, communications with spacecraft in either equatorial or polar orbit, as well as spacecraft in deep space.

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

Freedom does much more than provide clients full telemetry, tracking, command, and control capabilities — the software's advanced scheduling algorithm does all the work for the user, making the whole process not just easier and faster, but more cost-effectively.
Gone are the days of needing a separate satellite modem


*ATLAS Space Operations FREEDOM screenshot.*

for every antenna as Freedom needs only single point VPN access that integrates into the Freedom Network of global ground stations — this is a far more secure architecture.

Moving forward into 2019, ATLAS will continue seeking opportunities to support U.S. Government ventures into smallsat and expeditionary satellite services.

***www.atlasground.com***

*Mike Carey, a former USAF Major General with 34 years of experience in satellite and space-related operations is now shaping ATLAS's future through strategy development, business planning, and market engagement. Experienced with Air Force Satellite Control Network, Eastern/Western test ranges, the Space Test and Training Range, General Carey has the technical and political prowess to maneuver in the ever-expanding space markets.*

*ATLAS S-Band LINKS comparison photo.*

# BALL AEROSPACE

*By Brad Tousley, Vice President and General Manager, Commercial Aerospace and Strategic Technology*

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

The demand for data continues to grow — users want more data, received faster than ever before. Take the smartphone, for example. Many smartphone models now record and send massive 4K video files and users expect those transfers to happen in the blink of an eye.

As technologies such as smartphones advance, more data is being generated and transmitted than ever experienced. One could say users are "gigahertz guzzlers."

The problem is that current communications architecture, both satellite communications and ground, will not be able to support the speed, security and capacity needs of tomorrow.

How those demands are met within the constraints of scarce radio frequency (RF) spectrum means bringing transformational communications technologies to market — and fast.

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

### *Optical Communications*

Free-space optical communication systems provide an innovative complement to traditional RF solutions, bringing the Internet speeds of terrestrial fiber optics to space.

Using laser technology, optical communication systems offer a much narrower and more focused beam than traditional RF links, resulting in higher data rates, more capacity, greater security and smaller, lighter and more affordable terminals.

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


This year, Ball Aerospace announced a collaboration with Honeywell to develop a line of affordable, high-performance optical communication terminals for the commercial market.

Boasting a combined 60 years of experience in optical communications, Ball and Honeywell will work together to establish volume production of optical terminals for high-speed communications from ground to space, spacecraft to spacecraft and spacecraft to aircraft.

Together, Ball and Honeywell will optimize volume production, enhancing technical designs for low-cost repeatability and leveraging a proven, robust supply chain.

The team's proven capabilities in developing and manufacturing precision space-based optical systems will ensure that cost, volume and technical requirements of tomorrow's LEO and GEO communications satellites are met.

For customers who need data at the speed of light, optical communications technologies deliver.

Ball's partnership with Honeywell is enabling this innovative technology area to expand into the commercial marketplace.

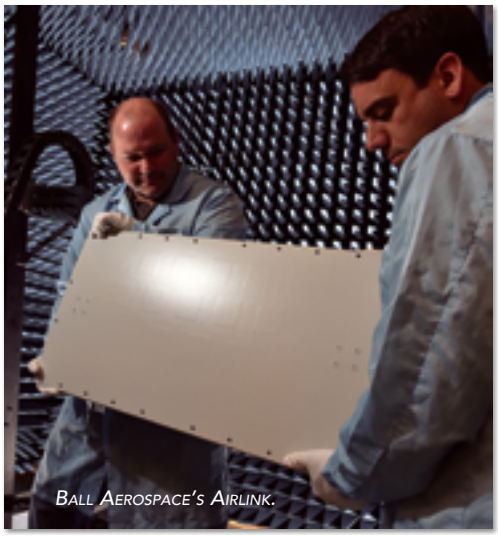
### *Phased Array Antennas*

Another encouraging technology trend over the past year has been the development and recognition of the potential of commercial phased array antennas.

Phased arrays deliver the critical 'last mile' connection, the gap between the data source and the end user. Wireless last mile solutions enable global network infrastructures and a whole new class of mobility applications.

Ball Aerospace has five decades of experience developing phased array antennas for the U.S. military, enabling mission-critical communications.

Now, Ball is leveraging that expertise to transition phased array technology to commercial communications markets, including SATCOM and in-flight connectivity. The benefits of phased arrays are numerous and exhibit why this technology area, though not new, has exciting commercial applications. Ball phased arrays are electronically steerable, with no moving parts, meaning customers enjoy higher reliability and lower maintenance costs.


Ball Aerospace's Airlink.

The fast, agile and accurate steering of electronically steered phased arrays enables quick and seamless tracking between satellites — key for today's in-flight connectivity (IFC) and tomorrow's large LEO constellations.

The low profile of phased arrays reduces drag on mobile platforms, which is most notable on aeronautical platforms, reducing overall operating costs. Electronically scanned phased arrays provide a significant size and weight advantage over mechanically steered antennas.

Much like many electronic devices today, these arrays are 'smart,' configured by software and aligned automatically, a major step up from parabolic dish antennas that require manual calibration and alignment. Ball is actively developing and selling modular, scalable antennas in the X-, Ku-, and Ka-band spectrums.

Phased array technology is enabling the future of 5G wireless, the next generation of wireless technology for the smartphone and smart device market. The 5G architectures of the future will use millimeter wave radio frequencies.

Ball has a wealth of experience manufacturing phased arrays that transmit and receive data in millimeter wave radio frequencies, delivering the speed and data throughput of fiber optics without the price — a must in the 5G marketplace.

To demonstrate the capabilities of Ball's commercial 5G phased arrays, Ball is working with **Anokiwave** and recently enabled the world's first 5G commercially available 256-elemend phased array at 28GHz and 26GHz.

The San Diego-based Anokiwave is a cutting-edge provider of highly-integrated circuit solutions that enable emerging mm-Wave markets and active antenna-based solutions.

While commercial phased array technologies are promising, their commercial viability depends on the ability to drive down costs by manufacturing at scale. Ball has already delivered phased array systems with all the key components to government markets.

In 2018, our focus remained ramping production into high gear with designs that can be manufactured in high volumes — a key solution for LEO communications constellations.

## *Looking Ahead*

For Ball Aerospace and the company's transformational communications technologies, 2018 was a banner year.

What's next in 2019? More key tests to demonstrate the potential of the firm's technology are on the horizon and Ball Aerospace will continue to leverage industry partnerships to deliver the best products for our customers.

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

In today's world, a company's success is directly related to its ability to connect with the people, technologies and markets that it depends on.

As the need for data grows and the number of smart devices increases, customers staying connected depends on innovative adaptations for proven technologies such as optical communications and phased arrays.

Ball is transforming the communications architecture, delivering reliable, high-speed, high-bandwidth connectivity — between satellites and to and from space.

The company's innovative, high-bandwidth inter-satellite links and Earth-to-space links meet customer needs for data at the speed of light and connect the world faster and more securely.

With low-cost phased array SATCOM antennas, innovative 5G Rapid Prototype Phased Arrays and advanced optical communications terminals, Ball Aerospace is helping the world meet today's data demand.

***www.ball.com/aerospace***

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

# BOEING SPACE AND LAUNCH

*By Dr. Bruce Chesley, Senior Director of Strategy*

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

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

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

The tantalizing possibilities associated with proposed new Low Earth Orbit (LEO) constellations are many, but questions persist: how many will be built, how long will they take and will they succeed?

These uncertainties have, until recently, held most major commercial satellite operators back from buying more satellites to replenish their Geosynchronous Orbit (GEO) fleets, despite a great need to do so.

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

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

In 2018 Boeing acquired El Segundo, California-based Millennium Space Systems, a leading provider of small satellite solutions.

Boeing's HorizonX Ventures also made strategic investments in BridgeSat Inc., a Denver-based optical communications solutions company, and in Accion Systems Inc., a Boston-based startup pioneering scalable electric propulsion technology for space vehicles.

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

- *Millennium's small refrigerator-sized satellites can*

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

*pack multiple space mission solutions into a much smaller package that is more affordable and easier to launch. These Millennium platforms, and the company's expertise in avionics, structures, electronics and antennas, will complement Boeing capabilities and ultimately enhance our product offerings.*

- *BridgeSat has developed a global network of optical ground stations that will allow satellite networks to more securely and reliably transmit large amounts of data to and from space. By investing in companies with advanced optical communication technologies, we aim to accelerate space-qualified optical communication around the world.*

- *Accion's expertise in innovative space vehicle engine technology featuring non-toxic, ionic liquid propellant and dime-size thrusters will increase the lifespan and maneuverability of satellites and other vehicles in space. Accion's technology is smaller, lighter, and more cost-effective than traditional ion engines and can serve as an efficient way to keep constellations of satellites in orbit and propel spacecraft designed for interplanetary exploration.*

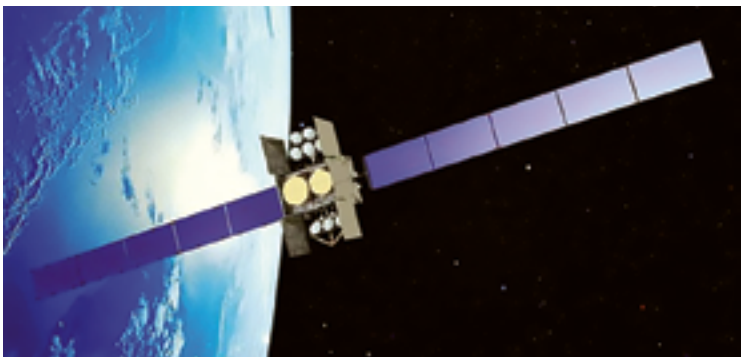
Clearly, Boeing sees that satellites — and technologies such as these that make them go — are an exciting and important part of its current and future space portfolio. It's a portfolio that already included advanced space and communications satellite systems for military, commercial and scientific uses,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

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

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

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

This latter group includes the seven MEO satellites that Boeing is building now for SES Networks' O3b mPOWER system. Boeing is developing cutting-edge technologies for mPOWER that will be incorporated into future spacecraft supporting a potentially wide range of programs and customer needs.
As the year drew to its close, Boeing shipped WGS-10 to prepare for its upcoming launch. We also submitted a proposal for NASA's lunar orbital gateway.



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

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

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

***www.boeing.com***

*Dr. Bruce Chesley is Senior Director of Strategy for Boeing Space and Launch, where he leads a team charged with analyzing the marketplace, establishing a growth strategy and helping shape the future direction of the Boeing Space and Launch division, which includes the International Space Station; government and commercial satellite systems; and Boeing's work on its CST-100 Starliner Crew Capsule and the NASA Space Launch System. Chesley joined Boeing in 2000 after serving in the U.S. Air Force. His Air Force assignments included positions at Air Force Space Command, the National Reconnaissance Office and the Department of Astronautics at the U.S. Air Force Academy. He holds a doctorate in aerospace engineering at the University of Colorado, Boulder; a Master of Science in aerospace engineering from the University of Texas at Austin, and a Bachelor of Science in aerospace engineering from the University of Notre Dame.*

# CPI ANTENNA SYSTEMS DIVISION

*By Tony Russell, President*

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

The past year has been a highly successful one for the new **Antenna Systems Division** (ASD) of CPI on several fronts. This was the company's first year as the newly consolidated Antenna Systems Division, which was formed by integrating the activities of CPI's two antenna divisions — the former **Malibu Division** in 2007 and **ASC Signal Division** in 2015 — under a single operating division. This effort was a significant undertaking and the synergies harnessed from operating as a single division have been substantial. Of particular note is that this consolidation better enabled us to unite the technological strengths of each organization in one, comprehensive offering for customers.

### *A Record Year for ATC Radar*

In 2018, in spite of a softer commercial SATCOM market, ASD's business grew and had several key areas of success, particularly within the government and military MILSATCOM market segments, which remained strong during the year, and industry interest in our transportable, multi-band, SATCOM ***Trifold***® systems is expected to continue.

CPI ASD's line-of-sight (LOS) telemetry systems and other unique products for MILSATCOM applications were also strong sellers. In addition, the firm's air traffic control (ATC) radar antenna business saw a record number of systems being manufactured and the near-term outlook for these systems is rosy heading into 2019.

### *The Link*

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

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

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

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

### *Two Key Areas of Growth*

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

In August of 2018, CPI grew the firm's antenna technology and expertise for various space and satellite communication markets, strengthening the product portfolio with the simultaneous acquisition of **Orbital Systems** and **Quorum Communications**.

These two related companies design and manufacture antenna positioners, as well as complete front-end systems that meet the high performance, accuracy and reliability needs of *Earth Observation Satellites* (EOS), direct broadcast (DB), telemetry and control (TT&C), UAV/RPV tracking, radar, search & rescue (SARSAT), and general satellite uplink and downlink applications.

*An Orbital antenna.*

CPI's acquisition of Orbital and Quorum brought the firm the designs for cost effective, high-quality full-motion antenna solutions for thesatellite remote-sensing market, including microwave receivers, demodulators, downconverterand feeds.

CPI ASD anticipates strong growth in these vertical markets over the next decade. With this acquisition, ASD offers a best-of-class antenna portfolio to address the demands of a growing customer base.

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

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

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

***www.cpii.com/asd***

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

# EM SOLUTIONS

*By Dr. Rowan Gilmore, Managing Director and Chief Executive Officer*

***Who would've thought in 2018...***

That by September, the share price of the "Big 3" satellite operators would rise by 250 percent over the past 12 months, outperforming aerospace and defence shares by a factor of four

- *That low-earth trials would prove that LEO constellations will become a reality — but that cost-effective ground terminals remain a pipe-dream?*
- *That more than 20 companies around the world would still be racing to develop a flat-panel tracking satellite terminal — while marketing hype still continues to outpace the commercial reality?*
- *That a 1 meter terminal could achieve data rates over 100 Mbps with a GEO satellite — and exceed the capacity of a much larger 2.4 meter terminal?*

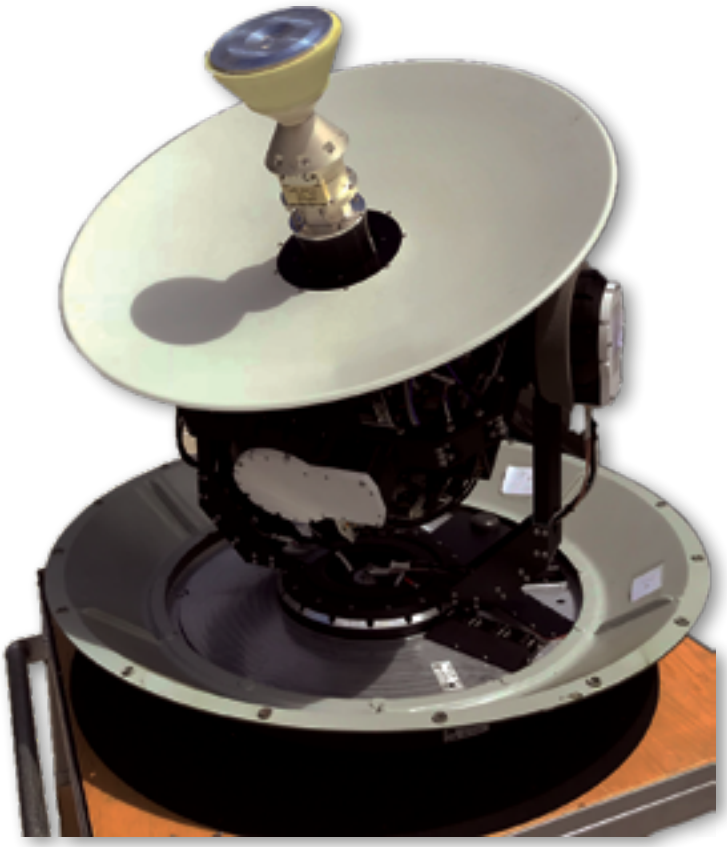
***Full of Surprises***

EM Solutions displaced a goliath in the industry. The company delivered the first ***Salamander*** roll-on, roll-off, Ku-band, *Communications-On-The-Move* (COTM) terminals that are designed for land and sea operations to an Asian army, plus, at the end of the year, completed the development of a power and size upgrade in order for the Salamander terminals to also be used by an Asian police force.

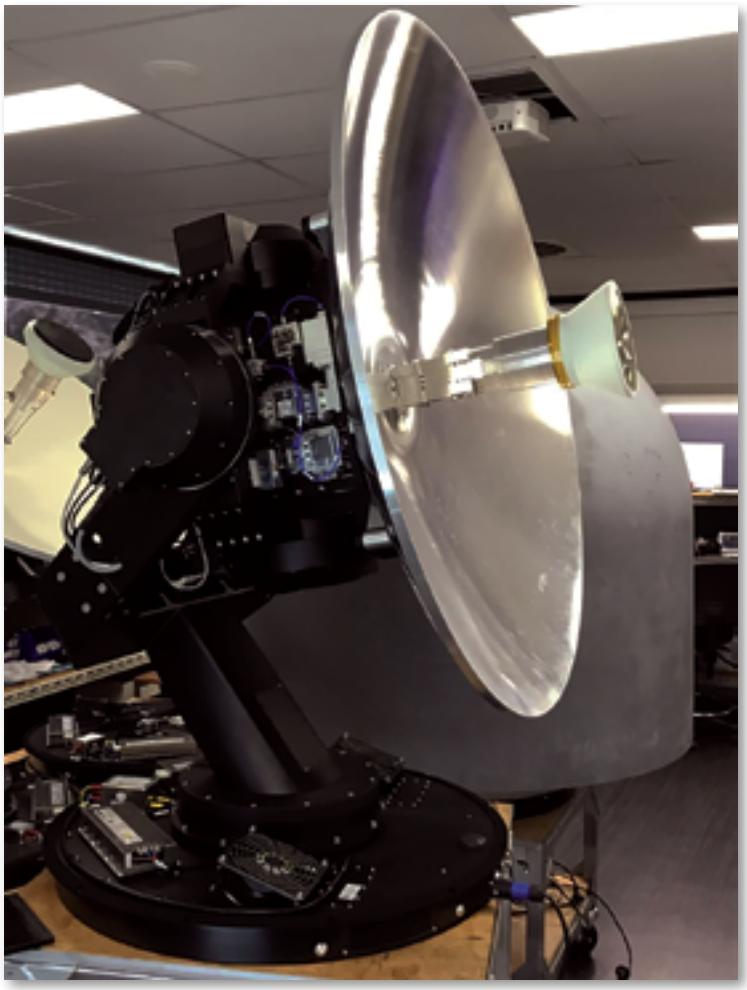
This unique terminal has constant gain over any terrain and thus maintains a high data rate when most needed and is the only satellite terminal that can be shifted from boat to truck for immediate use without modification.

Then in September, the company's well established Ka-band maritime ***Cobra*** terminal was used as an anchor node by a defense client to test a military satellite transponder as part of a star network with multiple terminal types. Not only did the 1 meter Cobra achieve data rates of more than 100 Mbps, the Cobra outperformed terminals twice as large in size.

It was only then that we realized how important accurate antenna pointing is at the higher Ka-band frequencies. Mis-pointing a



*The EM Solutions Salamander Ku-Band COTM Terminal.*



*Cobra X/Ka Triband Terminal prior to delivery from EM Solutions facility in Brisbane, Australia*

2.4 meter terminal by as little as 0.2 degrees is enough to cause the unit's transmit performance to be worse than the much smaller, but much more accurately aligned, Cobra.

The company has bragged about the firm's monopulse acquisition and tracking system for years; however, it took a trial such as this to make the firm realize that there is no point buying a bigger terminal if the unit's pointing capabilities are not up to scratch. EM Solutions expects that when LEO constellations do become operational, such errors in tracking will have to be addressed head on.

To complete the trifecta of surprises, in honor of the company's work in developing the Cobra terminal with the **Royal Australian Navy** and bringing it into operation on the first of their ships, EM Solutions was awarded the coveted *Essington Lewis Trophy for best Defence SME* by **CASG**, the Australian Defence procurement agency.

Since 1998, the company has been developing bespoke and customized solutions for customers, now including blue-chip defence forces. From the firm's roots as a developer of solid-state power amplifiers, filters, and oscillators, EM Solutions has progressed up the value chain to develop high speed receivers and transmitters for radios and now on-the-move terminals to become the partner of choice for several systems integrators and, increasingly, customers around the world.

For example, the company's ***50W and 80W Ka-band linearized transmitter*** (**BUC**) still remains the only airborne-qualified solid-state Ka-band BUC at this power rating on the market, specifically developed for a European prime contractor.

During the year, the company was awarded a multi-million dollar contract by that customer for use in IFC (*in-flight connectivity*) solutions.

The company's research with the **University of Queensland** also continued, with EM Solutions Research Fellow Dr. ***Yifan Wang*** leading an innovative project on a novel reconfigurable Flat Panel Antenna — to align with the company's strategy to offer on-the-move terminals that are both broadband and monopulse steered.

The firm's first prototype has shown the potential for this technology to satisfy both of the aforementioned attributes at a cost-effective price point in order for demonstrations to now be scheduled for later in 2019.

How can a small Australian company be unique and relevant? By being willing to customize SATCOM radio products, by providing multi-band solutions and by developing superior technology, such as terminal stabilization for high availability COTM.

Two of the company's biggest advantages have been its flexibility and innovation, and these haven't waned. Innovation occurs by building on the shoulders of giants that have gone before.

The real giants in the innovation puzzle are those customers who embrace innovation and are prepared to fund its development. Such customers push the technology envelope and drive innovation by demanding specialized requirements, new features, and performance improvements.

*As 2018 draws to a close, EM Solutions salutes the company's customers — they are the real heroes.*


***www.emsolutions.com.au***

*Rowan Gilmore is Managing Director and CEO of EM Solutions, the Brisbane, Australia, -based technology developer of high speed microwave radio and mobile satellite communications terminals. Rowan is a graduate of the University of Queensland (UQ) and Washington University in St Louis, Missouri, where earned his doctorate in electrical engineering. Since joining EM Solutions in 2011, the company has tripled its revenues and won a number of prestigious awards, including the 2016 Brisbane Lord Mayor's Business Award for Innovation. The company exports more than half its products, which are in use by customers as diverse as the New York Stock Exchange and the Royal Australian and U.S. Navies.*

# EXOS AEROSPACE

*By John Quinn, Co-Founder and Chief Operating Officer*

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

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

### *The Beginning…*

With a military background as a submariner in the U.S. Navy, Quinn has been involved with engineering most of his adult life. He and his close friend/business mentor, *David Mitchell*, co-founded **Exos Aerospace Systems & Technologies, Inc.** in 2015.

David worked on funding the operation, while John focused on the day-to-day tasks of developing the technology and the processes to mimic how commercial spacecraft are flown and "reused."

On August 25th, 2018, the Exos team successfully test-launched and recovered their ***Suborbital Autonomous Rocket w/GuidancE***, (**SARGE**) vehicle from **Spaceport America**, providing a glimpse into a future of increased space flight opportunity via reusable vehicles.

### *The Launch…*

The rocket was "light loaded with propellant," reached an altitude of 32 km. and was recovered less than 30 minutes later with 99 percent of the vehicle ready for reuse, validating the vehicle's robust design.

The test also demonstrated the capability of the autonomous control system, validated the preflight vehicle integration process and proved accuracy of the models that will be used for fine-tuning the vehicle for a NASA IDIQ qualification flight planned for January 5th, 2019.

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

### *The Impact…*

#### *Government/Military*

The implications of these reusable rockets will be pivotal in the industry. The SARGE rocket is designed to support up to 200 flights, but Exos plans to use the Lox/Ethanol vehicle as long as it's "safe" and ultimately desires to sell the liquid-fired rockets to Missile Defense Agency (MDA) as "hard-to-acquire" targets when they near the end of their economically viable life.

Meanwhile, plans for Jaguar to provide low-cost, fast turn-around solutions for satellite deployment could place Exos in the forefront of military and commercial space needs.

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

Looking back at Sputnik, the satellite weighed 83 kg.

*The successful Exos Aerospace SARGE launch.*

yet, today, its replacement would weigh only a few ounces. Exos intends to leverage what the firm calls the "*miniaturization of space*" as they initially develop their small-scale launchers to serve the sub-1000 kg. reusable (first stage) launcher market.

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

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

***BioMedical Research***
Unlike flying on traditional solid fuel spin stabilized rockets (such as missiles), Exos rockets are stabilized using fins and gimbal capabilities to keep the vehicle from rolling.

The gimbal used for controlling and directing SARGE is controlled by ***Morpheus*** flight software that was acquired through a Space Act Agreement with NASA. The drogue recovery system brings the rocket back from space and the Wamore GPS guided canopy system flies the rocket back to its launch site within minutes of launch. All this results in a very smooth (~5G) and efficient rocket ride that is friendly to even the most delicate of payloads, giving medical researchers hope for new space tests and data acquisition.

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

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

While working though the process of bringing Suborbital Capabilities to Italy with the Italian government and **PricewaterhouseCoopers**, Exos realized the many benefits and resources that are available in the region. In addition to the benefits afforded companies that come to support development in the SEZ (Special Economic Zones), it is also well positioned with Aerospace University pipelines and the broad base of expertise available across the EU.

When developing the business plan for Italy, the team said they could not deny the logistically enviable position they found possible if they expanded their plans for Italy to include development of the ***Exos Mobile Reusable*** (first stage) LEO Launch Vehicle. Based on this realization, this expansion will include additional facilities to support the added scope of LEO launcher development in Italy. Exos intends to commence construction of their Italy facilities in the second quarter of 2019.

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

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

***exosaero.com***

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

# FOXCOM

*By Allen Wald, Director, Sales and Marketing*

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

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

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

Foxcom met the challenge by providing long-distance connectivity over a single fiber using DWDM (Dense Wavelength Division Multiplexing), which reaches distances that were unprecedented in the industry.

This was achieved using the company's advanced Platinum series of links, along with high-power optical amplifiers (EDFA's), DWDMs and an all-encompassing Simple Network Management Protocol (SNMP)-based Monitoring and Control (M&C) platform.

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

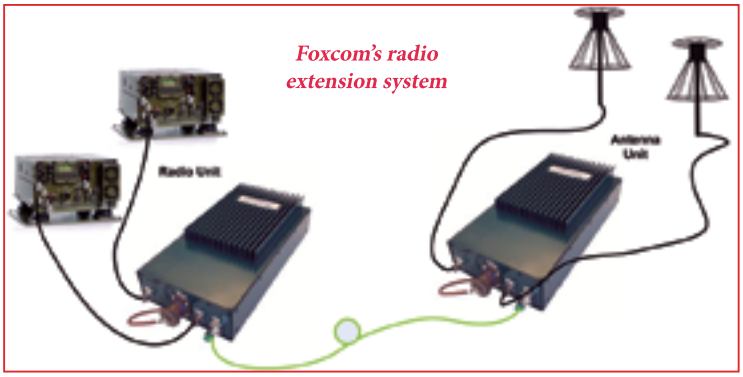
No challenge is too great for the company's R&D team. Thanks to their dedication, creativity and perseverance, Foxcom has rolled out a new range of products that are unique — if not revolutionary — in the industry.

### *Military Radio Links*

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

The Foxcom fiber solution provides a cost-effective alternative to coax cable deployments and allows military personnel to place their antenna far away from the military radio.

The equipment consists of two ruggedized units, one for the Radio-side (RSU) and another for the Antenna-side (ASU). The system supports two simultaneous radio channels and is equipped with a programmable microcontroller providing universal adaptive hopping frequency support

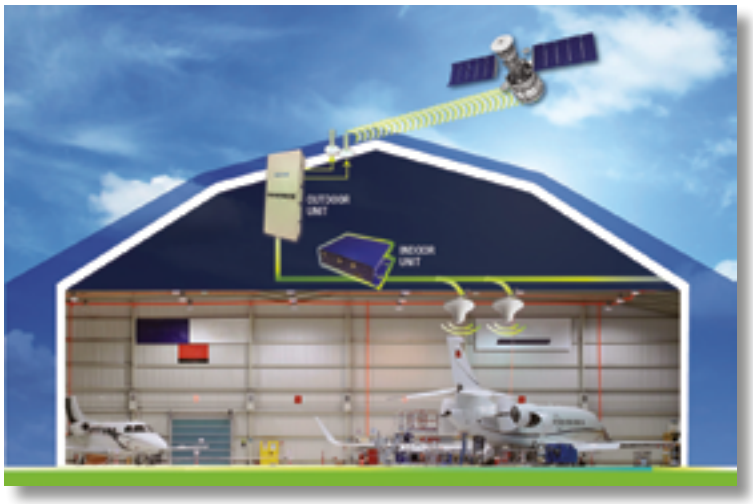


*Foxcom's radio extension system*

and a Dust-Proof mechanism for maintaining constant RF performance levels.

### *Iridium, Inmarsat and GPS Repeaters*

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




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

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

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

### *FiberGo — Low Cost VSAT Fiber Link*

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


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

### *Outlook for 2019*

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

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

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

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

***www.foxcom.com***

# GLOBECOMM

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

**My first day of work as a systems engineer, fresh out of college, is easy day to remember. It was 8-8-88: August 8, 1988. A great deal has changed since then, but one thing has been constant. Innovation. My company, Globecomm, began life as a systems integration company building satellite Earth stations.**

Today, Globecomm integrates complete satellite networks and provide sophisticated terminals to high-demand users in both government and commercial markets. But that is just the tip of the iceberg. The company develops and operates data and media centers, cellular and maritime networks, software platforms, global fiber-satellite networks, and much more. Technology innovation across multiple markets has become our business, and the end of the year provides a chance to assess where those technologies have taken us and will take us in the future.

### *Why We Must Do More with Less*

Globecomm continues to hear the mantra that they have to do more with less. Budgets have shrunk while most new starts and even existing programs that have been ongoing for years are being assessed by government decision-makers for value and appropriate return on investment (ROI). We believe this makes our entire industry stronger. We serve a combination of government and commercial customers, and continual customer assessment of their ROI is the norm with the enterprises we serve. Customers require more because the battlefield is becoming more and more connected. This brings advantages; however, the amount of data to be processed is staggering.

Developing how a battle element — whether that be a soldier or battalion, a sailor or battle group — ingests, processes and analyzes all the data that is being made available into an actionable offense or defense is the *Department of Defense*'s (DoD's) greatest task. Furthermore, this actionable data needs to be disseminated across organizations, agencies and units in a timely, non-political manner to maximize its usefulness. This requires the elimination of stovepipes and parochial organizational boundaries. Globecomm and its telecom industry peers are focused on facilitating data collection, transport, aggregation, storage and application development to assist the DoD in the broad context of the C4ISR (*Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance)* mission.

For the company's government customers, Globecomm provides integrated communications infrastructure, managed global network services, and life-cycle support engineering services. As the world becomes more and more connected, we look to leverage commercial innovation and RF and IP-centric technologies to help our customers implement enterprise-level solutions. This is particularly true for military forces that may be deployed anywhere from large cities to the most remote locations. Deployments may be small teams to enterprise-level divisions numbering into the thousands.

One of the drivers from government is the need to deliver media content to troops around the world. Satellite network technologies can provide the services, capabilities and infrastructures to furnish U.S. Government (USG) customers with connectivity services anywhere in the world in a highly secure and resilient manner. The global demand for broadband connectivity is increasing every day. Communication systems have taken the most formidable leaps in attempting to keep up with the demands that new use cases are placing on the network.

Government regulatory commissions and standards groups are working to provision communication spectrum that will support the traffic. The challenge is to support new connectivity requirements and uses of spectrum, while at the same time not diminishing the capacities or services that are currently in place (*e.g.*, video, voice, and Internet Protocol (IP) data).

### *Video Delivery Platforms*

Globecomm's new projects for the USG include wireless services, SATCOM engineering solutions and IPTV system integration and services based on ***Vector***, our state-of-the-art content delivery platform. For the **USS Gerald R. Ford**, the first-in-its-class aircraft carrier, Globecomm provided pioneering broadcast, IP video and satellite communications systems, and we continue to work on future program applications.

Vector simplifies video content delivery by using a scalable, cloud-based solution aggregating multiple functions of the video workflow to create an end-to-end solution. A virtualized solution allows the system to scale quickly and inexpensively with the government's needs, providing a lower cost of entry into the market to meet the ROI requirements of today's programs.

### *Disaster Recovery*

Globecomm also supported the USG in its response to international disasters through the *Office of US Foreign Disaster Assistance* (OFDA), part of **USAID**. OFDA responds to an average of 65 disasters in more than 50 countries every year, helping to save lives, alleviate suffering and reduce the social and economic impact of disasters worldwide. Devastating natural and human disasters around the globe witnessed the USG respond with support from Globecomm.

### *Smallsats, Non-GEO Constellations, 5G + EO*

An important element for first responder efforts is the ultra-high definition Earth imaging provided by the newer technology smallsats and non-GEO constellations. This is one example of how the government is using the *Internet of Things* (IoT) to obtain data for increased efficiency and effectiveness both on the battlefield and humanitarian response.

Of course, this ultra-high definition imaging comes with an increase in throughput which the newer generations of satellites easily provide. Including 5G technology in the mix allows governments to obtain higher broadband connectivity with extremely low latency. These are the early days for these technologies — especially 5G, which will not be fully defined until 2020 — and Globecomm continues to analyze their potential to enhance government applications.

### *Software Defined Networks and Edge Computing*

Of all the trends of the past year, the most interesting is the battle to manage the increasing complexity of applications and the networks they run on — more and more, we're noting the need for instantaneous, automated decision-making, supported by network resources — whether it is for autonomous vehicles, security applications, entertainment or e-commerce. This challenge screams for computing at the edge which, in turn, demands a mix of transmission technologies, of which satellite will always be a major consideration. The success of future satellite communications will require cooperation and interoperability between GEO, MEO, LEO constellations, terrestrial 5G and the multiple near-field technologies in use today and to come.

*Software-Defined Networking* (SDN) is dynamic, manageable, cost-effective, and adaptable, making it ideal for the high-bandwidth, dynamic nature of today's applications. This architecture enables the network control to become directly programmable and the underlying infrastructure to be abstracted for applications and network services – meaning that it fulfills the need to run across just about any kind of network.

### *Cyber Everywhere*

The future will be intensely networked, software-defined and edged-computed – and that offers the perfect environment for cyberthreats. The more services connected to the internet, the greater the threat to end-point operations, and from potentially degraded speed and service quality. Think of it as pollution. The world rushed to industrialize, and then it discovered that unchecked industry leads to unbreathable air, undrinkable water and ruined farmland. We have rushed to network everything that can be networked, and our appetite continues to expand. Only if we manage the cyber-pollution this creates will any of our dreams for a digital future be realized.

At Globecomm, we are designing cybersecurity into every network and the configuration of every end-point device, and we help our customers develop the plans and management systems needed to adapt to the changing threat environment.

### *Consolidation*

Recently completed was a blockbuster merger in the government vertical with **Harris** and **L3** agreeing to terms. As the service-provider industry for business and government customers continues grow, consolidation has been the natural result.

Globecomm is no exception. In August, **Speedcast International** announced agreement to acquire Globecomm, with the deal expected to close by the end of 2018. The opportunities this acquisition represents are exciting, as Globecomm sees the combination of the two companies to be highly synergistic. Globecomm complements Speedcast's global network of satellite and fiber connectivity — the company's trusted technological expertise and diversification of markets make the combination of the two companies tough to beat.

More important than technology, however, are relationships, old and new. Our missions converge in the importance that customers receive, which allows the firms to address the goals and expectations of clients and to provide the solutions that will meet those requirements.

I'm looking forward to the new future of our industry it continues to evolve and grow and, of course, deploy continuous innovation.

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

***www.globecomm.com***

*Paul Scardino is Senior Vice President of Globecomm's Sales Engineering, Operations and Marketing. He is responsible for the overall recruitment, leadership and development of the sales and marketing personnel, including the global sales executives, corporate technical subject matter experts and the marketing team. He oversees the sales, marketing and strategic direction of Globecomm's new and emerging products and services. He has been involved in the satellite communications field since 1988 and has been a key to Globecomm Systems' success since February of 1997.*

# IDIRECT GOVERNMENT

*By John Ratigan, President*

**iDirect Government (iDirectGov) takes great pride in hiring remarkable people who care deeply about our customer base and the company's mission to support the U.S. military and government.**

We build exceptional, high-performance products that withstand the most excruciating circumstances in the harshest of environments, where our customers fully expect them to work flawlessly when conducting their missions.

iDirectGov employs a strong team. We read the market and adapt accordingly.

The company understands and foresees where the market might go, and plans and executes tasks to create products to fulfill those needs and get them in the appropriate hands.

### *Major Releases, Major Growth*

iDirectGov attained several important milestones that made 2018 an excellent year for the firm.

Our most powerful major, defense-based software release — ***Evolution 4.2*** – launched into the market and has proven to be a true game changer.


This release unleashed the full capabilities of iDirectGov's ***9-Series*** satellite routers, particularly the airborne products, boasting faster speeds and more secure communications across the entire product line.

*iDirectGov's 980 satellite router board.*

### *Taking Flight and Going Rugged*

Our keystone product of 2018 was undoubtedly Evolution 4.2. This new software lets our 9-Series airborne satellite routers, including the ***980, 9800 AR*** and ***9800 AE*** take flight.

This software boasts speeds up to 29 Msps single carrier and features both one-way and two-way TRANSEC (*Transmission Security*), making MILSATCOM faster and more secure than ever before. With these enhanced capabilities, our team can now deliver more innovative and powerful products to the market.

One of those products is the company's first, fully ruggedized terminal designed to withstand the elements: the ***9050 OM***.

*iDirectGov's 9050 OM ruggedized terminal.*

Engineered to support the GBS program, our 9050 OM passed many harsh environmental tests, including a simulated *High Altitude Low Opening* (HALO) parachute jump as well as being submerged in water for 30 minutes.

The 9050 OM passed all of these challenges with flying colors and continued to flawlessly operate through all of the tests.

### *SWaP-ing Size for Security*

The industry continues to face two big challenges each year: Adversarial interference and finding ways to shrink satellite terminal sizes without sacrificing power.

As a manufacturer, iDirectGov continuously seeks ways to develop and build equipment and networks more secure while continually improving the ***size, weight and power*** (SWaP). Both of these challenges were addressed with the ***950mp***, our smallest man-portable board to date (***see the product image on the following page***).

This product is half of the size of its predecessor, the *e850mp*, more powerful and more secure, thanks to Evolution 4.2.

However, iDirectGov hasn't stopped there — we're always looking for more ways to make product smaller and more secure. The company is currently developing our anti-jam strategy and working on a newer, smaller board that keeps SWaP in mind.

### *New Launches and Approval*

Our greatest achievement, completing Evolution 4.2, was also the company's most formidable challenge. Like all great challenges, they always pay off in the end when those challenges have been addressed and conquered.

Moving Evolution 4.2 out the door has had a massive impact on the company's year. By doing so, iDirectGov has been able to give our customers the reassurance that they're operating on the fastest and most secure software available in the industry.

We also gained **ARSTRAT** approval and certification on our ***Evolution 3.4*** software and hardware — an enormous win for us and another impactful success for the company. This significant milestone gives customers the knowledge and security that the firm's products are backed by the **U.S. Army Forces Strategic Command,** making it easier for customers to purchase our equipment.

The most significant challenge now faced is how to strategically move forward into 2019, deciding which products need to be developed and to determine what hardware and software features needs the company's concentrated focus.

Half the battle has already been achieved — we've determined what the company's next products will be, and we're working with customers to refine how those products will be best used in the field.

### *Convergence*

As iDirectGov's platform options continue to increase with GEO, MEO and LEO satellites, the industry needs to decide which of these spatial technologies will be the most productive to use, how they will work and how interference can be reduced, from both a physical perspective and a bandwidth perspective.

Simultaneously, this a paradigm shift. This moment is an exciting one — these crucial challenges make iDirectGov's participation in this industry extremely exciting.

The industry will note the convergence of satellite and cellular networks during the next five to 10 years. Eventually, 5G networks will be aligned with satellite networks, spurring a possible convergence at the highest level, where major cell phone service providers will use satellites as part of their core platforms, not just as an ancillary channel.

As this convergence occurs and questions are raised, iDirectGov will continue to play a pivotal role in creating the new technologies that are so pertinent to that consolidation as the company continues to move forward with our customer base.

### *Forward*

As we progress into 2019, iDirectGov will bring new technologies into the fold while focusing on cutting-edge products for the MILSATCOM and SATCOM industries.

The company has exciting new software features that we hope to share during the new year, as well as innovative hardware that's certain to impact the markets. New ideas will grow as the firm looks ahead to industry-changing effects of cellular-satellite consolidation.

During 2019, iDirectGov will continue to dedicate resources to perfecting the company's family of products as we keep an eye on the horizon to ensure iDirectGov remains at the forefront of technology and customer acceptance.

***www.idirectgov.com***

*Ratigan started the Federal Group for iDirect Technologies in 2003 and then established iDirect Government as a wholly owned subsidiary in 2007. He brings more than 20 years of experience in the satellite communications arena. Prior to joining iDirect Government, Ratigan ran the East Coast operations for Fairchild Data and EFDATA and eventually partnered in his own company that helped EFDATA grow from $20 million to $120 million in revenue and as many as 700 employees in 2000. EFDATA became the pre-eminent leader in SCPC satellite technology in the late 1990s and provided the baseline knowledge and expertise that would later benefit Ratigan's role with iDirect Government and the migration of technology into TDMA.*

*In addition to starting his own company, Ratigan was senior vice president of North and South American sales for the start-up, Broadlogic, as companies started to run IP directly over satellite. Ratigan has a bachelor of science degree in marketing from the University of Maryland, College Park.*

# KENCAST, INC.

*By William Steele, Chairman and Chief Executive Officer*

**The potential of the new Non Geo-Synchronous Orbiting Satellite (NGOS) constellations are well recognized by the military. The lower orbit of both LEO, and even MEO, satellite constellations, compared to GEO satellite, provides valuable low-latency operation in critical military situations.**

This has drawn strong attention, and now investment, by the ***Defense Information System Agency*** (**DISA**) and other branches of the military. Also, these new polar orbiting satellites are very complementary to the GEO satellites in equatorial orbit, which in combination, provide a broader global footprint that U.S. military operations often require.

DISA, in addition to its own ***GEO Global Broadcast System***, frequently acquires complementary commercial satellite networking to respond to fast developing situations around the world. The NGOS constellations provide a whole new set of strategic and tactical possibilities when responding to conflicts and threats.

Because of this long-term experience in quickly integrating/adapting military networks with commercial network, the military is better positioned than most commercial entities, at least in the short-term, to take advantage of the possibilities provided by the new HTS NGOS and GEO capabilities.

There is a vast range of traditional and innovative ways in these new networks can be used in support of military operations enabled by these new satellites. In many cases, it will be most valuable if Military networks can be quickly combined as hybrid networks with the LEO, MEO, and GEO constellations and with 5G LTE-Broadcast (eMBMS) networks.

However, the military will be faced with the same issue the commercial market faces with the inevitable failures and consolidations going forward with these new satellites. Because of shifting technical and price leadership among constellations, antennas, and Earth station vendors, it behooves early application owners to implement with flexibility to take advantage of, or recover from, these shifts — that is, to launch and go forward with Open Architecture where feasible.

## *Constellations*

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

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

## *Antennas*

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

Success requires an antenna with a flat profile, low power consumption, and reliability in delivery, often of encrypted/DRM content, as well as strategies for dealing with the inevitable intermittent lost signal issue. Open Architecture strategies — that include forward error correction algorithms and availability simultaneously of multiple wireless network paths via MEO, LEO, LTE, with one or more antennas — provide approaches to achieve reliable delivery.

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

### *Strategies for Establishing Smallsat Open Architecture*

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

For example, some of the weaknesses of laser networking can be overcome by routing around bad weather, employing forward error correction schemes and/or switching to terrestrial wire/wireless network alternatives whenever necessary. Satellite carriers are currently experimenting with lasers and LTE and other RF networks for these reasons. Hybrid network offers the immediate alternative path option as well as the opportunity to more quickly take advantage of breakthroughs that will certainly happen from time to time with flat plate antennas, laser terminals, next generation LTE, satellite modems, and the satellites themselves.

### *Elements in an Open Architecture*

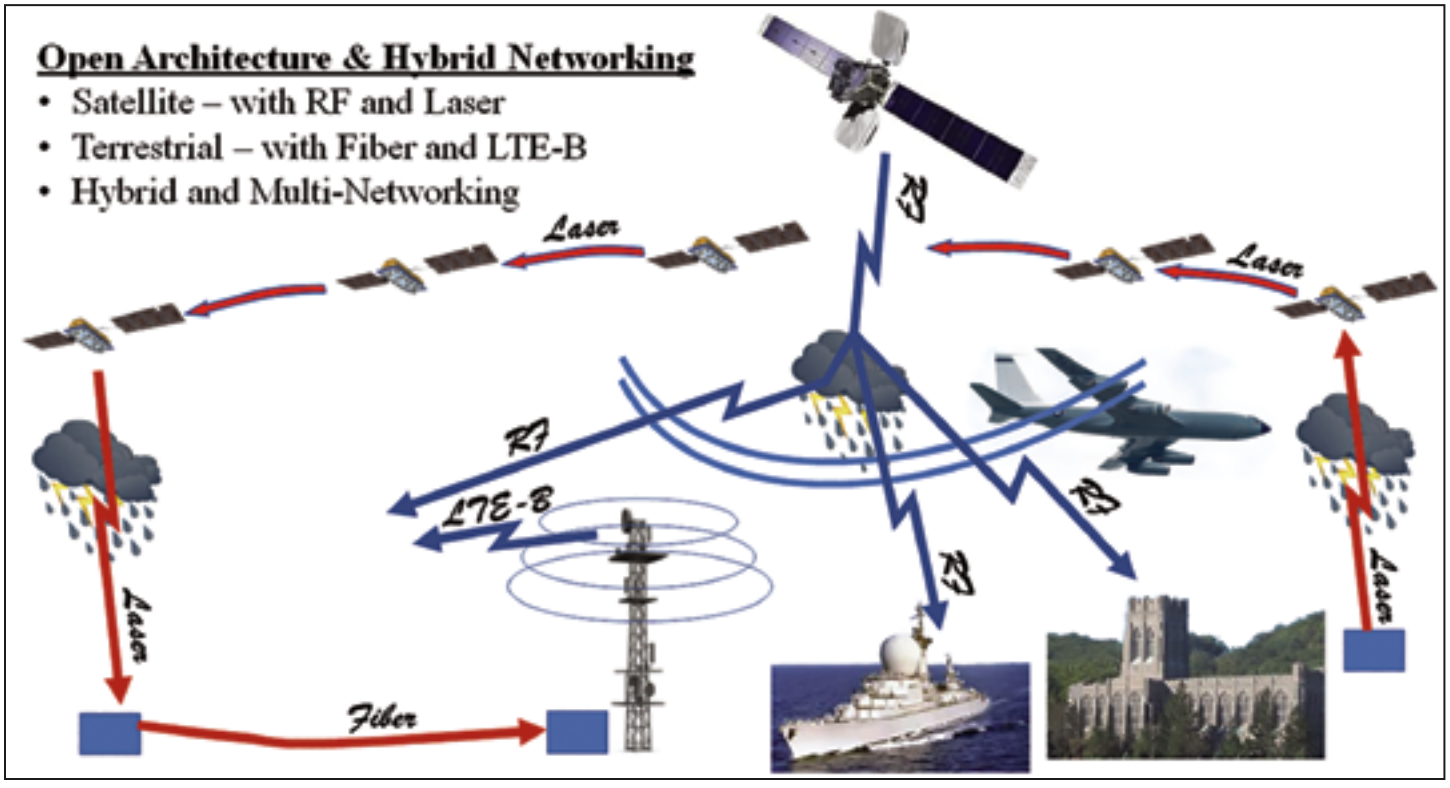
KenCast's ***Fazzt*** platform for content delivery is designed to provide the tools content owners, teleports, and integrators need to realize Open Architecture on new HTS Smallsat and GEO constellations.

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

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

**kencast.com**

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



# KEYSIGHT TECHNOLOGIES

*By Mark Lombardi, Satellite and New Space Test Solution Manager, Aerospace and Defense Solutions*

**Keysight Technologies, Inc. (NYSE: KEYS) is a leading technology company that helps enterprises, service providers, and governments accelerate innovation to connect and secure the world.**

This year, Keysight worked with the satellite and space industry to enable the rollout of multiple, new, emerging technologies that included phased array antennas, software defined satellites, and volume manufacturing.

The accelerated rate of change in the satellite industry has made it imperative to embrace process-based design and test strategies. To help the firm's customers respond to these new challenges, Keysight moved to provide solutions that are optimized with the needs of the space industry in mind.

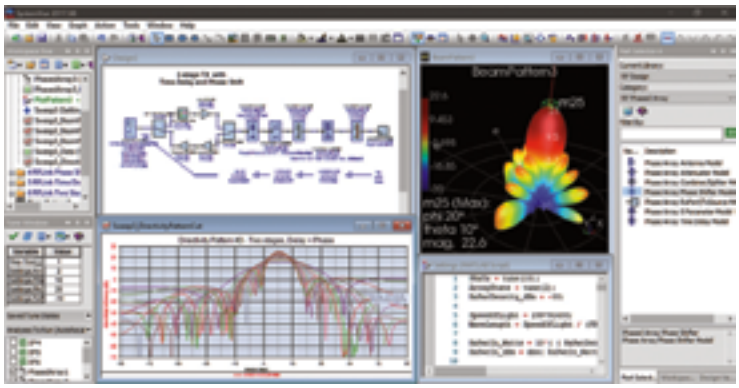
### *Simulation*

Satellite product life cycle is challenging at every stage, from concept to deployment readiness.

In the early concept and design stages, the selection and optimization of aspects, such as the satellite orbit, frequencies, and modulation formats, are key to avoid costly redesigns in later stages of the life cycle. The hardware design stage involves difficult decisions to meet the requirements set forth for the entire system.

The system engineering teams and the hardware and software design teams must collaborate with each other to maximize system performance for economic success.

This year, the ***SystemVue*** software platform has added new tools for the system designer with capabilities such as: RF cascaded analyses, phased array antenna beamforming and complex modulation scheme creation and analysis.



vLinks from SystemVue to industry tools for scenario emulation, such as ***System Tool Kit*** (**STK**) from **Analytical Graphics, Inc**. (AGI), are key enablers for early system validation in the presence of fading, atmospheric absorption, Doppler effect, and satellite mission kinematics effects.

SystemVue's unique connectivity to test equipment allows for sophisticated HIL (*Hardware-In-The-Loop*) analysis. This capability allows the designer to evaluate the complete system with available parts of the hardware while the remaining hardware resides virtually in software until the parts become available.

### *Payload and Component Test*

Innovation continued into communication payloads, with new approaches to high data rates, flexibility and networking.

Engineers are using custom OFDM, high order modulations for increased resiliency. There are also efforts to better integrate with 5G and IoT. Increasing digital content in satellites are bringing new challenges of working with high speed ADCs (*Analog-to-Digital Converter*), FPGAs (*Field Programmable Gate Array*) and DACs (*Digital-to-Analog Converter)*.

As innovation in technology allows, and the worldwide regulatory bodies permit the use of bandwidth at higher frequencies for satellite communications, there is uncertainty about how much capability in test equipment is necessary. Keysight's introduction of the ***Infiniium UXR-Series*** of oscilloscopes provide models ranging from 13 to 110 GHz of true analog bandwidth. It offers industry leading signal integrity and provides investment protection that meets the needs of technology advancements today and tomorrow.

The Infiniium UXR-Series, coupled with *Vector Signal Analysis* (VSA) software, enables modulation measurements at W-band and 10 GHz wide or more. The low noise floor and high vertical resolution provides unprecedented, in-band RF measurements such as EVM.

This year, Keysight also collaborated with **Ball Aerospace** and **Anokiwave** to validate the first commercial active array antenna product designs in the Ka-band.

The use of phased arrays at mmWave frequencies requires *Over-The-Air* (OTA) testing, as well as spatial beam measurements. Keysight metrology-grade test equipment offers the sensitivity that base station designers need to overcome these challenges and to go beyond simple RF parametric performance. New spatial measurement requirements include sidelobe levels, dynamic beam characteristics, and spatial variations of EVM and ACPR.

The Ball Aerospace-built, 256-element array uses Anokiwave integrated circuits and was designed to deliver modulation in GHz-wide bandwidths in either a single-beam mode or in MIMO applications for as many as four concurrent beams with up to +60 dBm EIRP.

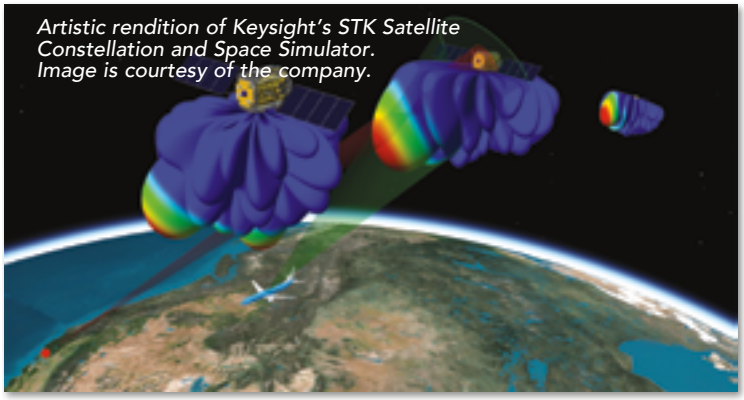
In support of the new LEO constellations, Keysight also introduced ***PROPSIM MANET Channel Emulation Solution***. This new solution secures end-to-end performance and interoperability of *Mobile Ad-Hoc Networks* (MANET) and mesh radio systems (a self-forming and self-healing reliable network that eliminates single points of failure) for tactical mission critical wireless communications.


To ensure the robust inter-operation of satellite systems for mission critical wireless communications, manufacturers and military forces require the ability to test mixed networks that combine tactical and avionics radios with satellite links. Increased complexity and technological advancements, such as MIMO and beamforming in wireless military communication systems, has accelerated the need to test large mesh-network topologies with dynamically changing radio channel and interference conditions.

To address this need, Keysight has launched a high-performing, network level channel emulation solution that enables users to easily replicate field-testing conditions in a repeatable way. The PROPSIM MANET Channel Emulation Solution is a highly scalable and flexible solution that supports full mesh configurations of up to 64 radios using 4032 independent fading channels in a single unit for testing large SISO (*Single-Input Single-Output system*) and MIMO (*Multiple-Input Multiple-Output*) mesh-network topologies.

### *Satellite Ground Station Installation and Maintenance*

The ground infrastructure is also undergoing major changes. Keysight's ***FieldFox*** handheld multi-function test includes coverage to V-band and provides a precise and comprehensive solution for satellite ground station maintenance.



*Artistic rendition of Keysight's STK Satellite Constellation and Space Simulator. Image is courtesy of the company.*

As satellite ground stations have long-range communication links, they must provide high uplink transmit power, receive a very low signal level on the downlink, and compensate for link variation due to weather and satellite/ground antenna changes. The ground stations contain many sensitive components and subsystems (*e.g.*, antenna subsystems, waveguides, coaxial cables, filters, LNAs, LNBs, BUCs, HPAs and TWTAs) that must be verified during installation and maintenance. As high throughput satellites (HTS) push the technical limits, the spectrum performance of the whole system must be monitored at ever more precise levels. Such tasks become even more challenging when the ground stations are in remote areas.

In response, noise figure measurements were added onto the FieldFox this year, building on the existing, all-in-one capabilities (*e.g.*, spectrum analyzer, full 2-port vector network analyzer, cable and antenna tester, real-time spectrum analyzer, power meter and more) allowing engineers and technicians to perform a range of benchtop-quality measurements in difficult test environments.

***www.keysight.com***

*Mark Lombardi has 25 years of test and measurement experience. Most recently, his focus is on identifying and developing Keysight's Satellite and NewSpace test solutions. Past responsibilities have included development and management of RT Logic's RF Satellite Link Emulator along with a wide range of Hewlett-Packard/Agilent product lines covering applications from DC to millimeter waves, digital, RF, and mixed signal. Mark's work is featured in a variety of electronics industry publications and trade shows presentations.*

# MICROCHIP TECHNOLOGY

*By Ken O'Neill, Director of Marketing, Spcae and Aviation*

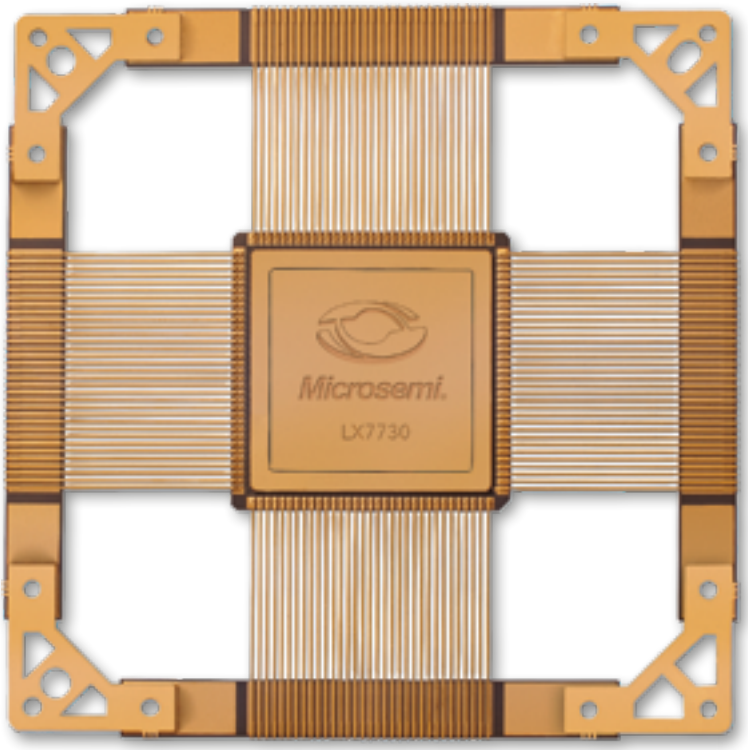
**As a leading supplier of radiation-hardened and radiation-tolerant electronic components for satellite systems, Microchip enjoys a unique vantage point to observe developments in the satellite industry.**

This vantage point was further enhanced with Microchip's May 2018 acquisition of **Microsemi Corporation**, which combined Microchip's family of radiation-hardened and radiation-tolerant processors, memory products, custom ASICs and standard products with Microsemi's complementary portfolio of FPGAs, mixed-signal ICs, clocks, oscillators, discrete semiconductors and power converters. The past year has seen continued high levels of investment in new space programs, running the gamut of commercial revenue-generating programs, civilian and scientific programs, and national security programs.

Over the course of 2018, the company has seen continued divergence in the satellite industry, as some programs continue the tried-and-trusted approach of using highly qualified, highly screened components for high capability spacecraft, while other programs adopt a less conservative approach using components that are not specifically built and tested for space-flight use, in an effort to reduce cost and improve procurement and manufacturing cycle times. Supporting this divergence in requirements can be accomplished by continuing to invest in high-level qualifications for radiation-hardened and radiation-tolerant components, while at the same time taking a novel approach to enable developers of satellite constellations make use of products with established space-flight heritage without paying for expensive screening required by traditional space programs.

For many years, the development of national security space (NSS) programs has required the use of the highest levels of component qualification and screening. The security of our nation depends on the flawless, continuous operation of these satellite programs, which provide precise timing and navigation data, surveillance and reconnaissance information, ICBM early warning and secure communications for our military. These are missions which cannot tolerate any failure, requiring the use of components screened to QML (*Qualified Manufacturers Listing*, the prevailing U.S. Government (USG) standard for component qualification and screening) **Class V**, **Class K** and JANS standards.

Microchip has a long heritage of investing in the development of electronic components which meet the requirements of these QML standards — 2018 saw the culmination of many years of effort in the qualification of the RTG4 radiation-tolerant field programmable gate array (FPGA) family to the QML Class V standard, which is the ultimate in reliability assurance for monolithic microcircuits. In addition, Microchip shipped the first QML-screened versions of its ***LX7730 Telemetry Manager***, a unique mixed-signal electronic component which simplifies the acquisition of critical telemetry data in space systems by integrating into a single small package many of the components required to gather dozens of telemetry channels measuring current, voltage, temperature, mechanical strain, magnetic field and other physical parameters required to assure the long-term health and operation of the satellite. The LX7730 does this while offering a dramatic reduction in board space, power consumption, heat dissipation and bill of materials cost.




*Microchip's LX7730 Radiation Tolerant Telemetry Controller.*

In addition to the traditional missions using highly qualified and screened components, we have seen a growth in interest in satellite programs characteristic of the "*responsive space*" initiative first proposed by the U.S. Air Force around 10 years ago. The thinking behind the initiative is that not all national security space satellites need the highest qualified components, and in fact there are advantages in building satellites quickly and cheaply in order to provide the military consumers of satellite services access to mission-critical data sooner.

The availability of low-cost launch services has helped to make this vision a reality, and military satellite operators are reaping the benefit by having access to imaging data with much faster revisit rates, so that imagery is much

more recent when the warfighter on the ground receives it. Programs are being implemented to examine the use of *Commercial-Off-The-Shelf* (COTS) electronic components in responsive space applications, however COTS components create some cost of ownership issues associated with lack of radiation and reliability data, lack of manufacturing lot traceability and decreased levels of technical support relative to QML components.

This past year Microchip launched two key initiatives to assist developers of responsive space programs solve these and other difficult cost and delivery challenges.

The first initiative, called the "*Sub-QML*" program, allows developers of low-cost satellite constellations to bridge the gap between commercial and QML Class V options by purchasing radiation-tolerant components with space flight heritage in cost-reduced packages, with screening reduced to levels less than QML components. The elimination of QML screening reduces the manufacturing cost of the components, and also improves the lead time, enabling components to be ordered closer to the critical need date for satellite manufacturing.The advantage of Sub-QML is that the components being offered have radiation and reliability data, which reduces the cost of ownership of the satellite developer, who would otherwise need to perform a large amount of component radiation testing and reliability up-screening if they were planning to use a commercial part without any space-flight heritage. Several Microchip radiation-tolerant (RT) components, including FPGAs and mixed signal standard products, are available in Sub-QML form.

The second initiative rolled out in 2018 is the *COTS-To-RT* initiative. This initiative takes reliable commercial products which have been qualified to the automotive AEC-Q standard, increases the radiation performance by process improvements and then characterizes their radiation performance. Flight risk is mitigated by starting with a proven design that has been qualified for a safety critical automotive application. Hardware prototyping and software development can be initiated early in the design cycle with commercial hardware while the RT part is being developed.

By characterizing the response of the components to radiation with *total ionizing dose* (TID) and *single event effect* (SEE) tests, Microchip assures satellite developers that the components are suitable for Low Earth Orbit (LEO) missions and, in some cases, for *Geosynchronous* (GEO), *Mid-Earth Orbit* (MEO), and *Highly Elliptical Orbit* (HEO) missions. Microchip offers a variety of microprocessor and microcontroller products in the COTS-to-RT program.

Another theme in 2018 was the continued emergence and development of the RISC-V open instruction set architecture for microprocessors. This has brought designers greater freedom to adjust and optimize the processor microarchitecture so that it optimally meets the needs of their development program. It also allows designers full inspection of HDL code for the purposes of design assurance and trust, without incurring very large charges from intellectual property (IP) vendors. In collaboration with our IP partners, Microchip has made available multiple versions of RISC-V processor cores which have been ported and optimized to the RTG4 FPGA architecture.

This year also saw the introduction of an innovative solution for precision timekeeping on satellites. Atomic clocks have been used in satellites for precision navigation and timing purposes for more than 40 years; however they have been used only for the most critical applications, due to their size, mass and cost. Microchip introduced a highly miniaturized *Chip Scale Atomic Clock* (CSAC) for terrestrial and airborne applications in 2016, and in 2018, introduced a Space CSAC with improved radiation characteristics relative to the commercial product.

The Space CSAC allows satellite developers to create a GPS holdover capability so that the satellite can continue to function with highly accurate timekeeping in the event of a denial-of-service attack on the GPS constellation. The new Space CSAC product has extremely low power consumption of 120mW max, in a highly miniaturized form factor occupying less than 17 cubic centimeters. Characterization of radiation TID and SEE indicates suitability for most LEO applications, and potentially short-duration GEO and deep space missions. CSAC provides intrinsic frequency accuracy of 5x10-10, giving the Space CSAC greater stability than crystal oscillators with significant reductions in size weight and power. In addition, CSAC is capable of providing autonomous time to the system.

Governed by our *DOC200103, Rev G*, Microchip has also introduced a new family of *Temperature Compensated Crystal Oscillators* (TCXOs), which provides a wide frequency range combined with low power and an industry-leading small form factor. Heralded as the "*smallest space-qualified TCXO in the world,*" the **2105/2205/2115/2215** platforms boast a 10 percent smaller surface area and 30 percent smaller volume than their next closest rival. This new flatpack enclosure is also available with optional lead-forming. Radiation performance is suitable for all Earth orbits and deep space applications requiring a tolerance up to 100krad (Si).

2018 has proven to be a robust year for the national security space market, and at the same time, it has been a period of change. We have seen funding released on many new programs as well as evolving requirements for component screening and qualification. We can be sure that 2019 will bring new challenges and opportunities. At Microchip we expect the debate and discussion on component screening levels to continue and intensify, and we are well-positioned to support program requirements on both ends of the component reliability assurance spectrum.

***www.microchip.com***

# MODULAR DEVICES, INC. (MDI)

*By Chris Alfenito, Director of Sales and Marketing*

**Modular Devices Inc. (MDI), a small privately held U.S. Corporation, has established itself for 45 years as a global power engineering resource that designs and manufactures high reliability power solutions for demanding applications. The company concentrates on DC power systems and subsystems.**

MDI measures success a bit differently than most companies. One of their most critical assessment factors is focused on how satisfied their clients are with MDI — not just the products, but across the spectra of the complete transaction.

The company's aim is to be responsive to their clients' needs before, during and after a sale. This is a collaborative approach with the firm's client partners, from the initial contact through in-depth engineering discussions and throughout the length of the program.

MDI offers lifetime support for their products. The company has yet to obsolete a product that is still required or requested by their customers.

One hundred percent of MDI products are designed, fabricated, tested and delivered from their facility on Long Island, New York. The staff has decades of experience in all key areas that allow them to comply with programmatic requirements that only larger scale organizations usually area able to offer.

More often than not, MDI provides clients with solutions for their power needs based on a custom or semi-custom requirement. The firm's clientele demand unique solutions for their programs and. MDI strives to ensure their mission success.

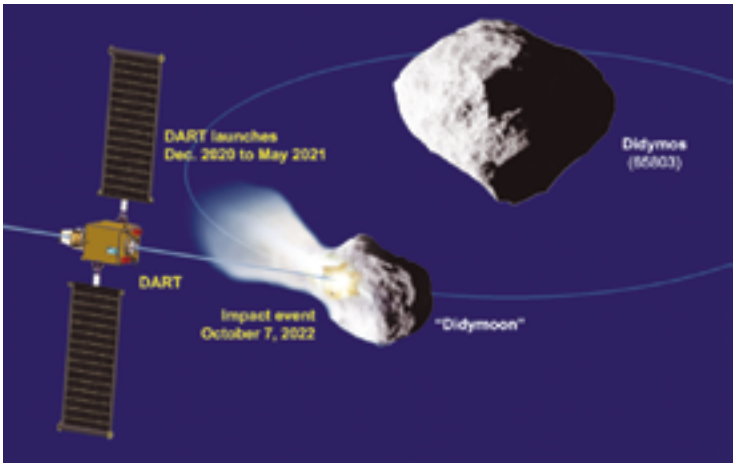
MDI products range from simple *Point Of Load* (POL) regulators to multi-output *Rad Hard Fully isolated DC-DC converters*, *Solid State Relays* (SSR), *In Rush* limiters, sequenced power switching modules, and *EMI Filters*.

MDI products are found in: Exo-planetary, GEO, & LEO space programs, military aerospace, Naval and ground systems, as well as nuclear power and high energy particle physics research activities.

2018 was a most exciting year for MDI. The company is extremely proud of the programs on which they were able to participate. In space, in the air, on land, and in the oceans, MDI products and designs find their place.

### *In Space*

- *NASA Planetary Defense Coordination Office, DART Mission (Dual Asteroid Redirect Test) is going to "nudge" a small asteroid, 11 million km away with a 500 kg spacecraft traveling at 6km/s (Mach 16) with an Ion Thrust Engine.*

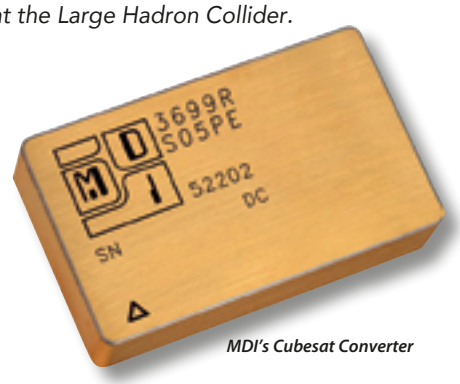



- *Helping to develop systems for new astronaut space suits and health monitoring aboard the ISS.*

- *CMIS (Compact Midwave Imaging Sensor) for high spatial resolution stereo imaging of clouds so as to enable 3D wind and cloud height observations during both day and night.*

- *Continuing in the exploration of our universe through such programs as the AMS (Alpha Magnetic Spectrometer) aboard the ISS searching for dark matter and ongoing subatomic particle physics research at CERN at the Large Hadron Collider.*

- *Working on next generation of spacecraft subsystems including scientific military and commercial constellations. This has covered a range of programs including space*




*MDI's Cubesat Converter*

*borne telescopes, Space borne lasers, Exoplanetary robotic exploration, and LEO Constellations.*

- *MDI is especially proud of their clients' recent successful launches to further Earth Observation Science systems globally.*

### *In Aerospace*


- *A Light Combat Aircraft pressure sensor power supply with a truly unique form factor.*
- *Continuing support of the warfighter on programs such as the AAGRM, SDB, LAIRCM, and Flight telemetry data systems through our defense contractor partners.*

### *Undersea*

- *Working with one of the key domestic UUV developers to supply power systems for the unique requirements of the mission environment.*

A more general overlook would be MDI's continuing advancement in product reliability and performance while undertaking significant reductions in cost to manufacture and lead time. The drive for lower cost spacecraft delivered in significantly less time than historically available has provided fertile ground for development in a number of areas including design, manufacturing, and qualification testing.

One such example is the ***3700 Basic Building Block Series*** of DC-DC Converter. While a fully hermetic package is offered, MDI has found alternative manufacturing techniques that significantly reduce the cost to manufacture of the assembly while maintaining the performance and reliability the industry demands.

As a "build to order house," MDI is continually faced by challenges that most high-mix/low-volume manufactures encounter.

Continually evolving product specifications, development and design, supply chain management, and production flow are some of the impediments encountered and overcome regularly, by using their collective experience to the maximum extent possible.

MDI produces 30 to 50 new product designs every year.

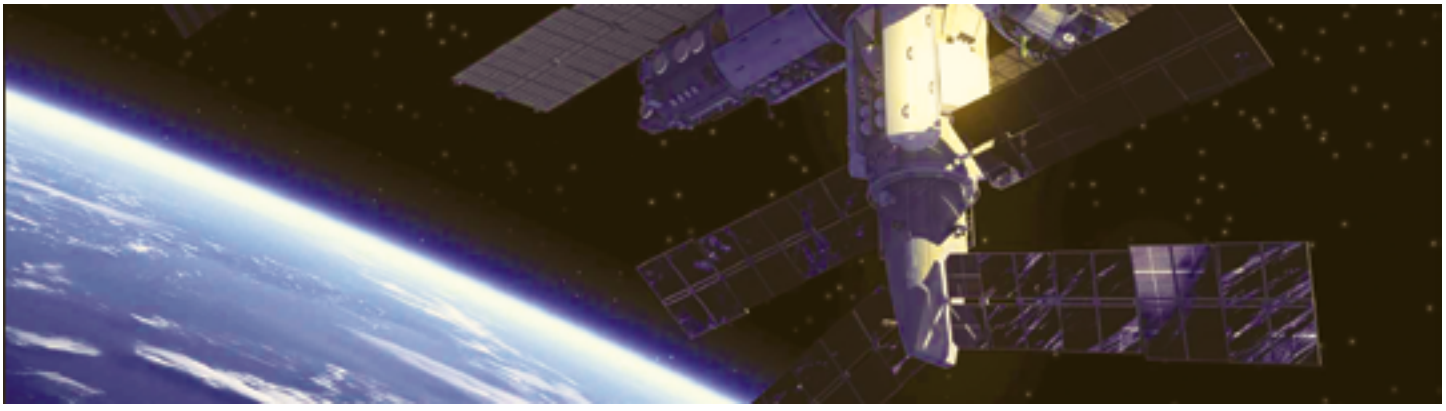
The constant industry demand for higher power, smaller footprints, Rad Hard SSR's (Solid State Relays) in NO (Normally Open), NC (Normally Closed) and Form C configurations, GaN device implementation and optimization, higher efficiencies, better EMI performance — these are all key product development areas.

The Commercial Space market vs. Government/Military space market is going to witness some dynamic swings in the coming year. The drive for a balance between quicker delivery, lower cost yet proven reliable performance of commercially available components and subsystems will force the industry to consider new paths forward.

MDI looks forward to meeting these challenges with unique products and programmatic solutions during the year to come.

***www.mdipower.com***

*Chris Alfenito is the Director of Sales and Marketing for Modular Devices, Inc., and is based in Shirley, New York.*



# NEWTEC

*By Koen Willems, Head, International Government Satcom*

**In light of the increasing tensions in global military hot spots and the growing amount of natural disasters around the world due to global warming, the need for disruptive innovation is gaining more urgency in order to enable us to face the challenges of today and tomorrow.**

The contributions to innovations that the satellite community brings evolve around 5G, the upcoming LEO, MEO and GEO High Throughput Satellite (HTS) constellations and agile, efficient and resilient communications to serve the needs of the dispersed and increasingly mobile military and humanitarian end-user.

The 5G revolution is more than simply marketing buzz. 5G is the fifth generation of cellular mobile communications, which promises higher data rates, reduced latency, energy saving, cost reduction and higher system capacity — all aspects of which are relevant in the military context. In fact, 5G serves as an aggregator technology that involves both satellite and terrestrial communications and encompasses a range of network types, applications and services including voice, data and video. The end-user remains connected to the 5G network across networks, devices and platforms such as vehicles, vessels and sensors. As such, there is a high degree of synergy between 5G and the ***Newtec Dialog***® multi-service platform, a multi-application system that connects multiple platforms on land, air and sea.

Linked to 5G connectivity, there will be an increased need for high data throughput and low latency required by new, HTS constellations to cater for the bandwidth hungry sensors and mission critical communications. At the same time, the new LEO, MEO and GEO satellites and networks will need to address operations at sea, on land and in the air on a global scale.

To address the complexity of military operations the end-user demands, small and easy to use satellite terminals with global connectivity to provide high throughput across **OTM**, **OTP** and **fixed platforms**. As with the 5G network and smartphones, the ground segment technology, the space segment and the services they deliver need to go hand in hand in a satellite network. With the new satellite constellations, these can no longer be considered separate entities. The ***Newtec Dialog VSAT*** platform hosts a concerto of technologies such as efficient waveforms, adaptive coding and modulation, beam switching, roaming, beam forming and satellite hand-over technologies to provide the end-user with seamless and agile communications across government and defense satellite networks whether they are traditional wideband satellites or new HTS constellations.

## *European Protected Waveform*

Innovations also focus on increasing security concerns. In today's military applications over satellite, security, information assurance and link efficiency technologies are inextricably linked. Different initiatives to make satellite communications more secure and reliable have not only been kicked off in the military context, but also increasingly in government and mission critical commercial applications. Individual nations (U.S., UK, France, etc.) are investing in the creation of their own protected satellite waveform to provide their homeland and peacekeeping operations with reliable, secure and consistent communications throughout a mission. These investments are entirely carried by large military nations for their own sovereign core tactical networks. Later, a trimmed down version of the protected waveform is sometimes shared with partner nations. Consequently, smaller nations do not always have the same access to protected waveforms.

The deteriorating security environment surrounding Europe, along with migration crisis and internal security threats, increases the need for Europe to invest in security and defense- related subjects. Brexit and the uncertainties created by the U.S. administration further complicate the global security landscape, calling for further European autonomy.

Against the backdrop of increased European focus on security, different initiatives such as **PESCO** (*Permanent Structured Cooperation*), **EDAP** (*European Defence Action Plan*), **EDF** (*European Development Fund*), **EDIDP** (*European Defence Industrial Development Program*) and **GovSatcom** (*Governmental Satellite Communications*) were launched to boost the cooperation between European nations and industries. Individual European nations are no longer capable of injecting large investments into the study and development of security and defense technology. Only through cooperation across European borders with the support of European-funded programs can both nations and industries obtain the latest innovative technology that can face the security challenges of today and tomorrow. In an increasingly digital world, secure satellite communications are at the core of the discussions to achieve a secure European environment.

Newtec supports the development of a ***European Protected Waveform*** (**EPW**) that can be shared among European nations for their military satellite networks to secure their communications in peacetime and during operations. A study should first check the end-user requirements and benchmark existing solutions in the market. In the end, the EPW should contribute to European autonomy and have the

flexibility to be used for multiple applications and platforms (fixed, on-the-move and on-the-pause) based on ***Software Defined Radio*** (SDR) devices.

The EPW project should be ambitious and combine the individual strengths of different nations and different members of the European satellite industry. The EPW program must be innovative and investigate future capabilities to support future government and defense operations, programs and satellite network designs.

### *Planning the Next Operation*

Thorough planning is an intrinsic element of any peacekeeping or humanitarian operation. Planning and managing a satellite network that covers multiple operations and theaters is not an easy exercise for network operators because a lot of elements need to be considered both on the space segment, ground segment and service side. Traditionally, such a satellite capacity planning exercise took a long time to prepare, required a diverse set of tools that were not centralized and even during the operation regular interventions were commonplace because extra capacity was needed, throughput requirements changed or operations were moving locations.

The good news is that, today, planning no longer needs to be tedious, time-consuming or absorb a lot of resources. As part of the toolkit that goes along with the Newtec Dialog VSAT platform and its Network Management System (NMS), Newtec introduces the ***Newtec Dialog Satellite Network Calculator***. This tool provides instant insight into the performance and potential of the satellite network, replacing multiple planning and calculation tools with a single user interface and the efficiency of planning the next government and defense satellite network. In short, a real-time dashboard for the next operation.

The Newtec Dialog Satellite Network Calculator was conceived out of the increasing request from satellite network operators to merge the multitude of planning, link budget and calculating tools into a common, real-time dashboard connecting inputs and results from ground segment, satellite data and network capabilities. More efficient planning results in more effective operations. A free, trial version of the tool is available at the Newtec webpage (***www.newtec.eu***).

### *2018, Another Successful Year for Newtec*

With the Newtec financial year closing at the end of September, the company already have a good idea of the overall 2018 results for the company. For the fifth year in a row, Newtec can present a double-digit percentage revenue growth.

The overall revenue for FY2018 increased close to 20 percent, while the government and defence revenue grew at a stunning 45 percent. You will need to look hard in the satellite communication industry to find such impressive results. The growth can be directly related to the success of the Newtec Dialog VSAT platform and the ***Newtec MDM9000 DVB-S2X*** modem in the Government and Defense market. We saw implementations of the Newtec Dialog solution in embassy networks, MoD networks, airborne ISR networks, welfare programs and humanitarian relief projects. Some of these are published at the Newtec webpage. Both the Newtec Dialog and the Newtec MDM9000 modem are **WGS** certification pending. The certification for the MDM9000 SCPC modem is expected by the end of 2018. As such, the MDM9000 is the DVB-S2X modem for military applications and the first DVB-S2X modem on WGS enabling high throughput and high efficiency for bandwidth hungry applications such as ISR.

The success formula of the WGS pending Newtec Dialog® VSAT platform for the government and defense market consists of nine main ingredients. The main ingredient (and the Newtec house specialty) is waveform efficiency, where Newtec, thanks to its DVB-S2X and Newtec Mx-DMA technologies, can provide double throughput at the highest service availability. The Newtec Dialog® platform will relay and exchange a mix of video, data and voice services (multiservice) coming from remote fixed, on-the-pause and on-the-move assets (mobility) in a seamless way. These assets are either part of a regional or global network (global connectivity). The size of the network can be scaled (scalability) depending on the increase of operations over time or when budgets become available.

As the Newtec Dialog system finds its origins in commercial networks, this ***Commercial-Off-The-Shelf*** (**COTS**) VSAT system is affordable and also combines OPEX and CAPEX savings. The platform embraces the growing complexity of satellite government and defense networks allowing to adapt infrastructure elements and services to the operations at hand (flexibility and agility). Furthermore, the platform is easy to operate, manage and install, as demonstrated in the above segment on planning the next operation.

Finally, security is high on the list of the Newtec Dialog® platform, avoiding revealing the location of the terminal by not exchanging any GPS coordinates and providing the capability to mute transmissions during operations. Interception can be avoided through the inherent Newtec Mx-DMA government-grade frequency hopping feature.

***www.newtec.eu***

*Koen Willems started his career in 1998 with Lernout&Hauspie as a project manager in the Consulting & Services division. More recently, he joined Toshiba as a Product Marketing Manager for the Benelux and, later, for the European market. In a total of 6 years, Koen contributed to all of the major Toshiba Retail IT product releases. Mr. Willems is, currently the Market Director for Government and Defnese for Newtec, a Belgium-based specialist in satellite communications. Koen holds a degree in Germanic Languages (University Ghent, Belgium, 1997) and completed a Masters degree in Marketing Management program at the Vlekho Business School in Brussels (1998).*

# NORSAT INTERNATIONAL, INC.

*By Dr. Amiee Chan, President and Chief Executive Officer*

**2018 has been a year of tremendous market success for Norsat International through a wave of new product development and diversification into new markets.**

During the past year, fly-away satellite terminals witnessed significant growth, especially within applications such as military intelligence and broadbase disaster response. This proved to be beneficial for Norsat, as the satellite communications market is expected to register a CAGR of more than 8.46 percent during the forecast period of 2018 to 2023.

Through our constant industry interactions, customer requirements and R&D, Norsat is showing that products can be rugged, reliable, and cost effective.

In 2018, Norsat developed and introduced next-generation terminals and a new lineup of compact microwave components and systems for the commercial and military markets. Whether customers are flying at 40,000 feet, in the middle of a rescue operation in a cave or driving leisurely across the country, Norsat delivers the best products to enable seamless communication.

### *Success Starts the Year*

Norsat's ***ATOM*** series of block upconverters are world-renowned for being one of the most powerful BUCs, with the best industry size, weight, power and efficiency.

With a strong focus on research and new product development, Norsat's ATOM 50 Watt Ka-band BUC and the industry's first 4- and 5-band Ka LNBs were launched, making the Norsat Ka-band satellite components offering one of the richest in the industry.

### *New Markets Diversification*

Commercial terminals have evolved over the years to become vital tools in the satellite industry. Norsat's market analysis revealed that light-weight, commercial terminals are becoming a mainstay for organizations that have to launch broadband connections in time-sensitive conditions. What originated as simple video or data uplink from a quick-deployable device has developed into an entire market segment.

Toward the end of 2017, there was an immediate and increasing customer demand for commercial satellite terminals in numerous designs, each slightly unique from each other, envisioned for specific applications. Keeping this in mind, customer-focused product development proved to be a key motivator for Norsat this year.

A further step in our market diversification was the launch of Norsat's ***WAYFARER***™ series of ultra-portable commercial satellite terminals at the NAB Show in Las Vegas, in April.


*Norsat supports the United States Coast Guard.*

This was a strategic move to further meet the increasing needs of our non-military customers seeking high quality and high value solutions.

This series includes an easy-to-deploy drive-away, fly-away and fixed terminal solution. Products in this series are ideal for a variety of commercial applications including broadcast, oil and gas, mining, forestry, emergency response and remote enterprises, enabling us to reach out to new markets. Our commercial customers have praised the fast setup, tool-free installation and weather-proof construction.

### *Think Local, Act Global*

With a history of more than 40 years of success, Norsat is well known locally in North America as the leading provider of innovative communication solutions for remote and challenging environments. This year, however, we have been witnessing significant orders from EMEA. This enabled Norsat to deliver its signature North American quality products overseas.

Europe holds one of the largest global market shares for the Satellite Services Market due to the presence of large integrators and operators and an increasing number of commercial customers using satellite communication as part of their overall communications plan.

Additionally, the joint venture of European Commission and European ICT industry to provide the 5G Infrastructure Public Private Partnership (5G PPP), will deliver solutions, architectures, technologies and standards for the ubiquitous next-generation communication infrastructures of the coming decade.

The company received a $3 million order from this region in mid-2018. Another set of products that witnessed significant growth and were a major success were the 4- and 5-band Ka LNBs. Our 1:1 and 1:2 redundant switch system witnessed a surge in growth, as well.

### *Moving Forward*

Known globally as an organization with a unique ability to 'customize fast', customers expect Norsat to deliver extremely specialized products quickly.


Rather than a mass-market approach, the company treats every customer's business as our own by developing solutions that adapt quickly to their applications. What has helped us survive and excel in the long run, for over four decades — is Norsat's exceptional dedication to the *LEAN Kaizen philosophy*.

Every year, we witness changing macroeconomic conditions, new technology with increasing competition. LEAN, done correctly, helps us maintain quality, be more flexible and adaptable to change as it occurs, rather than having customers suffer because of delayed responses.

Every employee at Norsat believes that 'not a single process is exempt from improvement' — hence, striving for excellence is a continuous process. Norsat is one of the top organizations in Canada following LEAN, with every employee going through LEAN training, with six Green Belts, and three Black Belt certifications present in our current team. In 2019, our LEAN goal is ultimate customer delight. We are working toward achieving one of the shortest lead times in the industry with the highest quality products, by making our business processes more efficient.

As we move into 2019, the growth of the SATCOM market is anticipated to be driven by high demand for uninterrupted, customizable, energy-efficient communication systems with longer lifespans, greater functionalities and dependability — which is exactly what Norsat provides.

Norsat will continue to expand our international customer base, closing deals in Europe, Asia, and South America. Moreover, we have already pledged a heavy investment in R&D and to all that is possible to ease the customer journey through the launch of the company's ecommerce platform.

2019 will, indeed, be a promising year for Norsat with significant new projects already underway.

**www.norsat.com**

*Dr. Amiee Chan, President and CEO has more than 20 years of experience in executive management and research & development in the telecommunications industry. Offering a rare blend of technical and corporate strength, Dr. Chan's strategic vision has driven Norsat's innovative product development program and resulted in consistent revenue growth since her appointment as CEO in 2006. Dr. Chan currently holds three U.S. patents in satellite technologies and has been involved in high level research teams such as the NASA ACTS Terminal Program.*

*Dr. Chan holds an Executive MBA from Simon Fraser University where she majored in Strategy & New Ventures, as well as an Electrical Engineering Ph. D. in Satellite Communications from the University of British Columbia. Dr. Chan currently serves on the Dean's External Advisory Board for the Beedie School of Business at SFU, the Science World Board of Directors and the UBC Engineering Advisory Council.*

# PARADIGM COMMUNICATION SYSTEMS

*By Ulf Sandberg, Managing Director*

**There were several successes for Paradigm during 2018, and they included:**

### *MANTA Launch and Partnership with Kymeta*

Paradigm launched the ***MANTA*** in October of 2018, a high throughput versatile satellite terminal designed to cater for both tactical deployment and SATCOM-On-The-Move (*SOTM*) operations.


Paradigm's integration of technology increases the capabilities of the **Kymeta**™ ***mTenna***™ antenna by including the ***PIM® (Paradigm Interface Module) terminal controller***. The addition of the well-fielded and proven PIM provides enhanced features and user experience; together with a fully weatherized and ruggedized self-pointing satellite terminal solution supplied in just one single IATA case.

Just add power for quick and accurate tool-free deployment either in a static situation or by quickly attaching it to roof bars for comms-on-the-move operation. The handheld remote offers additional control from either within the vehicle or at a distance from the terminal. The MANTA offers up tremendous potential for the mobile, rapid deployment requirements of first responder, military and government customers. Initial roll-outs are already taking place at the end of 2018.

### *The New HORNET Terminal*

Released in Q4, Paradigm's new ***HORNET*** flyaway terminal is a single case, lightweight, modular solution operational on Ka-, Mil-Ka, Ku- and X-Band frequencies.

The HORNET has been designed to provide a completely flexible, high throughput terminal, with modules that are changeable in the field. The antenna is comprised of segmented carbon-fiber and available in 60, 80 or 100 cm., all deploying quickly and accurately without the need for tools, together with the requisite RF feeds. The '*in-the-field*' change-out feature allows the operator to quickly transition between X-, Ku-, Ka- and Mil-Ka-Bands. The system is modem agnostic and supports all high performance modems. The terminal integrates the PIM. This means that pointing the antenna is a fast and simple operation using the audio cues and a visual cross-hair target of LEDs. The PIM also integrates adjustable legs to provide a low and wide operational footprint to maintain stability.


The HORNET is extremely rugged and weatherproof with low power consumption. It will pack down into a single case or backpack which are IATA compliant for easy transportation/ Meeting requirements for flexibility, rapid deployment and portability, the HORNET is an ideal solution for first responders, government and military users.

### *Global Demand for SWARM*

Paradigm's SWARM continued to meet demand from all over the world during 2018 for a rugged, high speed, hand-carry, SATCOM solution. Its consistent track record of reliability and high data throughput has seen take-up spread across five continents with field implementations across a wide range of military and commercial customers.

The SWARM achieves twice the efficiency of similar hand-carry solutions and provides BGAN-like simplicity with high data rate capability. It is now configurable for Ka-, Mil-Ka, Ku- and X-Band frequencies and is operational on a multitude of satellite constellations. The modem integrated in the PIM is interchangeable and all major modems are now supported. This commercial agility coupled with its field-proven reputation and ultra-portability will ensure that demand for this unique terminal is set to grow and grow.

### *SWARM Deployment by the RAF*

Operating on **Inmarsat**'s ***Global Xpress*** network, Paradigm's SWARM provided key support to the UK's **Royal Air Force** (RAF) for two major events during 2018.

The first was in July to provide seamless connectivity for the RAF100 Flypast over Buckingham Palace, London. This high-profile event was staged by the RAF to celebrate 100 years of the service and involved 100 aircraft that represented the past 100 years, all flying through the skies of London. The small but powerful SWARM terminal ensured that the media feed could rely on constant communications throughout the day in the face of high demand from the public on the terrestrial 4G network.

Following the event, Squadron Leader ***Gordon Henderson*** remarked on the "*outstanding level of service from the lightweight and easily operated SWARM terminal. By providing the Air Command Media team with access to Inmarsat's Global Xpress connectivity, they were able to continue uploading videos from the parade even as the 4G network in London begun to struggle.*"

The RAF's comms team were so impressed with the SWARM's performance and ease of use that the unit was quickly adopted for their major centenary event in September, the ***Himalayan Venture 18*** (HV18). This expedition united 75 members of the wider RAF family in a pioneering expedition to the Rolwaling and Khumbu regions of the Nepalese Himalayan range.

The high-speed SWARM satellite terminal provided invaluable support for the expedition. It was easily carried in a backpack and could be setup and operational in less than five minutes. The Alpine Team used the system every day. Its performance was completely unaffected by the heavy monsoon rains, by snow, and by sub-zero temperatures nearing -20°.

Using the SWARM was so straightforward that, as the expedition progressed, training other team members to setup and point it was quick and simple. Once pointed, the PIM's commissioning feature meant that any of the team members could simply power it back up and be automatically back on the network, calling family and friends back home and updating their own social media feeds.

The near-instant connectivity meant that Command & Control requirements were more straightforward, with all teams able to maintain regular contact with the expedition leader and embassy staff.

The media coverage throughout the expedition was exceptional and maintained high levels of exposure for the expedition's sponsors. The teams provided daily social media updates, posting high resolution photos and video. When the satphones were unable to connect, the SWARM provided the WiFii necessary for daily calls between teams and back home, to family and friends. As RAF Squadron Leader Gordon Henderson said, "*using the SWARM was like having the equivalent of a home WiFi system... while living at 5,200 meters*".

The teams' first-hand accounts of SWARM's ease-of-use and high-throughput in such challenging conditions are clear demonstrations of how this remarkable little terminal can make all the difference to mobile users needing reliable communications in areas where terrestrial options are either unavailable or unreliable.

### *2019 Plans and Ops*

Initial reactions to the MANTA and the HORNET terminals have been overwhelmingly positive and Paradigm expects to see some exciting opportunities with both solutions during 2019. Global deployment for the SWARM in all its form factors is set to continue across all sectors.

Additional feature sets for all three terminals will continue to be released by Paradigm and the company is working closely with partners and key customers to deliver enhancements and developments to the terminals to suit specific requirements.

The partnership between Paradigm and Kymeta to release the MANTA marks a strong collaboration between two of the most innovative players in the mobile satellite communications market. Paradigm is looking forward to the creation of more superior solutions for this fast-moving SATCOM sector and revolutionizing the SATCOMS-On-The-Move (SOTM) market.

2019 will see Paradigm continue to simplify satellite communication and increase its efficiency which, in turn, keeps costs down. With new satellites continuously being designed to deliver high data content worldwide, the assembly and operation of the terminals has to be achievable by the non-technical user.

When reliable satellite communication can be achieved over and over again because the setup and pointing process is foolproof, then a better experience is delivered to customers. The future of the industry is seamless mobility using smaller terminals with simple setups.

Over the course of 2019, Paradigm will release even more products that seriously simplify SATCOM, thereby ensuring that global communication via satellite will remain a viable option for any user.

***www.paracomm.co.uk***

# SPECTRA GROUP (UK) LTD.

*By Simon Davies, Chief Executive Officer / Managing Director*

**With Spectra SlingShot's versatility and interoperability, the availability of Beyond Line of Sight (BLOS) communication for all standard U/VHF communication system users is now a viable reality.**

*Beyond Line of Sight* (BLOS) communications have traditionally been a complex requirement when operating without recourse to conventional fixed infrastructure or satellite communications systems.

In today's technologically advanced world, where ease of communications is often taken for granted, many may question why this should be such a challenging concept, or even an essential requirement. Nevertheless, many scenarios still remain where independent access to BLOS communications is not just a convenience — it's a crucial, life-saving necessity.

Take, for example, the devastating effect of natural disasters or terrorist attacks on conventional, land-based communications systems. Emergency or disaster-relief organizations deploying to provide support and assistance following such events will have an immediate requirement for reliable, long-range communications in order to carry out their role to best effect. Or an emergency, non-combatant evacuation operation using multiple force employment.

Early-entry forces deployed by air may be required to mission plan and communicate using their tactical radio systems while airborne, while a naval contingent stationed offshore will need to join the operational net to communicate with the early entry force.

Both teams use tactical radios and, despite being potentially hundreds of kilometers apart, will require secure voice and data capability.

On landing, ground troops conducting the evacuation to the waiting naval ship will, using tactical VHF radios alone, need to communicate with both the air and naval platforms throughout the operation. Additionally, the national HQ in the home base will need to maintain a listening watch.

The challenge is how to maintain secure BLOS voice and data communications on tactical UHF and VHF radios throughout the operations taking place in these scenarios.

SlingShot is designed for precisely such challenges. With easily implemented SlingShot-enabled UHF or VHF radios in each node, and the provision of a bespoke, multi-headed, satellite beam covering the entire area of interest, interoperability becomes possible without the need for further re-equipping or training.

These scenarios clearly illustrate where safety or mission-critical BLOS communications can be essential; where lack of infrastructure could significantly impair command and control, situational awareness and passage of critical information when most needed.

These are the operating environments within which many disaster relief, security or military agencies operate, and it is just such agencies that are reaping the benefits of Spectra's revolutionary SlingShot communications system.

*Hungarian Special Forces equpiped with a SlingShot manpack system. This image is courtesy of* **https://honvedelem.hu/**

### *BLOS Voice and Data Communications on the Move*

Conceived and designed to meet demanding Special Forces requirements, Spectra's SlingShot is a unique, low SWaP system that enables UHF and VHF tactical radios to extend into the realm of BLOS *Communications-On-The-Move* (COTM) using **Inmarsat**'s commercial satellite network via ***L-TAC*** (**L-band Tactical Satellite**).

With its discrete, lightweight omnidirectional antennas, optimized to be man-portable, or easily fitted to vehicle, maritime and aviation platforms, SlingShot allows a tactical net to be broadcast over thousands of kilometers to meet a wide range of

tactical and operational network configurations. In addition to voice, SlingShot provides a data capability to support wide-ranging mission-critical applications, such as artillery fire missions, GPS tracking and biometric analysis, to name a few. With reduced cost compared to traditional TACSAT, increased channel availability and virtually no increase in the training burden, SlingShot is rapidly redefining tactical communications capabilities.

### *Multi-Agency Interoperability*

When, for whatever reason, fixed infrastructure communications are unavailable, SlingShot has a proven record of providing a reliable and easily implemented communications network for multiple agencies worldwide.

Following emergency or natural disaster, SlingShot enables reliable communications during that critical immediate deployment and operating time-period for disaster relief agencies. Organizations operating within this environment understand that flow of information is essential and is likely to require dialogue between multiple international agencies at multiple levels.

SlingShot offers the key defining capability of providing a collaborative network for interoperability; permitting seamless inter-agency communications between individuals or organizations likely to be using nationally distinct communications equipment.

SlingShot is able to provide this unique capability of organizational interoperability to disaster-relief agencies, customs and border patrol, anti-narcotics, maritime patrol, homeland security, National Guard, intelligence communities, police, and emergency responders.

### *Ease of Use*

SlingShot provides critical voice; when the user transmits, a channel is automatically provided to instantaneously transfer the message to an all-informed network. This is the significant difference between SlingShot and other range-extension systems that provide either an on-demand channel, where a channel is provided only if available, or Voice over IP (VoIP)/Radio Over IP (RoIP), where there is no guarantee of the IP network providing a circuit when needed, therefore giving no guarantee that the message will get through.


As a small, external appliqué connecting directly to the users' existing radio, SlingShot demands minimal training and reduces the cognitive burden on the operator. It can be powered from any 12 to 230v power source, using the users' existing power system or a host of any secondary power sources.

### *Global Sales Success*

Spectra Group (UK) Ltd is an internationally renowned specialist provider of secure voice, data and satellite communications systems, specifically optimized for use in remote and challenging environments. The company is a world-leading solutions provider of high-grade information security and communication capabilities, with more than 15 years of experience in delivering solutions for governments around the globe, elite militaries, special forces and private enterprises of all sizes.

Launched in 2013, over 3,000 SlingShot systems are now in operation world-wide. The system is used by 18 different organizations, including several NATO countries.

Spectra continues to expand its SlingShot business with more than 600 systems having been ordered across four continents during the last 12 months. Recent world-wide exhibits at Africa Endeavour (Cape Verde), Land Forces (Australia), DVD (UK), Global SOF (Spain), AUSA (USA) and the Africa Security Symposium (Senegal) have been met with considerable international interest, further endorsing Spectra's dominant position in the Tactical SATCOM marketplace. Globally, SlingShot is rapidly becoming the system of choice for tactical radio users needing increased range, flexibility and interoperability.

In Oct 2018, following contract successes in North America, particularly with their game-changing SlingShot system, Spectra Group (UK) Ltd established new offices in Fairfax County, Virginia, with Spectra Group (US) Inc.

Spectra Group's permanent presence in the USA enables the company to guarantee closer product support to their existing partners in North America, as well as dedicated product and service support directly to the end-user.

Spectra Group are now looking to expand their already substantial international sales into new sectors not currently covered by their existing U.S. partners; a significant development as, globally, the USA offers the largest Defense, Emergency Response and Homeland Security market.

As a dynamic, agile, security accredited organisation, Spectra can leverage their international delivery experience to also provide Cyber Advisory and secure Hosted and Managed Solutions on time, to spec and on budget, ensuring compliance with industry standards and best practices.

***spectra-group.co.uk***

# EXECUTIVE SPOTLIGHT: RICHARD WHITE, PRESIDENT, SSL GOVERNMENT SYSTEMS

*Mr. Richard White is President of SSL Government Systems, where is he is responsible for leveraging SSL and Maxar Technologies capabilities to serve the U.S. Government. He has served in senior management roles across multiple companies and mission areas, including intelligence, surveillance and reconnaissance, satellite antennas and payloads, and cyber security.*

*Mr. White brings deep knowledge and access across numerous U.S. Department of Defense (DoD), intelligence, and civilian agencies to SSL.*

In late 2017, **MDA** and **DigitalGlobe** combined to create **Maxar Technologies**. The newly combined company, which includes **SSL**, DigitalGlobe, **Radiant Solutions**, and MDA, offers a broader set of space-based solutions, increased scale, and a more diversified revenue base. Together with Maxar, SSL continues to gain momentum in growing its pipeline for U.S. government, Department of Defense, and civil space programs and celebrated a number of key wins over the year. Richard White offered his thoughts regarding 2018...

*What are some of SSL's highlights from 2018?*

***Richard White (RW)***

**On the U.S. Government (USG) business side of SSL, we were awarded multiple contracts over the course of the year.**

In October, we won the **SSPEDI** (*Small Spacecraft Prototyping Engineering Development*) contract to provide small to medium satellite solutions to the **DoD**. Under the contract, SSL is eligible to compete for multiple awards over five years, for up to a cumulative value of $750 million.

For SSPEDI, we're providing end-to-end mission systems that harness the collective power of Maxar Technologies and our close partnership with Maxar's Radiant Solutions, which provides innovative products and services that source, enrich, and analyze massive amounts of geospatial data to reveal insights where and when it matters.

In August, SSL announced that NASA had selected the company to provide the main onboard computer for the ***Psyche*** mission to explore what is believed to be an asteroid made of metal rather than rock or ice. In addition to the onboard computer, SSL is also providing a high power, solar electric propulsion spacecraft chassis based on our SSL 1300 platform.

We're also building critical equipment for NASA's ***Europa Clipper*** spacecraft, which will explore **Europa**, an icy moon of Jupiter.

The company continues to work across DoD, civil, and commercial space communities on several leading-edge programs and studies that aim to help USG agencies define next-generation space technologies, including advanced space architectures for the ***U.S. Air Force's Strategic Enterprise Vision***, missile defense concepts for the **Missile Defense Agency** and technologies for on orbit assembly, manufacturing, and refueling.

*On orbit servicing and assembly are emerging as a critical technology for next-generation space ecosystems. How is SSL involved?*

***RW***

We believe that in-space robotic operations are the gateway to an entirely new infrastructure for Earth Observation (EO), communications, space exploration, space travel, and habitats, and they are an integral part of Maxar's purpose to "*Build a Better World.*"

While billions of people depend on satellites for everyday needs like telecommunications, GPS, and internet, they are the only element of our essential daily infrastructure that cannot be serviced. Maxar has evolved the technologies for on orbit satellite servicing and assembly for more than three decades. The company has participated in over 200 successful robotic space missions, including those on the **Space Shuttles**, the **International Space Station** and every **Mars Rover** and **Lander** vehicle — including NASA's ***InSight Lander***, which touched down on Mars in late November. Our robotic arms have been used to assemble the International Space Station while on orbit and are routinely used to service the Station, capture and dock unpiloted spacecraft, and even move astronauts.

Leveraging this experience, SSL is working on three separate and complementary satellite servicing and assembly programs. In a public-private partnership with **DARPA**, we're building the spacecraft and robotic arms for the ***Robotic Servicing of Geosynchronous Satellites (RSGS)*** program. RSGS will enable unprecedented flexibility and resilience for GEO satellite operators through on orbit inspection, repair, and upgrade. We're also adding refueling capabilities.

SSL is also pleased to be working together with NASA on a separate servicing mission, called ***Restore-L***. Similar to RSGS, the company is building both the spacecraft and robotic arms for Restore-L, which will refuel a government-owned satellite in Low Earth Orbit (LEO) and demonstrate fundamental capabilities for future NASA missions.

SSL is also collaborating with NASA to develop ***Dragonfly***, an ultra-lightweight robotic system that is expected to enable entirely new architectures and capabilities for government and commercial missions through on-orbit assembly. With Dragonfly, large structures, such as platforms, apertures, and antennas, are no longer confined by the volume limitations of the rocket fairing, and sensitive instruments can be launched in a soft environment, removing the need to survive the harsh vibrations of a traditional launch environment.

*Small satellites and LEO constellations are emerging as affordable, resilient, and capable assets that complement GEO systems. How is SSL participating in the smallsat market?*

***RW***

In the smallsat realm, SSL is demonstrating ongoing success on a number of programs. We recently shipped two more ***SkySat*** EO satellites that we built for **Planet** to Vandenberg Air Force Base. Six of Planet's SSL-built satellites were launched in 2017 and five were launched in 2016. With this launch, there are now a total of 13 SSL-built SkySats on orbit. SSL continues to manufacture additional SkySats for Planet's constellation in the company's state-of-the-art manufacturing facility.

In additional work on remote sensing satellite constellations, SSL is making progress on the firm's innovative design for ***WorldView Legion***, a next-generation, high-resolution constellation for Maxar's DigitalGlobe. The LEO satellites will more than double DigitalGlobe's high-resolution capacity in important regions.

Additionally, in July, SSL announced that the company is working with **Thales Alenia Space** to pursue the development and manufacture of **Telesat**'s global LEO satellite constellation and end-to-end system. The constellation will transform global communications by offering an unsurpassed combination of capacity, speed, security, resiliency, and low cost with latency performance that is as good or better than the most advanced terrestrial networks. Telesat anticipates selecting either the Thales Alenia Space/Maxar team or an alternate team to begin work on the program in mid-2019.

*What is USG's role in advancing technologies that support American leadership in space?*

***RW***

The USG has a growing and evolving focus on space and on working with commercial companies to leverage the benefits of a competitive marketplace and space-proven systems. Innovative government contracting vehicles, such as Other Transaction Authorities and Public-Private Partnerships, are supporting collaborations that can result in ongoing commercially provided services that serve both public and private interest.

In this way, government support continues to play a very important role in the development of next-generation space technologies. Investment, partnership and cooperation from government help to identify and accelerate next-generation technologies that support American leadership in space

Earlier this year, *Jim Bridenstine* was confirmed as NASA Administrator. We're encouraged by his plan to go forward to the Moon as an important step in developing technologies that will enable humankind on its journey to Mars and are pleased to be providing concepts for one of the first major systems to support that journey — NASA's ***Lunar Gateway***. The Gateway is a human crew-tended spaceport in lunar orbit that will function as an access point to the Moon and deep space. SSL is leveraging its extensive commercial experience in solar electric propulsion systems to provide concepts for the Power and Propulsion Element, which would be the first Gateway module launched.

*What is on the horizon for SSL in 2019?*

***RW***

SSL is a world-renowned authority in designing and building commercial GEO satellites that deliver services to billions of people across the globe. We're also a world leader in space robotics, having provided every robotic arm on the surface of Mars. Now, together with Maxar Technologies, we're steadily building our reputation for smallsats and mission systems engineering.

In 2019, SSL will continue to diversify the business while maintaining the commitments already made to customers. We're investing in new technologies that unlock the promise of space for commercial and government markets and combining our decades of commercial experience to accelerate innovation for the new space economy. The future is looking bright.

***www.sslmda.com***

# WALTON DE-ICE

*By David Walton, Vice President*

**2018 has been an exciting year for Walton De-Ice, (W.B. Walton Enterprises, Inc.) as the company approaches 40 years of satellite industry experience helping to protect SATCOMS terminals, gateways and teleports from the effects of weather.**

The company's main focus in C4ISR infrastructure has been keeping Earth station antennas snow and ice-free with our ***Plenum Hot-Air*** De-Ice systems, and our more recent invention, the energy-saving ***Ice Quake***.

From our original hot air (Plenum) design which mounts behind antennas from 3.7 to 32 meters, to our ***Snow Shield***, ***Rain Quake***, and ***Ice Quake*** Walton De-Ice systems for 0.6 to 6.3-meter antennas, the company delivers the most innovative and effective solutions to help protect critical satellite networks from degradation and outages due to weather.

In recent years, our solutions have contributed to U.S. DoD programs that have included *SNAP* terminals, the *Modernization of Enterprise Terminals* (MET) and the U.S. Army's WIN-T (*Warfighter Information Network Tactical*). This year, new ultra-portable solutions were introduced to protect MILSATCOM and COTS micro-VSATs, LEO, MEO, GEO SATCOM terminals and transportable terminals from the effects of wind, sandstorms, heat, ice, snow and debris, and similar hostile environmental effects. Featuring exciting and new capabilities ensures cost-savings for customers as well as resiliency-boosters for tactical satellite networks.

### *Ka-Band Market Leadership and Growth*

Market demand from continued HTS and mobility growth has greatly benefited our business from satellite operators, service providers and integrators this past year as they have invested in new Ka-band ground infrastructure. We continued to expand Ka-band commercial leadership in the De-Icing field, with many hundreds of Ka-band large antenna systems now successfully deployed.

For Earth station antennas from 3.7 to as large as 32 meters, the Walton Plenum Hot Air De-Icing systems maximizes pointing accuracy that is so critical for protecting Ka-Band systems. Unlike competing anti-icing solutions such as electric pad systems that can cause reflector distortion, Walton Hot Air De-Ice systems heat the entire antenna reflector uniformly, which minimizes reflector distortion that can cause signal problems at the Ku- and Ka-bands.

Walton systems also uniquely offer maximum flexibility with electric, natural gas and liquid propane gas heater options. Infrared testing of optimal antenna heating distribution offers precision performance validation for the most demanding Ka-band customer applications
Also for Ka-band where antenna wetting alone can add significant degradation to link performance, not to mention the effects of any water in the feed bore sight, Walton's Rain Quake antenna covers help Ka-band (HTS) terminals squeeze even more bandwidth and bits out of links during rain events.

### *C-/Ku-Band De-Icing*

Walton teleport customers with C- and Ku-band traditional services continued to leverage the company's new automation and control features, along with the Ice Quake system, a super-low energy consumption solution for shedding snow off antennas from 0.6 to 6.3 meters in size. The Ice Quake can deliver up to 100x energy-savings when compared to traditional anti-icing solutions, which is why it has been adopted in teleports, and cable and broadcast facilities.


### *Unleashing New Possibilities: Portable Weather Protection*

In recent years, customers in locations such as the Middle East and Africa who experience the damaging effects of sandstorms, asked us for new ways to help protect antenna terminals. LEO/MEO developers asked for other solutions, as they looked for more cost-effective ways to protect terminals from other harsh conditions.

Walton De-Ice delivered several customer-specific integrations for these field requirements, for civil and defense applications.

Customers told the company they needed a solution to keep certain types of antennas operating in extreme and harsh environments, as traditional antenna radomes are not built for transportable operations.

Many of today's military and first-responders deploy their systems in locales where harsh elements demand radome-like protection. Enter the world's first portable satellite earth station antenna radome, the ***Walton Portable Radome***.


The Walton Portable Radome (Patent Pending) unleashes an entirely new set of possibilities for operating *Satellite Transportable Terminals* (STT) and micro-VSATs in extreme and mobile conditions to support military requirements for high capacity data, voice and video capabilities worldwide. This product provides a uniquely deployable weather protection solution for applications, such as military vehicular mount terminals, *Comms-On-The-Pause* (COTP) or *Comms-On-The-Halt* (COTH) units, VSATs, transportable uplinks, as well as enterprise terminals for LEO/MEO gateways.

This lightweight, rapidly deployable radome protects VSAT and transportable antennas from rain, snow, ice, wind, sand, debris and heat. Whether the mission demands staying on-air in an 85 mile-per-hour (136 kph) windstorm, a sandstorm, a blizzard, hail, or torrential rains — the Portable Radome helps make satellite networks more survivable and deployable into extreme or harsh environments. The Walton Portable Radome (available for C-, Ku-, X-, or Ka-band) also enables operators to realize significant cost saving versus conventional radomes for military or civilian networks.

Operational in constant wind load, the self-supporting structure requires no continuous power, unlike *Inflatable SATCOM Antennas* (ISA) antenna covers. It quickly assembles in less than an hour and requires no tools — unlike conventional radomes that can require two days and a crane to install, depending on specifications.

The flyaway lightweight (2.13x1.68 meters / 44.45 kg.) model is airline baggage checkable. And yet, for all these benefits, it can also support permanent site requirements. The Walton Portable Radome employs rugged, RF-passing, and hydrophobic antenna cover materials. Field-testing has shown a minimal G/T decrease at Ka-band when the Portable Radome covers a small antenna, such the Ka-band terminal type used in France by the Ministry of Defense.

The Walton Portable Radome offers cost-savings because, instead of having to procure more expensive ruggedized antenna structures, a lower-cost COTS antenna can be protected with the radome. This can enable allowing more terminal procurement spend on cyber hardening electronics or other investments. Additionally, in extremely hot climates, an efficient forced air/HVAC system can be added to protect equipment temperatures underneath the Radome and prevent equipment damage.

### *LEO/MEO/GEO Gateways*

The Portable Radome can also be used for fixed site ground networks. For LEO/MEO/GEO constellation infrastructure, it can deliver gateway site cost-savings and other advantages compared to traditional radomes.

### *Looking Ahead*

After beta testing multiple designs and customer-specific requirements and trade-offs, the company unveiled the baseline design in Q2 of this year to great response and interest from traditional and new customers.

Walton De-Ice continued to tailor the Portable Radome product features based on further user input and testing over several months and decided to focus initially on serving the needs of specific growth segments of the market.

Looking forward to 2019, the company is excited about the various opportunities at-hand to work with existing and new industry partners, operators and integrators in delivering the benefits of the firm's latest technology into LEO/MEO/GEO infrastructure, DoD programs, Earth station systems, and transportable networks.

***www.de-ice.com***

*David Walton is Vice President of Walton De-Ice (W.B. Walton Enterprises, Inc.), where he is responsible for the Snow Shield, Ice Quake products and new product development. He has over 37 years of satellite industry experience in the design, manufacture, and deployment of earth station technology, and holds several patents for his inventions in this field. He can be contacted at:* ***david@de-ice.com****, or visit .*

# WAVESTREAM

*By Joe Shilgalis, Vice President of Sales*

**With nearly 40,000 systems shipped to commercial, government and defense customers over the past 15 years, Wavestream has earned a reputation across the satcom industry for the innovative design, high quality, reliability and performance of its Solid State Power Amplifiers (SSPAs), Block Upconverters (BUCs), Block Down Converters and Transceivers.**

In 2018, Wavestream experienced rapid growth and product expansion, fueled by new technologies that address the demands of the in-flight connectivity and gateway markets. In parallel, the company continued to upgrade and enhance its industry-leading Ka-band SSPA amplifiers for mission-critical satellite communication systems for military applications.

## *Supporting New IFC Trends*

*In-Flight Connectivity* (IFC) is a burgeoning market with an almost insatiable demand for bandwidth, driven mainly by the explosive growth of WiFi service in commercial and business aviation.

A key trend is the transition from Ku- to Ka-band, which is becoming more prevalent as more Ka-band space capacity becomes available for IFC applications. In addition, the launch of LEO/MEO constellations is seen as a new opportunity to meet the increased demand for higher speed services across commercial, business and military aviation applications. Wavestream remains the leading SSPA supplier in the dynamic IFC market, offering a portfolio of BUC amplifiers for Ku and Ka bands.

These field-proven products have been integrated and operating within IFC systems since 2010, and are currently flying on B737, B757, B767, A320, and A321 commercial aircraft, as well as **Embraer**, **Bombardier** and **Gulfstream** business jets. Attesting to the robustness and stringent quality testing of our products, Wavestream BUC amplifiers are line-fit certified for **Boeing**, **Airbus** and other leading aircraft manufacturers.

Wavestream is recognized as the largest IFC merchant supplier of SSPA equipment across the world.

Leveraging its reliable product design and rigorous environmental testing standards, Wavestream's IFC products are designed to meet both OAE and IAE installations and are adapted for use in military applications.

## *Bringing SSPA Technology to the Gateway Market*

Wavestream entered the gateway market in 2018, and is currently manufacturing mass-producible SSPAs at power levels that could previously be achieved only by traveling wave tube amplifiers. As power levels continue to increase and satellite altitudes decrease, Wavestream is well-equipped to capitalize upon this opportunity.

Wavestream SSPA amplifiers and *Spatial Power Combining* technology provide major technical and operational advantages for satellite operators with global LEO/MEO constellations. SSPAs are also more reliable than tube amplifiers — a critical requirement for LEO/MEO networks with hundreds of gateways in remote locations that cannot be easily serviced.

Traditional GEO networks, in contrast, commonly require 1-3 gateways. Moreover, the fact that SSPAs can be mass produced enables faster buildout of global LEO/MEO networks that typically require up to 500-1000 gateway amplifiers.

Wavestream's new ***160W Peak Envelope Power SSPA***, designed for Ka-band gateway applications, enables operators to monitor real time power and make near-instantaneous power adjustments to ensure high bandwidth connectivity. This new SSPA is already in production and being installed in a next generation LEO network planned to comprise 400+ ground station antennas worldwide.

As an early technology leader in the LEO/MEO gateway segment, Wavestream looks forward to expanding its footprint as LEO/MEO networks become more prevalent.

The company's R&D team is exploring advanced linearization techniques that could be applicable to the wide bandwidth and complex waveforms used in gateway applications, enabling operators to further enhance efficiency and lower costs.

## *Defense*

Wavestream is proud of its rich heritage in supplying high performance, highly reliable SSPA products that meet the challenging requirements of the defense sector. The company's successful track record reflects a highly scalable

and flexible manufacturing capability, enabling Wavestream to produce over 1700 Ka-band products per year for military applications alone.

In 2018, the company continued to deploy SSPAs for portable manpacks and flyaways, Comms on the Move (COTM) vehicles and Satellite Transportable Terminals (STT) across Ku-, Ka- and X-band frequencies.

These SSPAs use patented next generation ***Spatial advantEdge***™ technology to achieve higher output power, greater reliability and increased efficiency within more compact packages than traditional amplifier solutions.

Wavestream solutions are designed, tested and manufactured to operate in extremely harsh and rugged environmental conditions with varying temperatures, dust/sand and humidity environments. Throughout its history Wavestream has built upon robust design and attention to detail to achieve or exceed MTBF requirements, making its products the industry standard in reliability.

Based on its industry-leading experience with implementing next generation GaN technology, Wavestream performed a major upgrade this year of its widely deployed Ku- and Ka-band BUC amplifiers for the defense segment.

This upgrade to GaN technology means less power draw and less need for heat sinking, reducing the product footprint and enhancing performance in high temperatures. The new 60W BUC, for example, delivers 40 percent more linear power while drawing 10% less DC power than the previous generation design.

Similarly, Wavestream also recently released an upgrade of its 50W Ka-band BUC amplifier, thousands of which have been deployed in *Comms-On-The-Pause* (COTP) applications for the U.S. Army. Both product upgrades to GaN technology ensure the continuous supply and support of proven technology for defense customers with long term sustainability missions.

These and other innovations are designed to meet the future needs of warfighters — such as new form factors, increased portability, less power draw with higher power output and multi-band (Ka-, Ku-, X-band) support — in a wide range of high-bandwidth applications and mission requirements.

### *Looking Forward to 2019 and Beyond*

During the upcoming year, Wavestream will continue to develop and innovate cutting-edge technology for commercial and government customers.

As new LEO/MEO networks become more prevalent in IFC applications, Wavestream's field-proven SSPA technology will be instrumental for enabling seamless switching between legacy GEO and new LEO/MEO networks. Wavestream foresees significant growth opportunities in the IFC segment as new markets, such as China, embrace IFC services.

The defense sector will continue to be a major focus for 2019. In addition to sales of our industry-leading Ka band offerings, the company plans to continue to invest substantial R&D resources in creating new products for military and homeland security applications.

Wavestream looks forward to sharing its successful experience and proven cutting-edge technologies for the IFC and gateway markets with government and defense customers looking for next generation solutions.

***www.wavestream.com***

# WORLD WIDE TECHNOLOGY

*By Bryan Thomas, Vice President, Federal Sales*

**At World Wide Technology, the company's goal goes beyond simply providing technology solutions — we partner with our customers to find technology capabilities that can drive business success.**

Over the firm's nearly 30 years in business, World Wide Technology has been a trusted technology solution provider to a wide range of clients from commercial and financial firms to educational institutions and the federal government.

Throughout our history, we've collaborated with government agencies to provide technologies that help them accomplish their mission objectives. We understand the government's need to stay on top of the latest developments in technology, but also the need to follow strict compliance and security standards.

Our goal is to simplify the complexity of technology by designing, building, demonstrating and deploying integrated solutions that deliver business outcomes.

This is especially true for federal agencies. The federal government faces unique challenges when it comes to security and compliance that differ from every other sector in the world. The federal government needs partners that understand these challenges, and more importantly can help discover solutions that can fit seamlessly into these gaps.

### *Helping Federal Partners*

One of the primary areas that World Wide Technology has worked alongside federal partners is with technology solutions to modernize their IT infrastructure.

By upgrading and simplifying their architecture, we can help them streamline communications systems using *Commercial-Off-The-Shelf* (COTS) consumer technologies that feature the best options available to the consumer market, but can be tailored for the agencies' specific needs.

Here are some of the functional areas where we help the federal government improve their IT infrastructure:

### *Next-Gen Security Architecture*

World Wide Technology offers multi-vendor security solutions with built-in continuous compliance.

These technologies work in harmony to help defense technology leaders better understand their network traffic while uncovering gaps that hackers could use to exploit.

### *Enhanced Collaboration and Workforce Productivity*

Today's federal workforce is increasingly mobile. World Wide Technology enables mobility with

*ScanEagle UAV image is courtesy of Insitu, a subsidiary of the Boeing company.*

technologies that securely connect government personnel to their critical information regardless of their location.

As a trusted technology solution provider, we understand the unique needs of the federal government, especially when it comes to security and mobility.

### *Cloud Migration*

Word Wide Technology helps government agencies assess their current environments, modernize and migrate applications to the cloud, and leverage on-premium investments in a multi-cloud environment.

### *Big Data and Analytics*

As government leaders seek to harness increasing amounts of data, World Wide Technology helps them to find big data solutions that make sense of both structured and unstructured data. We can help them work with analytics systems that can drive additional value from data systems already in place.

### *Lab-As-A-Service*

One offering that differentiates World Wide Technology from other vendors is our lab-as-a-service offering. This service brings innovative solutions to our clients, and allows technology leaders to get hands-on experience with these technologies and the opportunity to ask questions and see practical applications before committing.

By leveraging our **Advanced Technology Center** and **Integration Centers**, federal agencies can accelerate the process of evaluating, integrating, deploying and maintaining IT platforms on a global scale.

### *Leveraging Modern Communications*

More than anything, these technologies help the federal government take advantage of modern communications.

With personnel placed all over the world, the federal government faces unique challenges. The ability to keep employees connected, using unified communications and other workforce productivity tools, ensure federal employees can securely communicate in near real time.

World Wide Technology has worked closely with the federal government to tailor COTS solutions that provide the best fit for current needs while being flexible enough to support future needs.

***www.wwt.com***

*As VP of federal sales, Bryan Thomas is responsible for federal pre-sales operations including business development, account management and pre-sales engineering. In his role, Bryan is accountable for developing and maintaining relationships with customers, key vendors, prime integrators and vertical partners. Bryan is focused on providing clarity, direction, accountability and education to the field sales team for WWT. Bryan has been with WWT since 2000 and has held leadership roles across the federal business unit. Bryan holds a bachelors degree in computer information systems from Missouri State University in Springfield, Missouri.*

# XTAR

*By Jay Icard, President and Chief Executive Officer*

**It's no surprise that 2018 was a year of competition in the satellite communications (SATCOM) arena.**

The last 12 months witnessed a sharp increase in players in the market including new technologies which continue to emerge. Through this type of growth, it is natural for there to be a lot of noise as well as misconceptions as new players quickly work to find their niche but in the meantime, purport to have solutions for all users, commercial and government.

Human nature tells us to believe that the newest technology must be the best — and, in some cases, it is, but as XTAR points out, it is not necessarily the best fit for the government and military. President and CEO ***Jay Icard***, who started with the company in March, explains, "*Military and government users have a unique set of needs. Those needs cannot be filled by trying to retrofit a solution which was originally designed for a commercial user.*"

XTAR capacity has been used by some of the most demanding customers, due to their mission requirements. Icard states that it is available to many more who have either never used X-band or have their experience only on government constellations.

Despite increased competition, XTAR continues to send the message that it serves only one customer — the government and military user and the X-band frequency that is reserved solely for that use. The natural advantages of the frequency include low atmospheric attenuation, meaning satellite links hold strong in rain, dust storms and other challenging weather. X-band also enjoys a low probability of interference from other satellites. Finally, high throughput allows the military/government user to efficiently transmit bandwidth-heavy applications.

These advantages make X-band unique and, as Icard explained, makes X-band more relevant than ever as missions must be highly mobile, resist interference, and work consistently in challenging environments. "*We have to remain laser focused on that end user in the field. His or her mission depends on communications that don't fail in a little rain. It has to perform and has to perform well.*"

XTAR had the opportunity to demonstrate this performance in July when they conducted testing at Fort A.P. Hill with the goal to provide a ***SATCOM-On-The-Move*** (**SOTM**) data link from a small sub-meter terminal to a hub Earth station at a data rate greater than 25 Mbps. XTAR was able to successfully show the power of X-band to small terminals — the required space segment for this demonstration at 26/2 Mbps was 38.2 MHz, resulting in a bandwidth efficiency of 0.73 bits/Hz. During the demonstration, heavy rain began to fall, yet the link held strong.

### *Defining the Acquisition Process*

Undoubtedly, another challenge faced by XTAR and other satellite operators in 2018 has been the acquisition process. There is much discussion and debate as to the best way for governments to purchase commercial bandwidth, and to do so in an expedient manner.

XTAR has taken part in the ***Analysis of Alternatives*** (**AoA**) and been involved with several industry initiatives sharing their experience and opinion.

When it comes to acquisition, Icard sees XTAR's position as unique. As XTAR provides a government-only frequency, when an operation has parameters that requires a quick reaction capability, requires high throughput to a sub-one meter terminal, or simply needs additional capacity, they can seamlessly "point" to XTAR and continue service.

"*The discussion for streamlining the acquisition process is vital*," stated Icard, "*But XTAR positions itself as an instant alternative when bandwidth is needed immediately.*"

Several military end users have expressed their interest in further enabling streamlined acquisition for services similar to XTAR. Icard anticipates some procurement actions from ***Air Force Space and Missile Systems Center*** (**SMC**), which is the new home for commercial SATCOM acquisition for the DoD, in Government Fiscal Year 2019.

Despite this year's challenges faced by satellite operators around the globe, XTAR continues steadfastly doing its job, often quietly behind the scenes. The company feels that while competition is not going away, new players will find their own suitable specialized applications.


Icard explained, "*We're not out to proclaim that X-band is the one-size fits all solution. In many scenarios encountered by our user, X-band is the ideal frequency. But as military users evolve into multi-band systems where they can use the most advantageous link, X-band provides one of the tools in the multi-band toolbox.*"

### *Looking Ahead*

The year has been challenging for most satellite operators. However, like the X-band frequency which holds strong in challenging conditions, XTAR remains resilient. The company was the first commercial satellite operator to provide capacity in the X-band frequency. While XTAR has shared in the challenges faced by other operators, it is presented with a different set of opportunities as well.

Icard said, "*I came to XTAR because I was interested in having something unique to bring to market. We simply need to make the X-band product an enabler for the military operators and systems integrator community. It has to provide a competitive advantage on the solution and price and we have to make working with us easy. We are doing just that.*"

By dedicating operations to serve only one customer and not facing distractions from commercial sales, XTAR can remain laser focused on designing solutions for the government and military user.

Icard added, "*We have some exciting announcements coming in the near future that will expand our product set, provide broader coverage and further enhance our products in security and resiliency. XTAR is very eager to share plans for the new satellites with customers and partners. The future is exciting for our company.*"

Plans for XTAR's replacement satellites are in the process of being finalized now and Icard explains that the design of the new satellites reflects that focus on the government and military user.

***xtar.com***

*Mr. Icard was appointed President and Chief Executive Officer of XTAR in March, 2018. Jay is responsible for the overall direction, strategy and business operations for XTAR. Mr. Icard has over 30 years of industry experience in government and enterprise telecommunications. He spent the last 13 years in profit and loss management and business development leadership roles with TeleCommunication Systems Inc. (TCS) which was acquired by Comtech in 2016. Prior to his tenure at Comtech and TCS, Mr. Icard worked for Oracle, MCI and in the Department of Defense acquisition community.*

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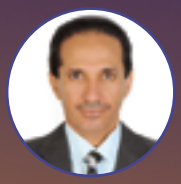

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