SATCOM for Net-Centric Warfare

MilsatMagazine

July / August 2019

Cover image is courtesy of Rocket Lab and the firm's launch of the Make It Rain mission, a rideshare flight contracted by Spaceflight that included two SOCOM Prometheus satellites.

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DISPATCHES

Rocket Lab's seventh Electron launch successfully lifts off

A Rocket Lab Electron launch vehicle successfully lifted off from Launch Complex 1 on New Zealand's Mahia Peninsula at 04:30 UTC, Saturday, June 29, 2019 (16:30 NZST).

The mission was Rocket Lab's seventh launch of an Electron rocket and the company's third launch for 2019.

Rocket Lab's Launch Complex 1 on the Mahia Peninsula in New Zealand.

The *Make It Rain* mission launched seven satellites to orbit for rideshare and mission management provider, Spaceflight.

At approximately 56 minutes after lift-off, the Make It Rain payloads were successfully delivered to their precise individual orbits by Electron's Kick Stage.

The seven satellites on board included two U.S. Special Operations Command (SOCOM) Prometheus satellites, BlackSky's Global-3 as well as Melbourne Space Program's ACRUX-1 satellite.

The mission took the total number of satellites deployed by Rocket Lab to 35 and continues the company's record of 100 percent mission success for their customers.

Rocket Lab's next mission is yet to be announced; however, a lift-off from the company's Launch Complex 1 in New Zealand could occur in the coming weeks.

Rocket Lab's manifest is booked with monthly launches for the remainder of 2019, culminating to a launch every two weeks in 2020.

Rocket Lab Founder and CEO, *Peter Beck*, congratulated the teams behind the payloads on this mission for another flawless Electron launch. It's a privilege to provide tailored and reliable access to space for small satellites like these, giving each one a smooth ride to orbit and precise deployment, even in a rideshare arrangement.

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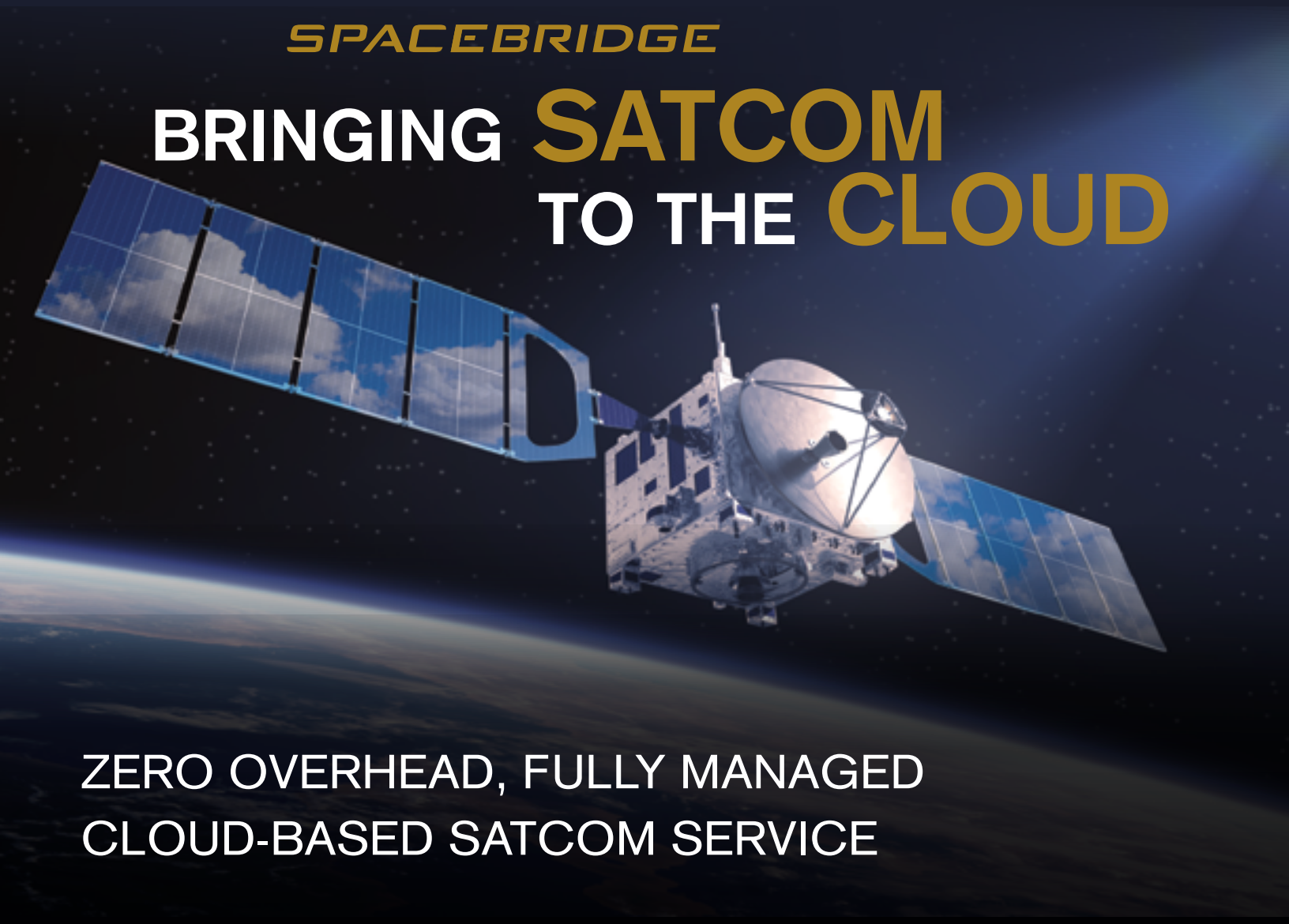

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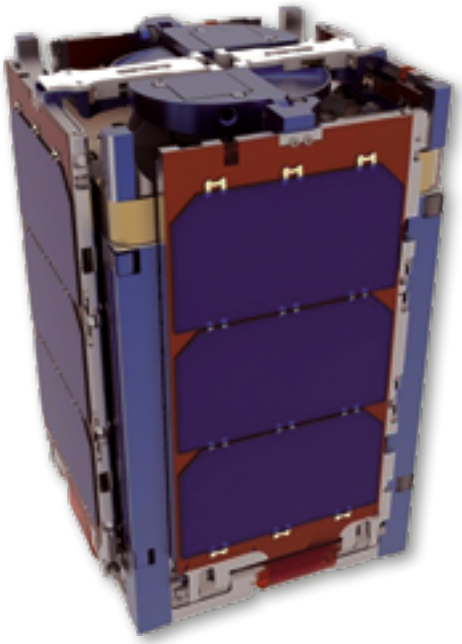
DISPATCHES

Rocket Lab launch information continued...

U.S. Special Operations Command (SOCOM) launched their first eight cubesats into orbit in November of 2013 to initiate the organization's project entitled, "Prometheus."

These smallsats were developed in partnership with the Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico and the program was recognized with a Secretary of Energy Achievement Award during a special ceremony in Los Alamos, New Mexico.

The Prometheus cubesats are part of a technology development and demonstration effort to explore the viability of using a smallsat constellation to meet existing special operations mission requirements. The Prometheus project is just one of a handful of initiatives are continuing to improve the responsiveness of space capabilities and provide SOF with tactically relevant information in shorter timelines.



An illustration of a SOCOM Prometheus cubesat.

"*Our special operations forces are often deployed to locations that place them at the very edge of traditional satellite communications capabilities. This can present a serious challenge for our forces to effectively operate*," said *James F. "Hondo" Geurts*, then the Acquisition Executive at USSOCOM. "*Seeing this problem set, the Los Alamos team mobilized their significant expertise and mission focused mindset to invent, refine, and rapidly field a radically affordable and operationally responsive approach to solving this hard problem. In doing so, this team enabled new capabilities for our nation's deployed special operations forces. We congratulate them for this well-deserved and significant recognition and are fortunate to have them as part of the SOF team.*"

The technology developed by the Prometheus team has helped to shape the future direction of agile space systems for the U.S. military and the Department of Energy.

The cubesats are demonstrating the capability to transfer audio, video, and data files from man-portable, low-profile, remotely located field units, to deployable ground terminals, using over the horizon satellite communications.

The Prometheus demonstration will provide the critical information needed to evaluate the approach, technology, concept of operations, operational utility, and affordability of future space systems.

www.army.mil/usasoc/

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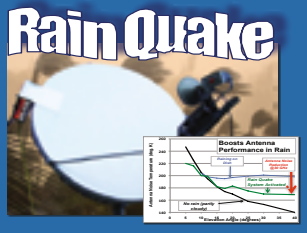

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DISPATCHES: *Sitting in the middle of space history...*

When Lieutenant Colonel Ryan Rose sat at her on console on July 2 to support NASA's Ascent Abort (AA)-2 flight test from Launch Complex-46, she'll was situated in the middle of 50 years of space history — the Hangar AE Control Center.

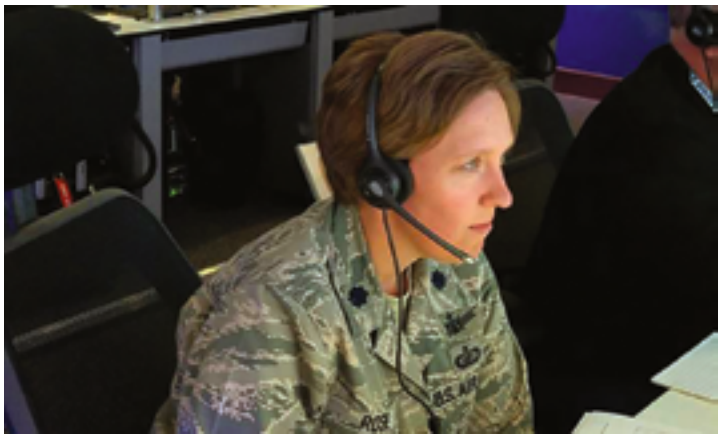
As a member of the AA-2 mission's senior management team with NASA and contractors, Rose was the senior Space and Missile Systems Center representative during the in-flight test of the launch abort system for the Orion multi-purpose crew vehicle. The three-minute mission of the Orion MPCV test article and its safety system will be conducted from the historic control center.

"*This place is nationally significant as the telemetry station for the Air Force's and NASA's unmanned expendable launch vehicle programs*," said Rose, chief of the Small Launch and Targets Division at Kirtland Air Force Base, New Mexico, part of SMC's Launch Enterprise Systems Directorate.

Adjacent to NASA's John F. Kennedy Space Center, the Hangar AE Control Center has long been used by SMC, NASA and other customers as a communications center, to receive and monitor telemetry data from launch vehicles and spacecraft, both on the ground and during flight.

The Mission Director's Center, or MDC, is the premier control room within Hangar AE. The MDC is designed for Lt. Col. Rose and other senior launch professionals, to support launch vehicle ground testing and liftoff operations.

"*This place is definitely getting a workout as part of SMC's 'Summer of Launch '19' campaign*," said *Robert Douglass*, chief of the Launch Operations Branch within SMC's Small Launch and Targets Division. "*It's being used for the integrated countdown exercises, or 'ICE' led by SMC teams handling the fifth Advanced Extremely High Frequency (AEHF-5) mission as well as our efforts to support NASA's Ascent Abort-2 flight test.*"



Lt. Col. Ryan Rose, chief of the Small Launch and Targets Division at Kirtland Air Force Base, New Mexico, sits on console during a countdown dress rehearsal prior to the July 2 flight test of the launch abort system for the Orion multi-purpose crew vehicle. Photo is courtesy of NASA.

Built in 1959, Hangar AE first supported the U.S. Air Force's Thor missile program, which has a strong California connection. Forerunners of today's modern SMC conceived, developed and managed Thor under the guidance of General *Bernard Schriever*, father and architect of SMC and military space.

The intermediate range ballistic missile was built by the Douglas Aircraft Company in Santa Monica and Rocketdyne of Canoga Park and Simi Valley and was tested on instrumented stands in Rancho Cordova, outside Sacramento, and the Phillips Laboratory at Edwards AFB.

Over the next five decades, the Thor IRBM would evolve into the venerable Delta and Delta II space launch vehicle. A legendary workhorse of the American space program until its final flight from Vandenberg Air Force Base in September 2018, the Delta variants launched rovers to Mars, sent robotic probes to the moon, comets and the asteroids, put astronomical observatories into orbit and deployed the Iridium global communications network as well as the first GPS satellites.

Originally known as Missile Assembly Building AE for the Thor IRBM, and later as the Spacecraft Assembly and Checkout Building, Hangar AE was acquired from the Air Force in 1960 by NASA and modified for unmanned missions. It contains a Class 10,000 horizontal laminar flow clean room complex, a telemetry ground station, an extensive communications center for data, voice and video, three launch vehicle data centers, the Mission Director's Center, and offices for payload and contractor personnel. Although located on Cape Canaveral Air Force Station, Hangar AE is maintained by NASA's Kennedy Space Center.

Lt. Col. Ryan Rose sits on console with Orion AA-2 Crew Module Manager, Dr. Jon Olansen, during a countdown dress rehearsal ahead of the July 2 flight test of the launch abort system for the Orion multi-purpose crew vehicle. Photo is courtesy of NASA.

The MDC underwent a major upgrade in 2017 to provide 34-inch ultrahigh-definition monitors, allowing senior managers to see video, voice and data all on one screen. With the modular design of the systems, the MDC can support missions at both Cape Canaveral AFS on the East Coast and Vandenberg AFB on the West Coast.

Robert DeWitt, Jr., who is running the launch checklist as the Air Force's Abort Test Booster mission manager for AA-2, offered another perspective on how the MDC has changed over time.

"*Over 50 years ago, a mission manager sat on this console using analog systems and vacuum tubes*," said DeWitt. "*For this mission, I used a digital computer system to manage launch data. I wonder what the next generation will be using when they are on console in the MDC.*"

Hangar AE allows independent verification and validation of vehicle and spacecraft telemetry for unmanned launch operations and provides real-time voice, data and video information for expendable vehicle checkout and launch operations. It provides connectivity to all launch pads at the Kennedy Space Center and Cape Canaveral AFS. Hangar AE can also obtain data from other launch sites beyond those at KSC and CCAFS. Launch sites for missions the facility has gathered telemetry on include Vandenberg AFB in California, the Reagan Test Site on Kwajalein Atoll in the Marshall Islands, NASA's Wallops Flight Facility in Virginia and the Kodiak Launch Complex in Alaska.

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DISPATCHES:

Space Norway, Kongsberg Satellite Services and Northrop Grumman combine forces for two, HEO satellites for Norwegian Defense and Arctic comms

Space Norway will work with Inmarsat and the Norwegian Ministry of Defence to offer mobile broadband coverage to civilian and military users in the Arctic.

Two satellites will be built by Northrop Grumman and are scheduled to be launched by SpaceX in late 2022 aboard a SpaceX Falcon 9 rocket into a Highly Elliptical Orbit (HEO), which will provide full coverage from 65 degrees North, which, in practical terms, is the area North of the Arctic Circle.

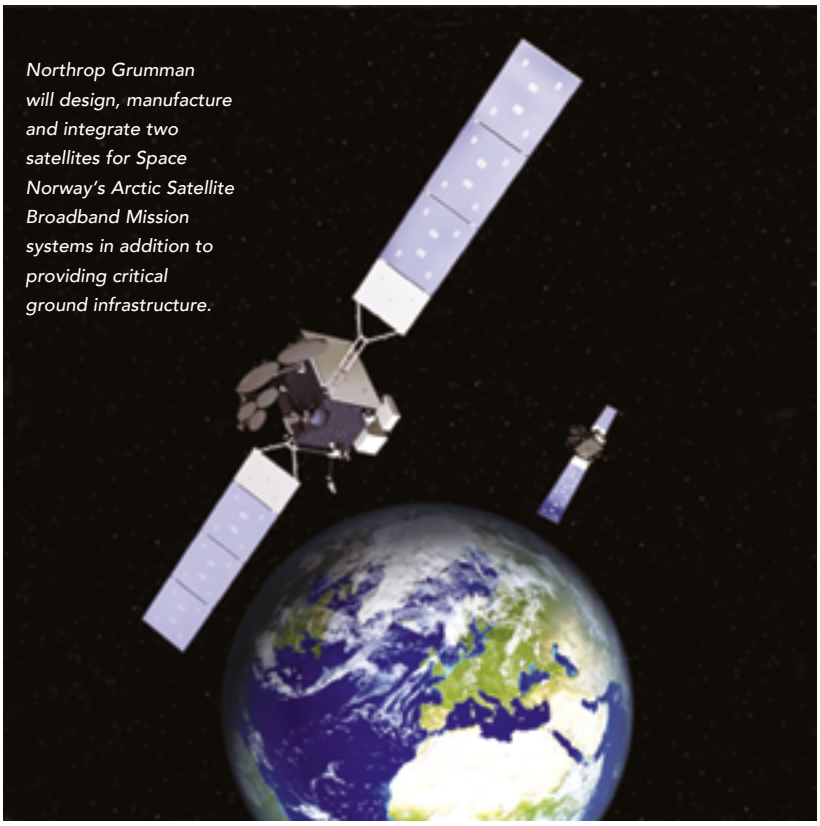
This limited liability company is owned by the Norwegian government and has established a new subsidiary company — Space Norway HEOSAT AS — to manage the program and operate the two satellites together with Kongsberg Satellites Services (KSAT) in Tromsø, Norway, who will be responsible for the ground stations to be established in North Norway and to ensure Norwegian control of this important capability.

Each of the two satellites will carry multiple payloads and the system is scheduled to be operational for at least 15 years, with users able to switch between current geostationary and HEO satellites. Each satellite will have a mass of 2000 kg. and provide 6 kWatt power through their sun arrays.

The program is fully financed with customer agreements in place for the service life of the satellites.

Northrop Grumman announced last year that it will provide two, Extremely High Frequency eXtended Data Rate (EHF XDR) payloads for the Enhanced Polar System-Recapitalization (EPS-R) to the U.S. Air Force for integration on the spacecraft. The systems are designed to improve secure and continuous communications in the North Polar Region. Additionally, Northrop Grumman was selected to provide critical ground infrastructure for EPS-R.

The ASBM satellites will carry multiple hosted payloads, including an X-band payload for the Norwegian Ministry of Defense and a Ka-band payload for Inmarsat. ASBM's satellite system will be designed, built and tested at Northrop Grumman's state-of-the-art satellite manufacturing facility in Dulles.



Northrop Grumman will design, manufacture and integrate two satellites for Space Norway's Arctic Satellite Broadband Mission systems in addition to providing critical ground infrastructure.

The satellites will be based on the company's proven GEOStar platform which has been integrated on more than 40 spacecraft. ASBM is scheduled for a dual launch in late 2022.

Frank DeMauro, Sector VP and GM, Space Systems, Northrop Grumman, said this contract award marks the company's first mission with Space Norway and will deliver high quality communication satellites. Northrop Grumman is eager to demonstrate the firm's ability to provide innovative solutions that regularly exceed customer's mission needs.

KSAT reported their inclusion in this major SATCOM effort and stated the 15 year service agreement covers ground station and the spacecraft operations requires the company to expand capacity and antennas in the Tromsø-region in Northern Norway.

Eirik Lie, President in Kongsberg Defence and Aerospace, noted that this award is an important milestone for Kongsberg Satellite Services. Providing broadband to the strategically important Arctic region demonstrates that the company is a world leading provider of satellite ground stations and services. This is an important step in ensuring the firm is a preferred partner for next generation space missions.

Rolf Skatteboe, President KSAT, added that this contract is of high strategical, as well as financial importance, for the development of KSAT. The contract confirms KSAT's strong position in this new space market and further expands the company's offerings. *Jostein Rønneberg*, Space Norway's CEO, said this will be a milestone for people in the Arctic who have very limited or no broadband access in the region. The company is building a robust communications capability in an area strategically important to Norway and partners. This will be vital for surveillance, fishery control and rescue operations in the vast sea area that is under Norwegian control, and will significantly improve our ability to operate in the High North.

Program Director *Kjell-Ove Skare* added that after a multi-year dedicated effort, the company has closed customer agreements with Inmarsat and with the Norwegian and U.S. militaries. This is an exciting, collaborative effort that ensures a cost effective solution for all parties. Now the company is eager to start the real work of building the satellites and the ground stations and looks forward to providing the world's first and only mobile broadband service in the Arctic region; something which has long been an important objective for the Norwegian authorities.

Space Norway was established in 2014 as a limited liability, governmentally owned company.

spacenorway.no/

www.northropgrumman.com/

www.kongsberg.com/ksat/

DISPATCHES: *L3Harris awarded a Falcon SDR, BLOS radio prototype contract by the USAF*

L3Harris Technologies (NYSE:LHX) has been awarded a development prototype contract from the U.S. Air Force (USAF) for the L3Harris Falcon® Wideband Airborne HF Radio and will now be part of a down-select competition to replace the service's AN/ARC-190 airborne HF radio.

The L3Harris Falcon Wideband Airborne HF Radio is a software-defined, digital multi-mode, wideband radio with the capacity to augment space-based Beyond-Line-Of-Sight (BLOS) systems, providing a much-needed alternative capability in a SATCOM-denied environment.

The radio addresses the USAF HF Radio Modernization requirement and will enable airmen to communicate data at speeds up to ten times greater than the legacy ARC-190 radios.

The L3Harris Falcon Wideband Airborne HF Radio features embedded encryption, electronic counter-counter measures (ECCM), low probability of intercept and low probability of detection (LPI/LPD) and is upgradable to accept new waveforms and software delivered capabilities.

The form factor combines three different pieces of equipment into a single package to reduce size, weight and power consumption, which is critical for airborne applications.

L3Harris was selected by the USAF in a competitive prototype effort and will now be part of a competitive down select. The initial development phase will lead to low-rate initial production followed by a full production decision.

Ryan McCarty, VP and GM, DoD Tactical Communications, L3Harris Communication Systems, said the capabilities provided by the L3Harris Falcon Wideband Airborne HF Radio will be a game-changer for the U.S. Air Force, with L3Harris' modernized software-defined technology that is designed to overmatch in contested and SATCOM-denied environments.

He added that this prototype development selection expands the company's airborne product line and brings L3Harris leadership in tactical HF radios to the airborne segment.

www.l3harris.com

DISPATCHES: *U.S. Navy C5ISR modernization and maintenance contract to BAE Systems*

The U.S. Navy has awarded BAE Systems a five-year, $90 million indefinite-delivery/ indefinite-quantity contract to modernize and maintain C5ISR systems embedded within vehicles, watercraft, and specialized communications platforms.

C5ISR includes command, control, communications, computers, cyber, intelligence, surveillance and reconnaissance systems that are integrated and networked to improve the situational awareness of their military operators and decision makers.

BAE Systems has been supporting Naval Air Warfare Center Aircraft Division's Special Communications Mission Solutions Division with mobile deployable systems for more than 25 years.

Work on this program will be performed in St. Inigoes, Maryland; Little Creek, Virginia, and Fayetteville, North Carolina.

Mark Keeler, VP and GM of BAE Systems' Integrated Defense Solutions business, said technology is constantly evolving and the mission needs of the company's customers can change. As systems integrators, BAE Systems is providing agile engineering, testing, and field support to help the firm's military customers adapt and maintain a tactical edge.

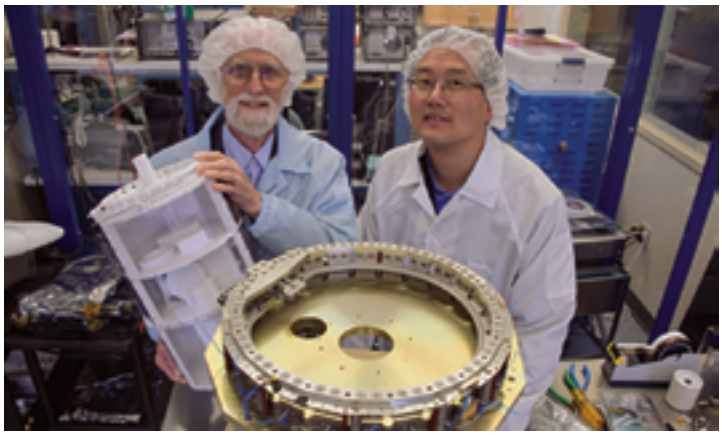
www.baesystems.com/

DISPATCHES: *Naval Postgraduate Schools' NPSAT-1 On-Orbit*

The long wait finally came to an end for faculty and researchers in the Naval Postgraduate School's (NPS) Space Systems Academic Group (SSAG).

Following several external delays to a launch that was originally scheduled for September of 2016, the university's own NPSAT-1 was launched and deployed into a 720 km. orbit by SpaceX's Falcon Heavy at 2:30 a.m. on Tuesday, June 25, from Kennedy Space Center Launch Complex 39A at Cape Canaveral, Florida.

The satellite is the product of years of student and faculty research and will carry several experiments from both NPS and the Naval Research Laboratory into orbit when it launches later this year.



Space Systems Academic Group Chair Dr. Rudy Panholzer, left, and Research Associate Dan Sakoda stand near one of several structural pieces to NPSAT1 in the university's clean room in Bullard Hall, January 11.

The mission was slated to be the "most difficult" undertaking by the Falcon Heavy to date, according to SpaceX CEO *Elon Musk* during an interview prior to Tuesday's spectacular night-time launch. The mission called for the release of 24 satellites during three individual deployment stages... each stage separated by a burn of the Heavy's thruster.

Overall, the mission proved to be largely successful, especially for the NPS team who watched NPSAT-1 successfully release from the SpaceX craft and enter into its orbit within seconds of its planned deployment. Like much of the research at NPS, the satellite is ultimately about student experimentation and study. Over the course of the craft's development, NPSAT-1 supported well over 40 student theses, noted SSAG engineer *Dan Sakoda*, with countless more students contributing via directed study.

On board NPSAT-1 are experiments developed by the Naval Research Laboratory (NRL) to investigate space weather and support space situational awareness (SSA), including ionospheric electron density structures that cause radio scintillations impacting communications and navigation.

my.nps.edu/

DISPATCHES: *Kratos' C5ISR contract*

Kratos Defense & Security Solutions, Inc. (Nasdaq: KTOS) has recently received a $4.1 million contract award to provide hardware and subsystems in support of a Command, Control, Communications, Computing, Combat and Intelligence, Surveillance and Reconnaissance (C5ISR) aerial defense related program and platform.

Kratos' C5ISR Modular Systems Division (MSD) provides engineering, system integration and testing/analysis support to deliver turn-key modular solutions.

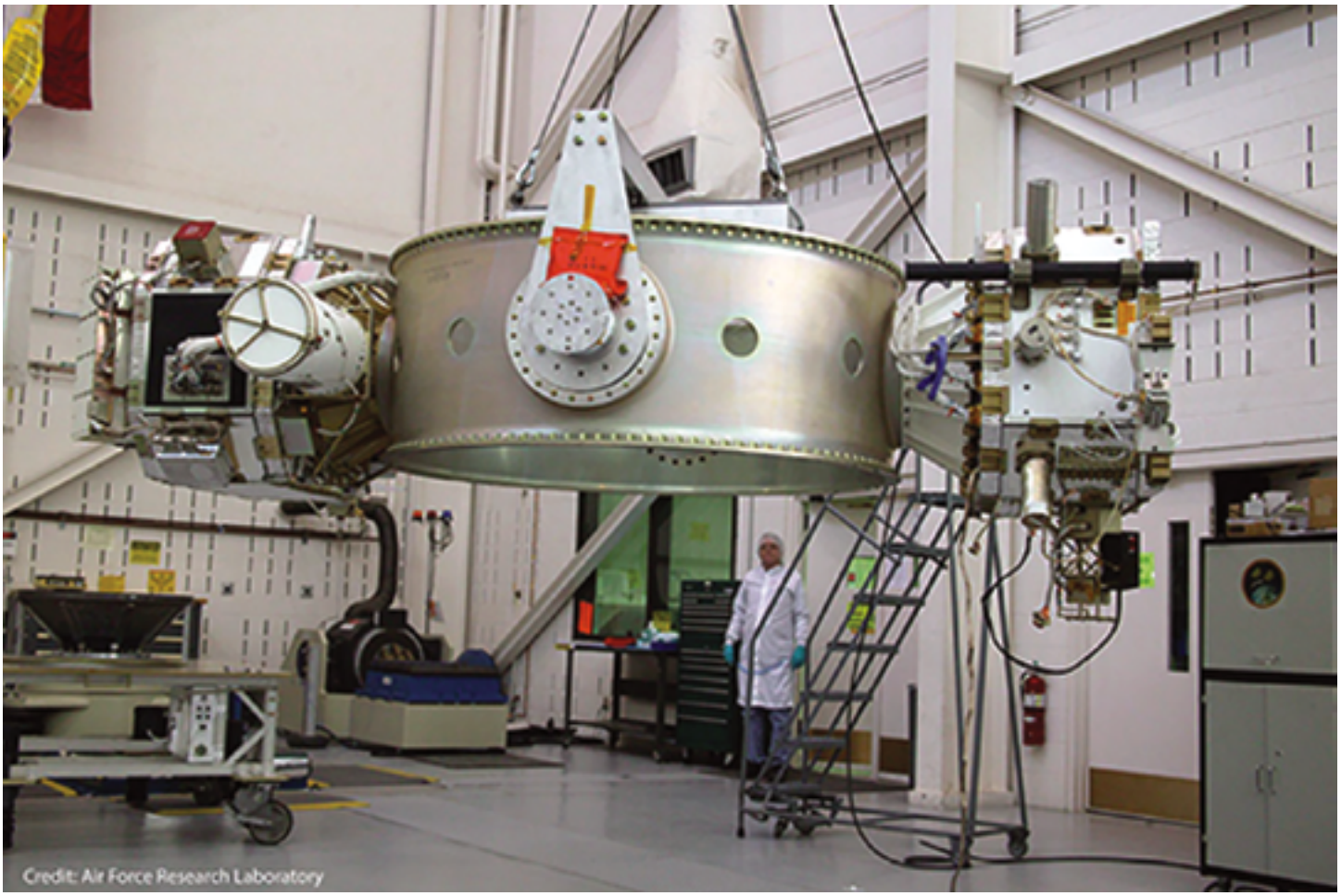
Kratos' C5ISR Modular Systems business provides specialized, High Altitude Electromagnetic Pulse Protected (HEMP) products, systems and subsystems in support of Missile Defense, Missile, Radar, Unmanned, High Power Directed Energy, Surface Combatant and other systems and platforms.

Work under this recent contract award will be performed in secure Kratos manufacturing facilities. Due to competitive, customer related and other considerations, no additional information will be provided.

Tom Mills, President of Kratos' C5ISR Modular Systems Division, said that ballistic missile and aerial defense systems and platforms are a core business area of Kratos and the company's entire organization is honored to have been selected to support this key national security related program.

www.kratosdefense.com/

DISPATCHES: *Sierra Nevada Corporation's DSX satellite now on-orbit for USAF*


Credit: Air Force Research Laboratory

The U.S. Air Force Research Laboratory's (AFRL) Demonstration and Science Experiments (DSX) free-flying satellite, built on a spacecraft platform designed and developed by Sierra Nevada Corporation (SNC), is on-orbit and successfully performing experiments.

The DSX platform provides a free-flying Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) platform for AFRL to better understand the dynamics of waves and particles in radiation, enabling better specification, forecasting and reducing impact of the harsh radiation environment of MEO.

DSX experiments include the following:

- *The Wave Particle Interaction Experiment (WPIx): Investigate the influence of very-low frequency (VLF) radio waves on particle dynamics.*
- *Space Weather Experiments (SWx): Measure and map the distributions of energetic protons, electrons and low-energy plasma in the inner magnetosphere to improve environment models for spacecraft design and operations.*
- *Space Environment Effects (SFx): Determine the MEO environmental effects on electrical components to launch as a secondary payload with primary missions requiring an EELV.*

DSX launched June 25th on the Space Test Program-2 (STP-2) mission aboard the SpaceX Falcon Heavy launch vehicle and is expected to be on-orbit for one year.

DSX is the latest innovative satellite program from SNC, the global aerospace and national security contractor owned by Chairwoman and President *Eren Ozmen* and CEO *Fatih Ozmen*, with the CEO stating that this integrated system represents the continued growth in SNC spacecraft from proven LEO constellations to developing GEO spacecraft and now increasing capability in MEO.

According to the company, SNC is expanding its satellite portfolio and the firm stated that the DSX spacecraft platform is a perfect example of how the company can offer great technology and platforms that are cost-effective, efficient and help customers achieve their strategic goals.

Joel Nelson, Senior Director of Programs for SNC's Space Mission Systems business unit, added the company's Space Mission Systems team is excited to add both a MEO platform and free-flying ESPA spacecraft to the firm's product line.

Nelson added that, given the need for Command, Control, Communications, Intelligence, Surveillance and Reconnaissance systems and enhanced resiliency, a platform like this can enable new capability for national defense customers in highly-elliptical orbit, MEO and GEO.

www.sncorp.com/

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The launch of six FORMOSAT-7 satellites by SpaceX.

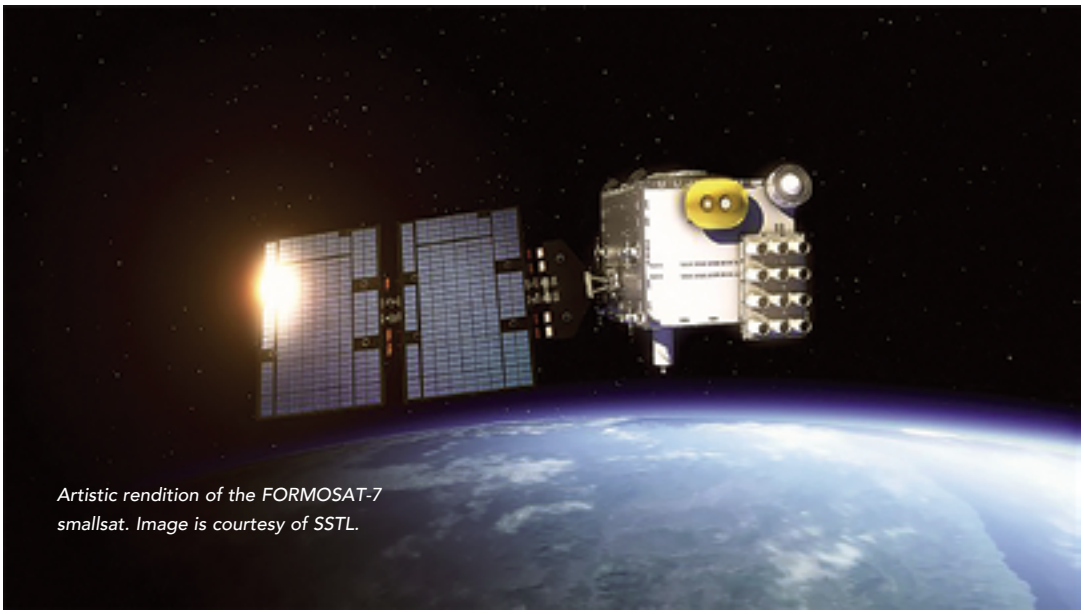
The successful launch on June 24, 2019, of six satellites for the FORMOSAT-7 joint US-Taiwanese weather forecasting constellation marks the start of another SSTL-enabled space mission.

The launch on the SpaceX Falcon Heavy rocket from the Kennedy Space Center was attended by SSTL staff including Managing Director, Sarah Parker, who said the company is proud of their role as space mission enablers and, hot on the heels of TeleSat LEO Phase 1 satellites' first ever demo of 5G connectivity, SSTL is delighted that the firm's smallsats expertise has — once again — helped the firm's customers achieve their ambitions.

The company congratulates their customers, NSPO in Taiwan, and NOAA in the United States, on the successful launch of their constellation and look forward to following their mission journey as they move through commissioning and into the beginning of operations.

FORMOSAT-7, also known as COSMIC-2 in the U.S., is a joint constellation meteorological satellite mission between Taiwan and the United States for observing and monitoring the global meteorology, climate, and ionosphere.

In addition to two science payloads for detecting ionospheric data, each of the six satellites in the constellation is carrying an advanced GNSS receiver to low-inclination-angle orbits and will collect atmospheric data at low and mid latitudes to provide sounding data to improve regional and global weather forecasting. The processed data will be provided by two data processing centers located in Taiwan and USA.



Artistic rendition of the FORMOSAT-7 smallsat. Image is courtesy of SSTL.

SSTL provided the platforms for this next-generation Global Navigational Satellite System Radio Occultation data constellation, enabling their customer, NSPO of Taiwan, to continue its participation in an internationally recognized science mission at the best possible value for money.

Collaborating with SSTL also enabled NSPO's engineers to work hand-in-hand with SSTL's engineering team throughout the program, gaining world-class small satellite expertise in the full range of satellite mission capability including design, assembly, test and on-orbit operations.

As a continuation of this program, NSPO is now developing their own FORMOSAT-7 platform, named TRITON, using some of SSTL's hardware under license in their own satellite structure and avionics. The satellite is scheduled for launch in 2021.

The first fully integrated and tested satellite for the FORMOSAT-7 constellation was completed at SSTL in the UK and delivered to NSPO in Taiwan in 2015. The other five satellites in the constellation were manufactured and assembled by SSTL in the UK and delivered to Taiwan where payload assembly and testing was completed at NSPO's facility as part of the knowledge transfer program.

The payloads for the satellites were provided by NASA (JPL), the U.S. Air Force and the University of Texas and were integrated to the completed platforms by the NSPO team, with support from SSTL. SSTL engineers also provided launch site support and are providing technical on-orbit operational support to NSPO's team who will be performing on-orbit commissioning of the spacecraft from the company's control center in Taiwan.

The launch of the FORMOSAT-7 satellites was managed by the U.S. Air Force STP-2 program.

www.sstl.co.uk/

www.spacex.com/STP-2

DISPATCHES: *General Atomics OTB satellite placed into orbit by SpaceX*

General Atomics Electromagnetic Systems Orbital Test Bed successfully launched on board SpaceX Falcon Heavy.

The General Atomics Electromagnetic Systems (GA-EMS) Orbital Test Bed (OTB) satellite was successfully launched on-board the SpaceX Falcon Heavy rocket from Cape Canaveral.

OTB was then successfully deployed into orbit after launch and communication was established between the spacecraft and ground operations to begin satellite commissioning and operations.

The launch, sponsored by the U.S. Air Force's Space Technology Program 2 (STP-2), is delivering 25 separate satellites to various orbits around Earth. The multiple hosted payloads launched on GA-EMS' OTB spacecraft include: NASA's Space Technology Mission Directorate's Deep Space Atomic Clock, designed and built at NASA's Jet Propulsion Laboratory, to support deep space navigation and exploration; a Modular Solar Array developed for the U.S. Air Force Research Laboratory (AFRL); an Integrated Miniaturized Electrostatic Analyzer sensor payload developed by cadets at the U.S. Air Force Academy; the RadMon next generation radiation effects monitor; the FlexRX programmable satellite receiver; and Celestis cremated remains.

OTB's modularity and versatility allows for the simultaneous launch of multiple demonstration payloads on a single satellite. This eliminates the need for customers to bear the costly burden of a dedicated platform and launch.

Scott Forney, President of GA-EMS, said this first OTB launch marks an exciting beginning for the company and the firm's multiple payload customers. GA-EMS is extremely proud of the team, whose tremendous efforts over the past few years have culminated in this successful launch. GA-EMS has successfully initiated the post-launch commissioning activities and the start of payload mission operations.

Nick Bucci, VP of Missile Defense and Space Systems, added that establishing the proper orbit, communications and control is the first critical post launch step for the hosted payload customers.

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A LACK OF FIRST RESPONDER COMMS =

Lost lives...

By Henrik Nørrelykke, Vice President, Land Mobile, Cobham SATCOM

To preserve safety and protect as many lives as possible, rural first responders should be supported by satellite-enabled Push-To-Talk extensions to their LMR radio — *Henrik Nørrelykke*, Vice President, Land Mobile, at Cobham SATCOM, offers his views regarding the technology and application for the first responder and NGO communities.

As citizens, we sometimes take the role of first responders for granted. Although we may only face an emergency once or twice in our lives, paramedics, emergency medical support, police officers, firefighters, and rescuers risk their lives daily to ensure we can all live safely and peacefully.

Their dedication goes a long way to ensuring the best possible result in an emergency. But in order to guarantee their quick and efficient response, technology has a key role to play in improving the support we all receive. This includes ensuring the correct services arrive to any call in the fastest way possible.

Upon arrival, and as an emergency unfolds, it is also vital that teams have access to clear, consistent and uninterrupted interagency communications that facilitates continual discussion between first responders and their respective headquarters.

...when there's limited access to healthcare and law enforcement, research consistently shows that lives are put in danger.

While many expect communications in an emergency to be a "given," the reality is that reliable radio coverage remains a significant issue across the globe. This is particularly the case in rural areas with so called "*white spots*" where little or no radio reception constrain first responders' abilities and cause major delays when every second counts. The consequences of this can be serious.

Investment in Developed Countries

In recognition of the need to improve emergency communications, great strides and investment have already been made in many developed countries including the U.S., UK, Australia and South Korea.

These improvements have been driven by the ongoing transition of traditional Digital Mobile Radio (DMR) and Land Mobile Radio (LMR) radios to Long Term Evolution (LTE). This has brought huge advantages to first responders, including the ability to use

4G wireless broadband technology, increased network capacity and speed to mobile device users.

However, 4G is restricted in its coverage to mainly urban areas, much like we are all used to using when employing 4G on our mobile phones. This is a huge anomaly for a first responder community that is tasked with providing vital support in any location — no matter how remote — at any time.

Taking the U.S. as an example, the country has recently embarked on the ambitious roll out of its nationwide FirstNet emergency management network, which is designed "*to develop, build and operate a nationwide broadband network that equips first responders to save lives and protect U.S. communities.*"

The system is being established with considerable investment in LTE Mission-Critical-Push-To-Talk (MCPTT). FirstNet is commendable in terms of driving interoperability and encouraging the use of MCPTT systems. However, it will fall short of its mission to deliver nationwide coverage unless additional provisions can be made to address "white spots" in remote areas which have little or no LTE coverage.

This issue is universal and is being experienced by other LTE MCPTT first movers. If other countries also choose to invest in new LTE MCPTT systems, then their first responders operating in far-flung locations will experience similar issues. Areas including Australia, New Zealand, Canada, parts of Europe and the Middle East with large rural and remote communities are likely to be particularly exposed.

Enabling Interoperability via L-Band

Fortunately, there is a strategic solution that enables seamless and continuous connectivity between first responders and the public that is available today. This solution enables interoperability between DMR, LMR, LTE and MCPTT systems. The solution works by harnessing L-band satellite technology to provide continuous, uninterrupted connectivity regardless of geographical location. In addition, it operates seamlessly with LTE MCPTT, LMR or DMR, consistently ensuring that the public service purse is getting the most cost value for its connectivity investment.

Applying a combined L-band satellite and LTE communications systems to MCPTT also delivers a continuous interface between the user's data device (computer, tablet or mobile data terminal) back to the central IT systems.

"*On the ground*" support can access this technology by extending VHF/UHF based trunk radio systems with push-to-talk (PTT) solutions such as Cobham's PRISM PTT+. The combination of radio, LTE and satellite provides users with Beyond Line-of-Sight (BLOS) voice and data communication that systematically routes communications between the most reliable terrestrial (2G/3G/LTE) and satellite (L-band) networks (multiple bearers).

This network agnostic, user friendly solution provides a failsafe solution that enables users to make mission critical and often life-saving voice calls, as well as sending and receiving important data in all conditions. This means, for example, that first responders can discuss and update trauma doctors on a patient's condition and vital signs during their journey to hospital.

Avoiding a Radio Investment Dead End

While LTE MCPTT systems have enabled first responders to realize great benefits, particularly in urban areas.

However, in regard to 4G wireless broadband technology, increased network capacity and speed to mobile device users, it's important that those considering updating their radio communications networks do not lose sight of the limitations of LTE MCPTT systems – particularly in rural and remote areas.

By ignoring the capabilities gained by adding L-band satellite accessed via network agnostic PTT solutions, global communications systems will not fully benefit from disruptive radio technologies — and huge tracks of investment may head up a dead end.

www.cobham.com

Henrik Nørrelykke is the Vice President, Land Mobile, with Cobham SATCOM.

CONSTANT CONNECTIVITY

For mission-critical communications

By Ulf Sandberg, Founder & Managing Director, Paradigm

Critical to the success of a mission is reliable and effective communication. The modern warzone demands live surveillance, high data transfer capability and detailed intelligence from reconnaissance missions. This will be achieved by deploying communication equipment which is mobile, reliable, rugged and easy to use.

The PIM® and PIM-enabled terminals from Paradigm provide this unfair advantage.

The PIM, designed and developed by Paradigm, is an easy-to-use, environmentally rugged terminal controller which is integrated into all of Paradigm's mobile terminals. This means that once users can operate the PIM, they can operate any PIM-enabled terminal. Additionally, the technical agility and versatility of the PIM allows it to be integrated with all types of satcom terminals and modem technologies; so other manufacturers can, and do, use it as the brain of their system. This further standardizes the process of satellite communication and the training required to use it.

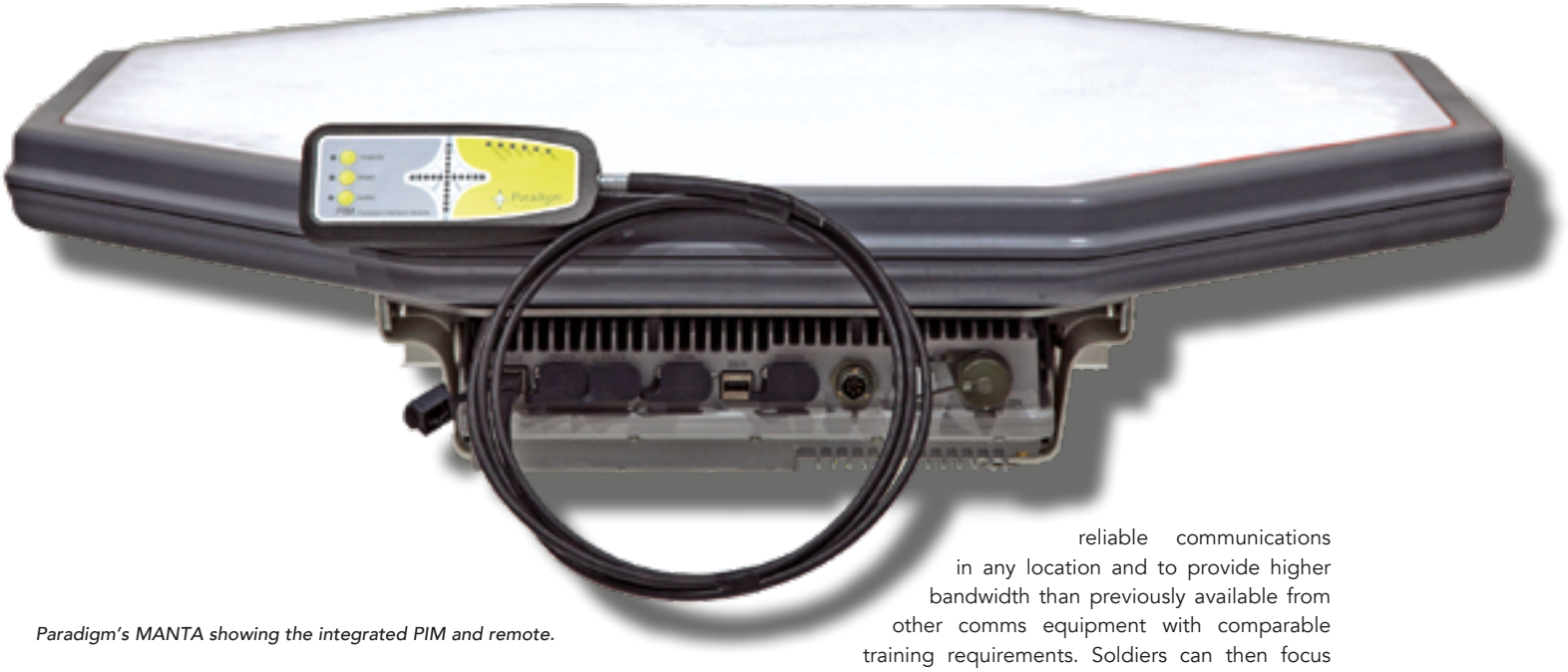
Personnel with no previous SATCOM experience can be trained to deploy a PIM-enabled terminal in around 20 minutes. Actions such as pointing the terminal, getting it operational on a satellite and transmitting and receiving data, then takes less than a minute to perform, with the user guided by easy-to-follow, simple instructions delivered via the PIM's basic onboard interface; no spectrum analyzers, laptops, PC's or external equipment is necessary.

When personnel can focus more easily on the task in hand because they have setup and deployed their communication network in minutes, then satellite communication is a practical and viable option. When the network will automatically switch between cellular, Wi-Fi and satellite — depending on real time availability for instance — then it is also a hugely reliable option. When training costs are reduced because the satellite pointing process is the same regardless of which satcom terminal is being used, then it also becomes a cost efficient option.

By having a reliable, always-on communications network that requires a minimum of installation and setup, operatives can focus on the mission's critical priorities.

Defence and government users are already operational with a number of different PIM-enabled mobile terminals from the backpackable SWARM to the tough, three-case CONNECT100T, designed for a longer term temporary installation. All terminals are field-proven and have been deployed in theatre.

Paradigm has successfully made satellite communications more accessible for the mobile soldier, not least by avoiding the requirement for trained satcom engineers to setup, point and operate satellite terminals. Less training is required than before to enable the setup of reliable communications in any location and to provide higher bandwidth than previously available from other comms equipment with comparable training requirements. Soldiers can then focus



Paradigm's MANTA showing the integrated PIM and remote.

Paradigm's MANTA "ouf-of-the-case" operation.

more easily and quickly on the task in hand, supported by equipment delivering high bandwidth for fixed, or on-the-move use.

Paradigm's latest terminal to integrate the PIM is the MANTA, launched in conjunction with Kymeta. The MANTA is a single case, airline-checkable complete solution for mobile operation either in a tactical, static environment or attached to a vehicle's roof bars for SATCOM-On-The-Move (SOTM).

It integrates a self-pointing antenna with the PIM, so it's really easy to use for either scenario. In fact, it removes the need for satellite terminal pointing entirely, utilizing flat panel hardware and software-controlled beam forming technology. Users just need to add power to be connected to the network and they can then be making calls and transmitting video and hi-res images in minutes.

The discreet profile, flat panel design provides maximum efficiency and optimum radiation characteristics for improved data throughput and availability. The antenna's software tracks the satellite and a remote — which can be either handheld or dashboard-mounted — provides live beam heading indication, satellite selection, transmit mute and system status information.

The MANTA will revolutionize the SOTM and SATCOM-On-The-Pause (SOTP) market for the military; it is quick and easy to use and because of the PIM it will accommodate a multitude of modems. The flat panel design combined with the beam forming technology makes it discreet to meet BLOS requirements. Its easy fitting means it can be quickly attached to any vehicle or vessel with standard roof bars; no need for complicated wiring or rack-mounting components, it just needs one cable to connect power either via the vehicle or vessel's DC or from regular AC. Alternatively, for SOTP operation, it will operate straight 'out-of-the-box', quickly and accurately without the need for tools.

Military users who need connectivity for remote operations, in urban environments where existing infrastructure is compromised, or any situation where operations depend on reliable communications now have a rugged, easily transportable and completely straightforward connectivity solution.

Paradigm has developed the MANTA further with the launch of the MANTA+ terminal, combining all the existing features of the MANTA with seamless network switching via an integrated router. Essentially, the MANTA+ provides users with a fully integrated satellite terminal and 3G/4G/LTE cellular, radio and Wi-Fi network connectivity. This means that users can benefit from all the usual advantages of cellular, UHF/VHF and Wi-Fi coverage when they are available, but with the reassurance and back-up of satellite connectivity when entering remoter areas or when terrestrial infrastructure has been overloaded or damaged.

The MANTA+ will ensure constant connectivity by routing any device connected to it to Wi-Fi, cellular, radio or satellite depending on real time availability, service weighting and/or least cost.

While the MANTA+ has significant implications for the commercial and emergency responder sectors, it has its developmental roots in the military with the US SOF community being one of its first adopters. The flat panel, low profile design is ruggedized for extreme environments and with no moving parts, it is less vulnerable to the effects of sand, salt, moisture and temperature fluctuations than alternative satcom solutions. By having a reliable, always-on communications network that requires a minimum of installation and setup, operatives can focus on the mission's critical priorities. They do not need to undergo hours (or even a half hour) of training, or care about how the communication system works. They can rely on an end-to-end system delivered simply and quickly that enables anytime and anywhere connectivity. A system that allows them to spend minimal time on installing, troubleshooting and configuring and all their time on the mission.

Paradigm and the MANTA can now provide this dependable platform for soldiers to stay in contact with each other and the outside world. The MANTA and MANTA+ are responsive to coverage needs and easy for anyone to operate.

For more information email ***sales@paracomm.co.uk*** or visit ***www.paracomm.co.uk***.

Ulf has more than 30 years of experience in the global satellite and telecommunications world. After completing his MSc in Physics at the Royal Institute of Technology in Stockholm, he served in the Swedish Armed Forces. From there Sandberg joined Notelsat, the operating company for Tele-X, one of the earliest Nordic Communication satellites. From there, he was with the Swedish Attaché for Science and Technology office, based in the USA. Leaving the Government sector, Mr. Sandberg worked for Swedish Telecom International and then Unisource, where he advanced to be Managing Director for the satellite business based in the Netherlands. As well as Versatel in the Netherlands, Mr. Sandberg was also involved in the start-up and creation of a number of companies and ventures in Europe and the USA.

In 1993, Sandberg became Managing Director, EMEA for ComStream, a San Diego-based satellite communications systems company, and was responsible for growing regional operations including the setting up of an office in Moscow, Russia. He was then with ACT Networks prior to starting Paradigm in 1996, where he has spent the past 20 years as Managing Director.

THE GOVERNMENT SATELLITE REPORT

A new space race...

By Ryan Schradin, Executive Editor, Government Satellite Report

A few weeks ago, senior military decision makers and leaders joined industry thought leaders and executives in Crystal City for the annual C4ISRNET Conference. This year's event was the 18th annual conference and, as in years past, the focus was on the networks and IT systems that are making the military more connected, aware and capable in-theater.

While much of the discussion at this year's conference was focused on new, disruptive technologies the government and military are looking to embrace on-base and in the field — including mobility, IoT, AI and Big Data — there were two other incredibly poignant and important trends identified that are occurring in space.

These trends were identified and discussed during a panel discussion entitled, "*Capitalizing on the commercial space renaissance.*" The panel was moderated by C4ISTNET Editor, *Mike Gruss*, and featured a list of space experts, including:

- *James Comfort, Principal Deputy Director, Geospatial Intelligence Systems Acquisition Directorate, National Reconnaissance Office*
- *Col. Steve Butow, Space Portfolio Director, Defense Innovation University*
- *Victoria Samson, Washington Office Director, Secure World Foundation*
- *Pete Hoene, President and CEO, SES Government Solutions*

After decades of innovation and invention in space being driven by the United States government, things have shifted, and private industry has taken over in both innovation and investment.

What were the trends? The first was the advent of a new space renaissance, and the second was the potential resurrection of the Space Race, which dominated headlines and stretched the imaginations of people around the globe for a large part of the 20th century.

Let's look at each of these trends individually, although they are inherently linked.

A new Space Race?

It was just a little more than half a century since the United States and the former Soviet Union were working to out-science and out-spend each other in an attempt to make it into space and onto the Moon first.

Now, 62 years after Sputnik, the starting gun may have been fired to begin a new Space Race. And it's no longer being run between two parties.

For much of the past few decades, space has been a benign environment for the United States. We have utilized

it to deliver capabilities and communications to the warfighter without a significant threat to our space assets. But, as *Pete Hoene* pointed out, "*Space is not a safe haven…it's a warfighting domain. Right now, China and Russia threaten our actions in space.*"

This is a problem for the U.S., which has historically enjoyed a technological edge over adversaries thanks in large part to its space assets. However, with the emergence of threats in space, and with adversaries once again investing and innovating in space capabilities, that technological edge could be evaporating.

This was well articulated by Colonel *Steve Butow* when he said, "…***we use technology as our offset. If we lose our technological offset, we have to fight a fair fight, and that's not what we want to do. We want to have technological capabilities that keep us in a dominant position in all domains.***"

This is where the commercial space and satellite industry could help, and where the next trend, the new space renaissance, could factor in.

A Renaissance in Satellite Technology

After decades of innovation and invention in space being driven by the United States government, things have shifted, and private industry has taken over in both innovation and investment.

Today, satellite owners and operators are rapidly expanding constellations, introducing new satellite technologies with drastically increased throughputs and putting satellites in new orbits. And this is all creating new capabilities and tools that the government can implement and thereby reap the benefits.

As Mr. Hoene explained, "*Sixty-two years ago, Sputnik was launched and it created the biggest space race we'll ever see between the U.S. and the former Soviet Union. In the following 50 years, we spent a lot of money in the U.S. government. Over the past ten years, what we've found is that commercial has taken over in terms of investment and innovation.*"

The introduction of these new technologies and new orbits means that high-throughput satellites (HTS) are now available on orbits closer to the Earth's surface — including MEO and LEO. The result are incredible throughputs and bandwidth with significantly lower latency since the signal has to physically travel a shorter distance.

Not only can these new satellites meet the high-bandwidth, low-latency requirements of today's innovative IT solutions, they also have the added benefit of helping increase the resiliency of America's satellite infrastructure through disaggregation and diversification.

As Mr. Hoene explained, "*Think about how that would confuse and complicate the enemy's targeting calculus if you're looking at 150-plus satellites [operated by commercial owner/operators] as well as the ten WGS satellites. Then think about a multi-orbit approach, where you have LEO and MEO in play and how that can help with overall resilience.*"

This ability to increase capacity and resiliency has many military leaders and industry executives advocating for a military satellite network architecture that incorporates both military assets and commercial services. And, based on the following from *James Comfort*, appears to be the future direction for the military:

"*We don't think it's a 'one size fits all.' LEO does good stuff. MEO does good stuff. GEO does good stuff. What we need to [identify] is, what's the right thing in MEO? What's the right thing in LEO? What's the right thing in GEO? We will probably end up with a mixture…*"

Exciting talks of improved resiliency through a combined, integrated architecture are only superseded by the potential for innovation. The speed of development in the space industry drastically outpaces the development within the government and military.

This stark difference in pace of innovation was laid bare by Mr. Hoene who explained, "*It takes [commercial providers] two to three years to identify*

the requirements for a satellite, get it on a launch pad and get it on orbit. The hosted payload, CHIRP, which was hosted on one of our satellites took about three years from contract award to on-orbit capability. The commercial space community… is able to turn around things in a couple of years when purpose built systems for the Department of Defense could take eight to ten years."

By embracing commercial solutions and integrating commercial into the military's space architecture, the government is expediting its speed of adoption for new, innovative satellite technologies.

This means that commercial technologies, solutions and services could give the technological edge back to the U.S. military in today's Space Race. But only if they can acquire commercial solutions in an efficient and timely manner.

During that discussion, the panelists talked about how America could be embroiled in a new, 21st Century Space Race. Unlike the previous Space Race, which was all about getting a man into space and onto the Moon first, this Space Race involves the development and deployment of satellite capabilities and networks.

Also, unlike the previous Space Race, the panelists seem to believe that there was a real chance that America could lose.

Unfortunately for the United States, the near-peer adversaries that we're currently racing against are gaining on us. But the U.S. government and military could have an ace up their sleeve in the form of the commercial satellite industry, which is currently innovating and advancing space and satellite capabilities at a breakneck pace.

Peter Hoene said, "*If there's a way to share some of the threat requirements and demand signals… [commercial SATCOM providers] can get the investors in our companies to pursue new and innovative capabilities to meet emerging U.S. government threat characteristics.*"

However, to take advantage of those capabilities, the government will need to overcome some familiar challenges — including acquisition and spending challenges that have been bemoaned by the satellite industry for years. Challenges that our adversaries don't necessarily face.

The Bottleneck

Keeping the military's technological edge is becoming increasingly difficult. The United States simply doesn't play by the same rules as its adversaries.

While the United States has a clear delineation between the private companies spearheading innovation and the country's government, military and national defense organizations, adversaries such as Russia and China do not. Our adversaries also have less stringent oversight on spending and fewer hurdles keeping them from acquiring the technologies and solutions they need.

As Col. Butow explained, "*[The United States] work[s] in one-year steps. Our adversaries don't. They want it, they buy it and employ it tomorrow. If we're too late for the FY 2020 [National Defense Authorization Act], we'll have to get it in 2021.*"

Combined, these factors could contribute to the United States running a Space Race against extremely advanced, near-peer adversaries with its legs bound. And while the country may have enjoyed a head-start, the restrictions and limitations that it uniquely faces could have the other runners breathing down our necks in no time.

The problem was explained by Victoria Samson, who said, "*There is a recognition over the past couple of decades that the way that military space has been developed and acquired is not current… the government is trying to figure out how we handle that. We see that in Congress right now. The appropriators want one thing, the authorizers want another. They're probably not going to get it sorted anytime soon. It's a time of change, and our institutional processes are struggling to keep up.*"

Overcoming the Acquisition Hurdle

Historically, the government and military have treated the acquisition of satellite capacity and services the way they would any other commodity. Satellite capacity has been bought on the spot market, which often costs more.

However, the extra cost isn't the largest problem with acquiring satellite this way — it's the lack of cooperation and collaboration with the satellite industry that results from spot purchases that is really hindering the government.

The government and military could benefit greatly by working hand-in-hand with the satellite industry in a collaborative, consultative environment. By sharing their challenges and requirements more fully and working collaboratively with industry to address them, the government would effectively gain access to an innovative partner that could help them identify new and different approaches and technologies to help them overcome their problems.

To make this a reality, the government and military would have to rethink its approach and relationship with the satellite industry. This was a sentiment that was expressed and championed by the panelists — many of which urged the government to work more closely with the space and satellite industry, move to embrace more public-private partnerships and work to give the military more freedom and flexibility in how it spends dollars.

Along these lines, Mr. Hoene called for increased, clearer communications between government customers and commercial owners/operators when he said, "If there's a way to share some of the threat requirements and demand signals… [commercial SATCOM providers] can get the investors in our companies to pursue new and innovative capabilities to meet emerging U.S. government threat characteristics. Industry can bring a lot to the table if we ask the right questions and we're given the proper answers."

Discussions at the C4ISRNET Conference showed there is a new Space Race ongoing – but this one has more participants than the one previously won by the United States.

While our military has a head start, it's quickly evaporating. If the U.S. is going to keep its technological offset, commercial industry is going to be the key. Military leaders and Congress need to make it easier and faster for decision makers to purchase and acquire the innovative solutions they need.

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Ryan Schradin is the Executive Editor of GovSat Report. A communications expert and journalist with over a decade of experience, Ryan has edited and contributed to multiple popular online trade publications focused on government technology, satellite, unified communications and network infrastructure.

His work includes editing and writing for the GovSat Report, The Modern Network, Public Sector View, and Cloud Sprawl. His work for the GovSat Report includes editing content, establishing editorial direction, contributing articles about satellite news and trends, and conducting both written and podcast interviews. Ryan also contributes to the publication's industry event and conference coverage, providing in-depth reporting from leading satellite shows.

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SECURE WORLD FOUNDATION (SWF) INSIGHTS

Avoiding conflict in outer space

By Secure World Foundation's Dr. Brian Weeden, Director of Program Planning, and, Victoria Samson, Washington Office Director, and, Chris Johnson, Space Law Advisor

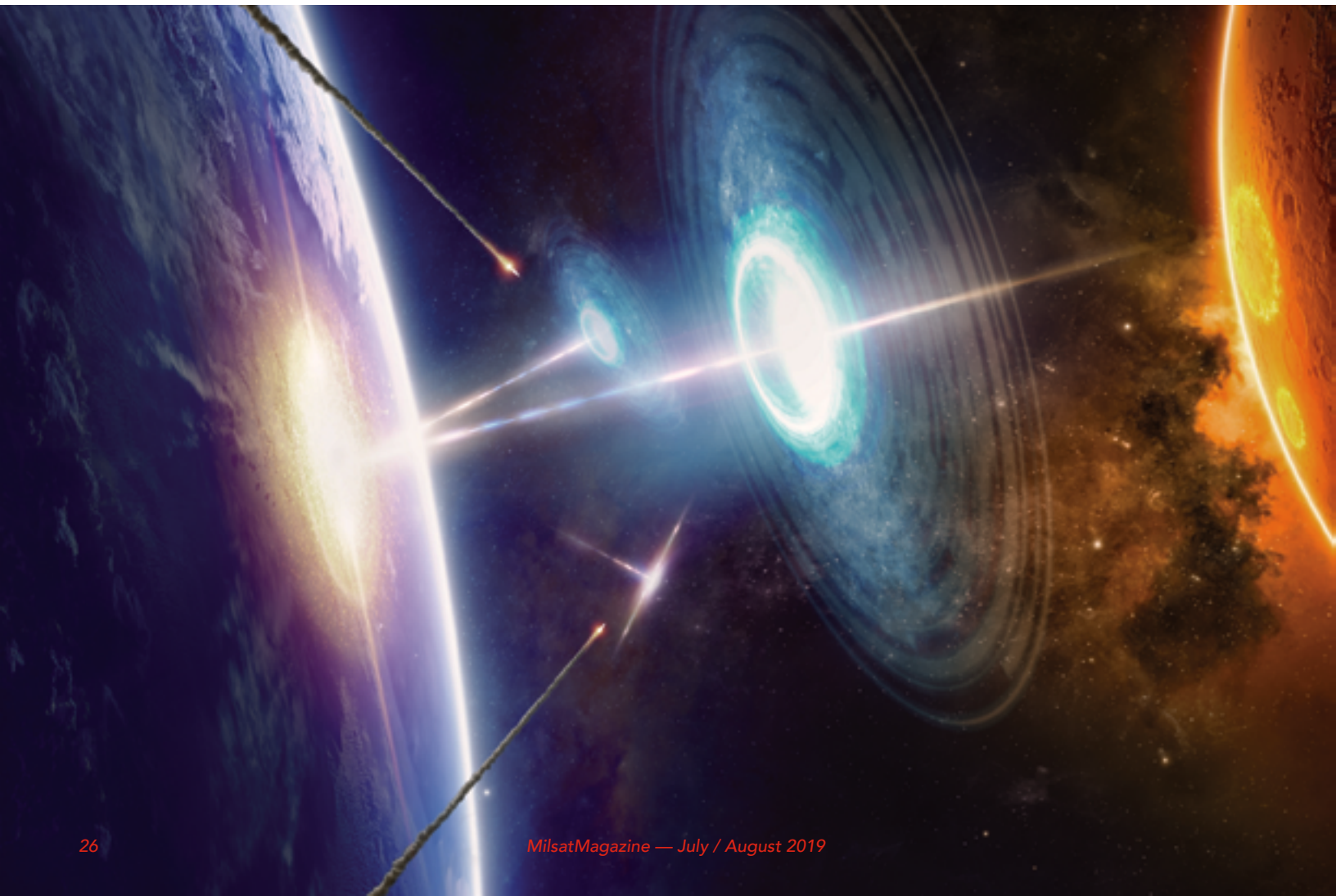
There is growing concern that outer space may soon become an arena for armed conflict. Although outer space has long been used to support military and intelligence activities, many fear that the increased use and reliance on space may mean it becomes an active part of future conflicts between space powers. If armed conflict was to extend into outer space, it is likely to have serious implications for global civil and commercial space activities and the long-term sustainability of space that last far beyond the conflict. As such, there needs to be a sharper focus on how to avoid armed conflict extending into space.

Although some of the rhetoric on space as a warfighting domain is overblown, there are legitimate concerns and troubling trends. As SWF documented in the 2019 version of our Global Counterspace Report, multiple countries are developing a wide range of counterspace capabilities and anti-satellite (ASAT) weapons.

Although current use of these capabilities and weapons is limited to jamming, spoofing, cyber attacks, and other non-kinetic methods, research, development, and testing of destructive kinetic methods is continuing. In March, India became the third country to destroy one of their own satellites with a direct ascent ASAT weapon in what Indian Prime Minister Modi described as a matter of "national pride" and a symbol that India had become a space power. India's ASAT test may create political incentives for other countries to conduct their own tests, which in turn may exacerbate strategic stability in outer space.

SWF is actively involved in developing mechanisms to prevent conflict in outer space across several different threads.

Since the 1980s, several multilateral discussions have attempted to develop arms control measures that address the development and proliferation of weapons that could harm the orbital domain. For years, discussions in the main UN body which covers space security issues, the Conference on Disarmament (CD), could not reach consensus on its agenda.



The primary space security issues being discussed at that level were ritual annual votes in the UN General Assembly on preventing an arms race in outer space (PAROS) and the Russian-Chinese proposed Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT), which has been criticized for its lack of verification and language that would still permit ground-based anti-satellite weapons, and has failed to draw significant international support.

However, during the past several years, three small changes have built some forward momentum.

First, the CD agreed in February of 2018 to form four subsidiary bodies that would discuss individual agenda items, since it could not reach consensus on an overarching agenda. Subsidiary Body 3 was charged with discussing PAROS; it met six times throughout the year and was able to create a consensus report that was sent on to the CD plenary, which in turn was able to generate a procedural report. By creating a consensus report, this means that the entire group, including representatives from China, Russia, and the United States, were able to at least agree upon some aspects of this issue.

Second, the UN Disarmament Commission (UNDC), which is part of the General Assembly, established a working group to look at how previous recommendations for space transparency and confidence-building measures (TCBMs) could potentially be implemented, which planned to meet in the spring of 2019. While its formal beginning was sidetracked by unrelated geopolitical tensions, the existence of the UNDC working group indicates the international community is interested in looking at practical, usable TCBMs.

Third, the UN General Assembly voted in December 2017 to establish a Group of Governmental Experts (GGE) who would meet to consider and recommend further practical measures on PAROS. The GGE on PAROS met in August 2018 and March 2019. The 25 nations represented, including the permanent five members of the UN Security Council and 20 geographically representative nations, had many spirited discussions but in the end, were unable to come to a consensus for their final report: a not-uncommon end to a UN-generated GGE involving many different countries with differing perspectives.

While these steps may seem incremental at best, they signal a growing salience of the space security and arms control issues within the UN system. These efforts, even the unsuccessful ones, also continue the conversation in multi-lateral fora and in small, yet crucial ways, enhance and deepen awareness of complex issues that lack other outlets for discussion amongst major space powers and competitors.

At the same time, there are ongoing discussions outside of the formal multilateral channels that are also contributing ideas and perspectives. Two of the most prominent involve non-governmental efforts to develop manuals on how international law applies to military activities in space. The Manual on International Law Applicable to Military Activities in Space (MILAMOS) Project is led by McGill University in Canada with financial support from the government of Canada and participation from several universities around the world. The Woomera Manual is co-led by the University of Adelaide and University of New South Wales in Australia, the University of Exeter in the United Kingdom, and the University of Nebraska-Lincoln in the United States.

Both MILAMOS and Woomera have teams of legal and technical experts developing manuals on how existing international law applies to military activities in space, both in peacetime and armed conflict. This task is harder than it may seem, as the existing international legal framework for space activities lacks specificity on many aspects, particularly with regard to military activities, and there are few if any court cases and legal precedents on armed conflict in space. Nevertheless, the MILAMOS and Woomera efforts are important endeavors, if only to identify the gaps and limitations of the existing international legal framework that may inform future efforts to shore up space governance.

SWF is actively involved in developing mechanisms to prevent conflict in outer space across several different threads. Our first line of effort is to increase global awareness of space security trends and threats through our counterspace research. Our Global Counterspace Capabilities report is an important tool for increasing transparency on the proliferation of counterspace and ASAT capabilities and as a foundation for discussion on policies and strategies to prevent armed conflict in outer space.

The SWF held panel discussions in partnership with the Center for Strategic and International Studies (CSIS) in April of 2019 at the Space Symposium in Colorado Springs, Colorado, and in Washington, D.C., on what the United States should be doing to address these challenges in a sustainable manner, and will continue these discussions in other countries at SWF events throughout the year.

The second line of effort is to support the MILAMOS and Woomera efforts as we see their discussions and end products as important foundations to inform norms of behavior in space and future development of space governance. SWF Director of Program Planning, Dr. Brian Weeden, and Space Law Advisor, Mr. Christopher Johnson, serve as technical and legal advisors to the Woomera and MILAMOS projects, respectively. As these projects move towards completion over the next couple of years, we will look for ways to socialize their end products to help inform national policies and strategies, shape global norms, and inform future multilateral efforts.

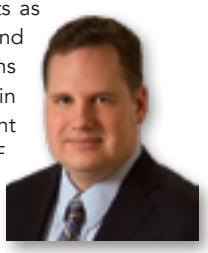
Finally, SWF's third line of effort is to support the multilateral discussions on space security and arms control. SWF continues to serve as both observer and outside expert to most of the multilateral efforts described above, including providing recommendations to the GGE on PAROS and briefing the UNDC working group on counterspace trends. SWF is also continuing to support and co-organize the United Nations Institute for Disarmament Research (UNIDIR)'s annual space security conference in Geneva. The UNIDIR conference has enabled broad discussion on the stressors to space stability and security and helped educate the Geneva diplomatic corps about the nuances of space security and stability issues.

This year's conference, "*Supporting Diplomacy: Clearing the Path for Dialogue*," will include a media panel and a special film screening to explore the wider societal implications of international cooperation in space, and will be broadcast live for those who cannot attend the conversation in-person.

Although the threat to space security posed by future armed conflict in outer space is worrying, the SWF believes that the developments mentioned above indicate that there are still opportunities to prevent that future from happening. At the very least, the impact conflict has on the long-term sustainability of space can be minimized.

For all of the doom-and-gloom rhetoric from politicians, there are still signs of hope and a growing willingness among governments, industry, and civil society to take steps to cooperatively create a brighter future for everyone in space.

swfound.org



Dr. Brian Weeden

Victoria Samson

Chris Johnson

COTM LAND AND AIRBORNE TECHNOLOGIES

Vital components for successful missions

By Aaron Titus, Norsat International

Every military commander will agree that communication is the key to any successful mission or in-field operation. One of the most vital components for military command and control is the ability to communicate seamlessly, offer support and share information for mobile personnel and groups deployed in remote locations anywhere, at any time.

Effective COTM systems ensure intelligence information reaches personnel on time, and surveillance data is properly relayed, even when users are on the move. Leaders can make better tactical command decisions when they receive reconnaissance observations on time, in turn increasing military strategic advantages

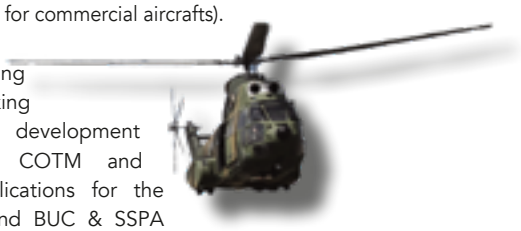
A large number of organizations are now working on improving mobile communications capability beyond the line of sight to enhance their Communications-On-The-Move (COTM) capability. This primarily involves portable satellite technology, specifically relating to military and defense land vehicles, maritime or airborne platforms. The core principle behind COTM is that any moving vehicle on land, air or sea equipped with a SATCOM system is able to establish and maintain communication with a satellite.

COTM Land and Airborne technologies require specialized equipment that have tight weight and size specifications with extreme form factors as well as extra design capabilities and standards including electromagnetic interference, vibration and shock. This is because military operations are growing to be asymmetric and non-linear, requiring LIVE responses to changes that occur during a mission, or on the battlefield. As the demand for improved on-ground communication increases, state-of-the-art modern military mobility equipment users look towards SATCOM manufacturers to implement innovations in SATCOM technology to deliver data to and from hostile environments without interruption.

Size, Weight, and Power (SWaP) are the three crucial physical attributes that must be considered for COTM systems.

Stringent Specifications

In this regard, Norsat has been a pioneer in developing SATCOM solutions as our LNBs and BUCs are ideal for COTM and airborne applications. Besides great performance, our signature products like the ATOM Series of block upconverters and solid state power amplifiers (BUCs & SSPAs) are tested to meet the most stringent standards like MIL-STD-461 (EMI/EMC), MIL-STD-704A (airborne), MIL-STD-1275D (ground), MIL-STD-810G environmental (shock, vibration, salt fog, blowing rain sand) and RTCA DO-160 (standards for commercial aircrafts).



The engineering team is working on multiple development projects for COTM and airborne applications for the ATOM Ka-band BUC & SSPA and ATOM Ku-band GaN BUC. Another aspect that we see driving potential growth is the opening of the company's manufacturing facilities in the United States, delivering Norsat's signature North-

American quality, which has been well-received by our customers in the military and defense contractor communities.

SWaP Considerations

Size, Weight, and Power (SWaP) are the three crucial physical attributes that must be considered for COTM systems. Minimizing weight and size while maximizing power are competing aims, and optimizing this balance is at the heart of BUC/SSPA design. The advantages of low SWaP in COTM come from lighter, smaller BUCs that are easier to position, operate, access and service. In airborne COTM applications, the constraints of restricted space and fuel consumption margins call for small system size and low weight. Contrastingly, in maritime COTM weight is less important than space, as the constraints of radome mounting impose compact form factor requirements, in addition to thermal and vibration considerations.

In the case of land-based COTM, space is even more limited in vehicles and tanks, and heavy weight reduces speed and performance. Output power vs Power consumption (Power efficiency) is a factor for every single COTM application, since there is a fixed level of usable power in a moving vehicle, irrespective of being airborne, land-based or maritime. All other factors being equal, the lightest and smallest components outputting highest power with the lowest possible consumption, is what customers are ultimately seeking to implement.

Future Trends

COTM applications for military purposes require more power to operate independently while on the move. But, adding more power to a unit also results in more heat, which creates the need for more components in order to cool it down. Catching the wave with this trend, Norsat has developed GaN BUCs with excellent thermal management and more output power. For example, Norsat's 80W Ku GaN ATOM BUC is 62 percent lighter and 70 percent smaller than competing products in the industry, weighing just 2.3 kg.

When it comes to terminals, Norsat's premier maritime COTM offering is the MarineLink Naval Series. They are designed to meet the new-age demanding requirements of modern navies as outlined in the following Military Standards:

- *Mechanical Shipboard Vibration: MIL-STD-167-1A*
- *High-Impact Shipborne Shock: MIL-STD-901D*
- *Military EMI / EMC: MIL-STD-461G*

Because of these rigorous and standardized certifications, Norsat is able to provide our military customers with demonstrated, high-capacity communications systems, designed to perform under even the most extreme maritime environments. Additionally, terminals in Norsat's MarineLink Naval series have been certified for use on the Military Wideband (WGS), CE0678, Intelsat and Anatel networks.


Norsat Maritime.

These maritime terminals have unique features that benefit COTM applications like fast tracking speeds (90 deg/s) for accurate and dependable signal lock and 3-axis operating platform for WGS reliable operations even in rough sea states (up to Sea State 6). Additionally, they also feature a built-in motor brake, shock absorber, and wire-rope isolator for longevity and reliability, and unlimited azimuth for precise tracking and ease of cable management.

In the near future, SATCOM manufacturers will need to pay attention to COTM parameters such as ground user uplink power, transponder gain, ground user antenna aperture size and satellite downlink power. Organizations have begun research into mobile antenna pointing and stabilization to provide robust solutions by offsetting the reduction in gain and using numerous wider beam antennas.

COTM Land and Airborne Technologies will witness further development over the next two years as customers expect better SWaP, increased need for manufacturing demands such as FOD, FAI requirements, more standard requirements, higher temperature and lower temperature specs than the usual, altitude specs and tighter integration with the antenna.

Over the past 40 years, Norsat products have been used to support vital mobile communications for not just ISR (intelligence, surveillance and reconnaissance), but also battlefield communications, supply logistics, search and rescue, UAVs (Unmanned Aerial Vehicles) and disaster site video.

Norsat stays committed to providing customers with the best solutions for all their COTM applications where situational awareness and life-saving information is required in a moment's notice.

www.norsat.com

AN MSUA CONVERSATION WITH...

Susan Miller , President and Chief Executive Officer, Inmarsat Government Inc.

By Catherine Melquist, President, Mobile Satellite Users Association

Susan Miller is President and Chief Executive Officer of Inmarsat Government Inc., a wholly-owned subsidiary of Inmarsat plc, the world's leading provider of global mobile satellite communications to the United States government.

Ms. Miller is responsible for the overall strategy of expanding Inmarsat's leadership position across U.S. defense, intelligence, homeland security and civilian organizations.

Ms. Miller has more than 20 years of senior executive leadership experience across a wide range of satellite communication technologies that serve the U.S. government and commercial sectors. Prior to joining Inmarsat, she held leadership positions at MTN Satellite Communications, Spacenet Inc, Intelsat General Corporation, Ligado, Lockheed Martin and Hughes Aircraft Corporation.

Ms. Miller holds a Master of Science degree in Electrical Engineering from the University of Southern California and a Bachelor of Science degree in Electrical Engineering from the Rensselaer Polytechnic Institute.

MSUA

Susan, thank you for taking time for a Mobility News interview. At two different points in our careers, we've worked for the same company at the same time — beginning with COMSAT and later with MTN Government. Now that you've been leading Inmarsat Government for over five years, it's an ideal time to check in with you to learn how it's going and what your leadership goals are for the next couple of years. I also believe MN readers will be interested in hearing your perspective on satellite industry trends and market dynamics facing U.S. Government customers.

How is it going at Inmarsat Government and what is your next two to five-year leadership mission?

Susan Miller (SM)

Thank you, Catherine. It is nice to reconnect and update you on Inmarsat Government and my personal views of the ever-changing and dynamic satellite industry.

These are exciting times for Inmarsat Government, and the next two to five years will be no different as we continue to deliver innovative satellite communication (SATCOM) solutions to the market. We are the world leader in global, mobile satellite communications. Our customers trust us to provide seamless, reliable connectivity for mission-critical communications no matter the location — on land, at sea or in the air.

The government and industry must collaborate together so private industry complements existing government resources, enhancing the robustness of the architecture.

Inmarsat owns and operates the world's most proven global portfolio of satellite networks specifically designed for mobility. We hold a multi-layered, global spectrum portfolio that covers L-band, Ka-band and, in Europe only, S-band. These assets enable us to provide an unrivaled breadth and diversity of connectivity solutions.

Our team will continue to develop new and innovative technologies and solutions that maximize our satellite networks and deliver critical mobile connections demanded by our servicemen and women. To achieve this, we address the unique challenges that users in the air, on the ground and at sea face by providing access to an end-to-end, easy-to-use, feature-rich, "one-stop shop" solution.

We also design our systems and infrastructure to complement the military's own system in a way that offers seamless interoperability between the two, backed by experienced and knowledgeable team members whose skill sets are aligned with the needs of our users. We take our responsibilities as a trusted partner seriously and to heart, and are driven to deliver the best possible value for our customers.

Clearly, Inmarsat's mobility-centric vision and strategy continue to help us reach these goals, and remain on target with the government's demand for mobile connectivity, anytime and anywhere in the world. Highly mobile government users must share information in real time, wherever

their mission takes them, and stay connected. Given that these users are always moving across the globe, there is a sense of urgency for high-performing, reliable and secure voice, data and video that "moves" with them. A dropped connection could jeopardize the mission.

Getting into some specifics, Inmarsat-5 F4 (I-5 F4, also known as GX-4), the fourth satellite in our renowned Global Xpress constellation, was launched in May 2017 and entered full commercial service in March 2019. The 4thGX satellite adds further capacity to the Global Xpress network. In addition to delivering additional capacity in regions of greatest demand, it provides in-orbit redundancy that further upgrades the reliability and resilience of Inmarsat's service offerings.

An additional Global Xpress satellite (GX-5), is on schedule for launch in the last quarter of this year. It will be a Very High Throughput Satellite (V-HTS) providing capacity across the Middle East, Europe and the Indian subcontinent. The payload will seamlessly join Inmarsat's existing Global Xpress high-speed global wideband network. By combining the latest satellite technology and a focus on areas of high demand to drive high-capacity utilization, we will offer a very low cost per bit delivered.

Furthermore, in 2020 and 2021, Inmarsat plans to launch the first two satellites in its sixth generation (Inmarsat-6) constellation. These satellites, currently under construction, are the most powerful and flexible L-band mobile communication satellites ever created by Inmarsat. Together with advanced ground infrastructure technology, they will support enhanced user devices and services for the coming 5G era. Both spacecraft will also carry Ka-band payloads (GX-6a and GX-6b), adding further capacity to the Global Xpress network.

Plus, Inmarsat's new infrastructure roadmap is already progressing.

In addition to what we are doing at Inmarsat, I am equally encouraged by the achievements and ideas set forth by government and industry leaders. With so many inspiring initiatives and current events taking place in our industry and the U.S. government, the criticality of space resilience and the necessary support of commercial SATCOM (COMSATCOM) have never been more important.

I cannot think of a better time to speak with you about our business and technology innovation to further increase Inmarsat's U.S. government market presence. The future of satellite technology is exciting. It is a place where science and technology come together to solve real-world problems, and no one is better positioned to meet those challenges, and turn them into opportunities than Inmarsat.

MSUA

When you think back on your past five years at Inmarsat Government, what do you regard as your biggest triumph(s)?

SM

What makes me most proud, my biggest triumph, is the criticality of the missions we support every day by delivering trusted satellite communication capabilities to our brave military servicemen and women, first responders, those charged with delivering vital services to the public, and the civilians who support them.

Furthermore, to take a broad view as we celebrate Inmarsat's 40 years in operation, I think of our overall, highly successful track record of delivering solutions that ensure our government and military users have access to resilient, robust and secure satellite communications wherever they are, at a moment's notice. We remain committed to government users. We understand their unique requirements and invest ahead of the need to deliver innovative, next-generation capabilities and end-to-end managed network solutions that enable them to achieve their missions.

I am proud to be part of a team that has delivered significant technological innovations in mobile satellite communications, sustaining our leadership through substantial investments in L-band and Ka-band capabilities — for satellites, services and terminals. This is all supported by a powerful network of technology and manufacturing partners that develop best-in-class solutions and foster competition.

MSUA

During this same time, what have been some of your most notable learning points — either as a satellite industry executive or service provider to the U.S. Government market?

SM

In all of our experiences, we must never forget that government users want results. To successfully support their missions, they must have access to resilient, robust and secure SATCOM wherever they are, across the full spectrum of engagement. Given the world of uncertainties, access to high-throughput, always-on communications for mobility operations remains a top objective of the U.S. government and allied nations. All of which must also have a focus on agility, cost-effectiveness and enhanced combat readiness.

At the same time, the military's own satellite infrastructure is under pressure from increased demand and users cannot always access it as necessary. Many government programs began before some of the modern concepts of operations were envisioned, such as unmanned Airborne Intelligence, Surveillance and Reconnaissance (AISR), and cannot flexibly meet all requirements with often competing demand for military SATCOM (MILSATCOM) access for mission-specific surges in some geographies.

In my experience, the bottom line is that these users want results in the form of maximum capability, flexibility and resiliency. SATCOM capability needs to go where they go, with smaller, easier-to-use equipment, and multi-band terminals to ensure it stays up and running no matter how challenging the situational or geographic conditions. Users do not care who "owns" SATCOM. Bottom line, they want results, in the form of superior capability. We must never forget this. If we do, then would be doing a great disservice to the users and the criticality of their missions.

MSUA

I know your academic background is in electrical engineering, did you always know you wanted to work in space-based business? What influenced you to pursue this course?

SM

I was originally a fine arts scholarship student who loved math and switched to a double-degree engineering program after a year in college. I never looked back! I have worked in satellite technology my entire career, including the Ronald Reagan administration's Strategic Defense Initiative.

For me, the passion comes from using science and technology to solve real problems. As a design engineer, there is nothing more exciting. I still feel that wonder — even after more than 25 years of doing this — and I am really eager to see what the next phase of innovation and development will bring.

MSUA

Clearly the U.S. government has increased its focus on space-based communications, security, and warfare. In your view, how should the satellite industry amplify its partnership capabilities to meet the evolving needs and interests of U.S. government customers?

SM

Via its policies and statements, 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. The National Defense Strategy shifts focus onto highly mobile mission sets to support advancements in intelligence, surveillance and reconnaissance (ISR), demanding resilient SATCOM, inclusive of COMSATCOM.

The government and industry must collaborate together so private industry complements existing government resources, enhancing the robustness of the architecture. With a strong business case supported by clear demand signals, industry can innovate more rapidly, and ahead of the need, than the government. As a result, we improve protection, resiliency and global portability, along with efficiencies and cost effectiveness.

As a commercial satellite provider, Inmarsat is making a high standard of performance possible by investing in solutions with government users in mind, thereby, complementing military satellite resources cost-effectively.

We in the industry are excited about recent space-related actions and see a promise of a sea change in the way the U.S. government acquires critical satellite communication capabilities. Expectations are high, and we are ready and able to deliver the needed capabilities now.

MSUA

As the leader of Inmarsat Government, I can imagine there are a lot of business and market issues competing for your attention. What does your daily dashboard of priority topics look like? And, what area of the business do you find to be personally most compelling?

SM

I will address the last question first because it is a great source of pride for me: Our team at Inmarsat Government, frankly, amazes me every day. About 35 percent of these dedicated professionals have served in the military. They understand the unique needs of servicemen and women and are totally dedicated to supporting them. By combining the expertise of our industry partners, who have been at the forefront of satellite communications-related technology and innovation for nearly four decades, as well as input from our U.S. government customers, we continue to develop next-generation commercial services and technologies built for users in all domains. We all feel pride in being a partner to the military and government and take that responsibility seriously.

Now, as for my daily dashboard: as the President and CEO of Inmarsat Government, I am determined to advance our overall strategy of expanding Inmarsat's leadership position across U.S. defense, homeland security, public safety and civilian agencies. This requires technology innovation and problem solving. One quick example is our LAISR — L-band Airborne ISR service — meeting the unique needs of airborne ISR government customers. LAISR is a high-data rate, end-to-end airborne communication solution, via Inmarsat's redundant, worldwide space and ground networks, through micro-antennas as small as 5 inches, and is managed 24/7 by a U.S.-based, security-cleared operations and engineering team. LAISR is about leadership, dedication and innovation — qualities that raise our standing within the U.S. government.

Then, I turn my attention to our satellite solutions for first responders. They are making a significant impact and saving lives. Inmarsat Government is very proud to be part of the core team AT&T selected to help deliver the FirstNet communication platform, providing resilient, secure SATCOM capabilities for our country's first responders.

MSUA

We're expecting significant areas of new satellite-based mobility innovation — from new LEO constellations and next-gen ground systems to precision-driven data analytics and industrial automation. What changes do you believe the U.S. Government customers are most eager to put to use?

SM

Actually, to put innovation to use for U.S. government customers we must first think of change in the form of overcoming a perceived obstacle with terminals.

With the release of some of the conclusions from the Air Force's Analysis of Alternatives (AoA) for a follow-on wideband communications system to the Wideband Global SATCOM system (WGS) last year, that perceived obstacle was called out — that most military satellite terminals are not compatible with modern SATCOM technology, creating concerns about recapitalization costs. On the industry side, some of us do not view legacy terminals as an insurmountable challenge. Commercial technology innovation and flexible business models can resolve this perceived impediment by delivering modular terminals to replace vertically integrated systems.

Government and military leaders can leverage commercial satellite communication platforms to support critical missions through our end-to-end SATCOM as a Service business model that includes satellites, the ground network as well as terminals that are type approved to work on that network. With this, there would be a clear path toward "Terminal as a Service," which will result in continual technology refresh and modernization at an affordable rate.

MSUA

As a longtime partner of Access Intelligence, MSUA will be hosting a series of user panels at SATELLITE 2019 focused on satellite mobility in the 5G era. In one of the sessions, MSUA will host a discussion with wireless connectivity decision makers, specifically CIOs, CTOs, and Mayors from U.S. cities — both urban and rural — about topics such as rural broadband, smart city/IoT-based infrastructure, security, and emergency response communications. If you were moderating this panel, what questions would you pose to these potential satellite users?

SM

My thoughts would immediately turn to natural disasters, and the role SATCOM plays in supporting first responders during these unwanted and unpredictable events. Hurricane Maria, for example, had a catastrophic impact on Puerto Rico's communications network: Immediately following the storm, over 95 percent of Puerto Rico's wireless cell sites were out of service. Satellite-based communications have proven essential during and after such unfortunate events, when local terrestrial infrastructure and mobile phone networks are often overloaded, damaged or non-existent.

My main questions would be: How are you incorporating SATCOM into your disaster relief planning? Is SATCOM playing an essential role? How so?

MSUA

As you know, satellite companies and coalition groups have been diligently working to ensure satellite has an expanded role in the emerging new 5G standards and system architecture. Are U.S. Government customers talking about 5G and if so, is there an expanded communications role satellite can play with this market?

SM

With the ever-increasing need for seamless connectivity delivered holistically everywhere, the satellite communication industry will play an increasingly important role in providing 5G across the globe. We are already seeing advances in satellite technology moving in this direction. However, spectrum availability is required to meet this growing demand.

As for U.S. government customers, we must educate them on the important differentiating roles a satellite in a 5G world offers and the use cases where 5G services can best be supplied by satellite.

To fully implement 5G for the society of the future multiple industries will have to collaborate. Inmarsat is already playing an active role in this cross-industry collaboration. Our European Aviation Network (EAN) — the first of its kind worldwide — combines mobile satellite coverage with a complementary 4G LTE ground network, developed by Deutsche Telekom, to deliver the world's most advanced passenger Wi-Fi experience on flights throughout the European Union. And we are in a strong and unique position to leverage the existing network by introducing 5G technology, even further increasing the performance of our EAN solution.

MSUA

Do you envision growth in the take-up of hybrid wireless communications by government customers? Why or why not?

SM

I certainly do. Please allow me to use the public safety environment as an example: when a disaster strikes — such as a tornado, hurricane, earthquake or wildfire — it can disrupt the local wireless communication ecosystem of fiber optic cables, microwave backhaul systems and tower infrastructure. This is where hybrid networks with integral satellite communication capabilities prove essential. Satellite networks use redundant,

widely geographically diverse downlink sites to link from the satellite into the backbone voice and data networks. Thus, a localized emergency will not disrupt the satellite network.

MSUA

"User experience" has become a critical driver to business growth and success — spurring new modes of customer interaction, new product types and new models of businesses. How relevant is user experience in the satellite industry and do you see any of these trends taking shape in the U.S. government market today or in the relatively near future?

SM

User experience is critical and will always be critical. High operational and mission readiness is a top priority for government users. Failed connectivity can cause mission failure and the potential loss of lives. Hence, government users demand seamless access, reliability, information assurance and simplicity, along with the significantly reduced size, weight and power (SWaP) of equipment.

We view this demand as a trend for the present and indefinite future, and with this in mind, we will continue to set the world's standard for mobile government COMSATCOM solutions that meet information assurance requirements. This is part of our history of commitment to our global mobility-centric strategy, which is distinguished in our market.

MSUA

What does the satellite industry need to do to enhance the user experience for U.S. Government customers?

SM

We are convinced that much of the experience depends upon the greater adoption of managed network services. Mobile users thrive through worldwide connectivity on demand, especially when a single operator is managing the services from start to finish. With this in place, users connect wherever they are, even in the most geographically difficult environments. With guaranteed service level agreements and committed information rates, the quality of the acquired service is assured.

As mentioned previously, we offer this as part of our SATCOM as a Service business model, which is addressing our government users' most essential challenges while achieving new levels of innovation. SATCOM as a Service is an end-to-end fully integrated capability that establishes mobile, high-throughput connectivity the way users seek it: easily, affordably and operationally available — anytime, anywhere.

I am confident we will reach a point in which this business model emerges as the norm. To get there, we on the commercial side must continue to invest in ongoing technology innovation as the foundation, granted by a trusted partnership between the government and industry and supported by relevant policies, structure and budget resources. With this, government and military users will have the reach, resilience and technology modernization to focus on and successfully execute their missions even through contested domains.

MSUA

What weren't you asked about that you would like to mention?

SM

Other than our LAISR technology, we didn't really get a chance to talk about Inmarsat Government's technology roadmap which is rich with an array of user-specific terminals that enable multiband support across different satellites and adaptability to support different modems.

For example, we are building small, high-throughput terminals that operate in both military and commercial Ka-band that allow our customers to roam from the WGS MILSATCOM world onto Inmarsat's Global Xpress network, seamlessly augmenting their mobility environment in all domains — land, sea and air. We are developing these cutting-edge devices to deliver multi-megabit data rates to and from very small airborne platforms as well as maritime and land mobile systems — and we offer this specialized technology, tailored to U.S. government customer requirements, as an end-to-end 24/7 managed service that meets their specific performance requirements.

We are solving the hard problems, from complete rotary wing solutions to unique terminals that support tough expeditionary missions. Inmarsat Government is excited to partner with our U.S. government customers to really deliver what they require.

MSUA

What is your personal favorite form of recreational mobility (boating, hiking, camping, horseback riding) when you're not at work focusing on satellite mobility? (By the way - Rebecca's answer was Glamour Camping or "Glamping.")

SM

I am an avid hiker and will travel to great extremes to experience the treasures our world has to offer. And while I would like to think I can move mountains, at least I have been known to climb them, and have even enjoyed a technical climb or two on my adventures. Little known fact is that whenever I really get off the grid, I usually have a satphone in my kit, and it always works so I am never really away from the safety net of satellite mobility.

www.msua.org

This interview is courtesy of MSUA and is republished with the organization's permission.

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

Catherine Melquist is a strategic marketer with more than two decades of experience developing marketing and public relations strategies for global companies in the satellite and space-based market.

Catherine is the principal strategist at CAM & Company, a boutique marketing practice offering a cost-effective, ready-to-go alternative to resourcing an in-house marketing team or contracting with a traditional marketing firm. Ideal for start-ups, companies in transition, or established businesses looking to augment their staff, CAM & Co helps companies navigate the market to achieve brand awareness, strategic outreach and revenue success. CAM & Co employs a carefully selected network of professionals with satellite and aerospace expertise and shape-shifts them into teams to meet the unique needs of each client.

SENSING THE FUTURE

The multi-domain battlespace is being powered by advances in semiconductors

By Ellen Hamilton, Director, Land & Avionics C4ISR, Mission Systems, Northrop Grumman

The multi-domain battlespace is no longer a future vision. It is a reality now, connecting sensors and shooters through secure and resilient networks. As these systems require increasingly higher levels of reliability, power output and frequency coverage, engineers are turning to high performance materials such as gallium nitride (GaN) to keep up with the evolving requirements.

As a semiconductor material, gallium nitride offers efficiency and high power density, an ideal combination of attributes for radio frequency applications, including radars and electronic warfare systems. Northrop Grumman is using its decades of expertise with GaN and other advanced materials to empower warfighters in their missions.

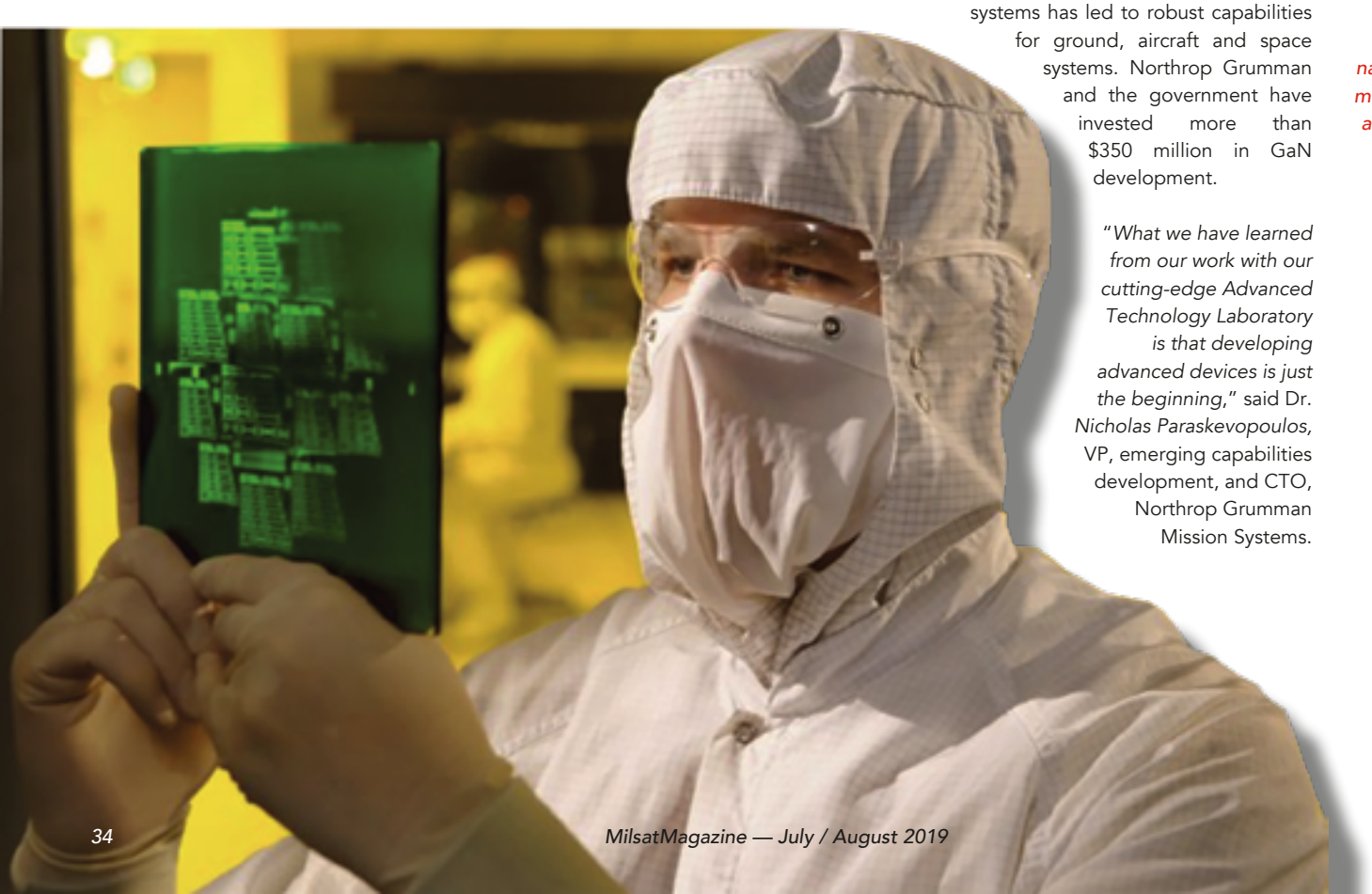
Advancing the Science of Semiconductors

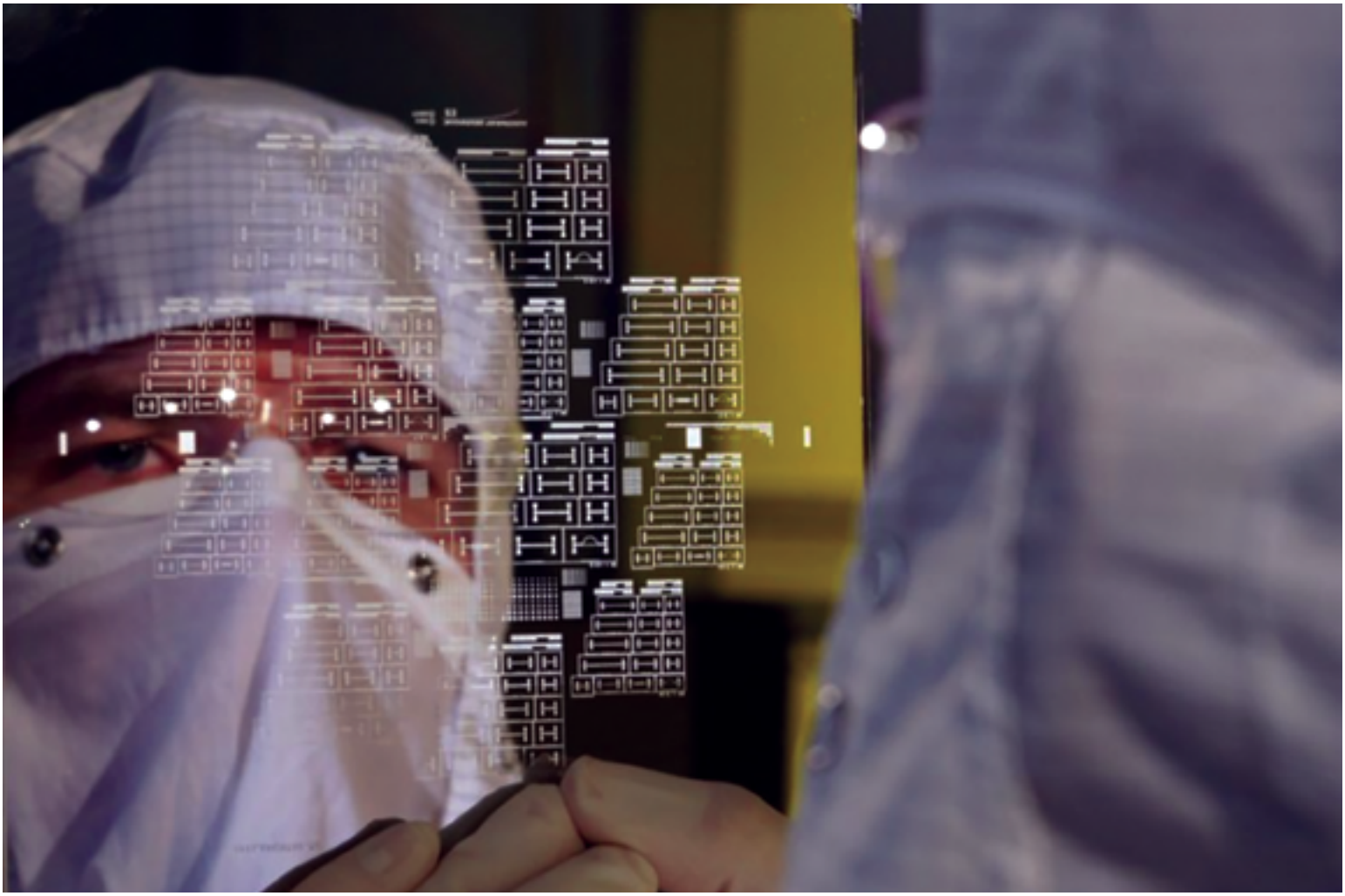
Fifty years ago, Northrop Grumman opened its Advanced Technology Laboratory (ATL) to create semiconductors for critical military programs. The facility, now a Department of Defense trusted foundry, has delivered more than eight million components that support missions from undersea to outer space and every domain in between. The foundry maintains a wide range of processes in gallium nitride, gallium arsenide, silicon, and silicon carbide in the production of military spec microelectronic chips, some of which are radiation hardened. Nowhere else in the world will you find a single foundry with this broad mix of device fabrication capabilities. A variety of ground-based, aircraft and space systems programs have sourced components from the laboratory.

The ability to move a component through the full design cycle — from mission requirements through to flight test quickly, and all within a two mile radius — makes ATL a unique facility. The lessons learned through that seamless process have transferred to countless Northrop Grumman programs. The company's experience in developing and integrating GaN into military systems has led to robust capabilities for ground, aircraft and space systems. Northrop Grumman and the government have invested more than $350 million in GaN development.

Gallium nitride's ability to provide high power for signal amplification and pulse generation make it a natural fit for many military applications.

"*What we have learned from our work with our cutting-edge Advanced Technology Laboratory is that developing advanced devices is just the beginning,*" said Dr. *Nicholas Paraskevopoulos,* VP, emerging capabilities development, and CTO, Northrop Grumman Mission Systems.





Inside the Northrop Grumman Advanced Technology Laboratory, which has been in operation for 50 years.

"*Ensuring that the device performance will meet or exceed our customer's expectations once integrated into a complex military system, under challenging real-world conditions, is where our technical team's expertise makes the difference. This is systems thinking in actio*n."

One significant example is the Marine Corps AN/TPS-80 program, the first and only multi-mission ground radar in the Department of Defense to use GaN technology. Applied to the AN/TPS-80 radar, GaN enhances system sensitivity and efficiency, increases power density and improves reliability. The system achieved Initial Operational Capability and was fielded last year.

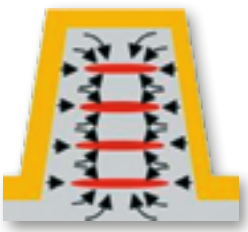
GaN Meets the Law of Large Numbers

Gallium nitride's ability to provide high power for signal amplification and pulse generation make it a natural fit for many military applications. But defense is not the only field that is taking advantage of the benefits of GaN. The telecommunications industry, currently investing heavily in infrastructure for 5G, is using GaN to power key parts of the network. Those investments are creating positive effects for all users of GaN technology.

The implementation of 5G has created economies of scale for GaN production, driving down prices and increasing the quality and reliability of the components. What was once a specialty item is now approaching commodity status — and that is a good thing, said *Rob Howell*, a Northrop Grumman fellow and chief technologist.

"*Producing GaN components requires hundreds of steps, and ensuring that each one is carried out to specification is critical to the effectiveness of the final product. The investment of commercial industries in GaN has led to a significantly higher process uniformity, from which the military can also benefit*," said Howell.

What's Next: SLCFET and SiGe



The next generation of microelectronics is taking shape at Northrop Grumman. One technology under development is Super Lattice Castellated Field Effect Transistor (SLCFET), the company's patented structure that uses GaN to offer even greater levels of performance.

Sensing the Future_3

The SLCFET is a novel device specifically engineered to provide superior ultra-wideband frequency performance for the next generation of military radio frequency (RF) systems.

The device is based on a superlattice of GaN to create parallel, stacked channels of current, which are each controlled by the three dimensional castellated gate, so named due to its resemblance to the top of a castle wall. As RF switch performance is a dominant factor for next generation wideband systems, the SLCFET is a key technology enabler for realizing these future systems.

The company is also a leader in silicon germanium (SiGe) designs, which permit a dramatic reduction in the number of chips required and are ideal for highly integrated RF and mixed signal systems.

With decades of experience in semiconductor design, development and integration, Northrop Grumman provides a range of technologies, including GaN, to power the future of advanced systems in the multi-domain battlespace.

www.northropgrumman.com

ACHIEVING THE TACTICAL EDGE

Spotlight on Spectra's Slingshot

Conceived and designed to meet demanding Special Forces requirements, Spectra's SlingShot is a unique, low size, weight and power (SWaP) system that enables existing UHF and VHF tactical radios to extend their reach into the realm of Beyond Line of Sight (BLOS) Communications on the Move (COTM).

By using Inmarsat's commercial L-band Tactical Satellite (L-TAC), SlingShot allows a tactical net to be created over 1000s of kilometers to deliver a comprehensive range of tactical and operational network capabilities. SlingShot provides voice and data capability for Command and Control (C2), encrypted if required, and to support wide-ranging mission-critical applications, such as artillery fire missions, GPS tracking and biometric analysis, to name a few. With greater capability compared to traditional TACSAT, increased and guaranteed channel availability, and virtually no increase in the training burden, SlingShot is rapidly redefining tactical communications.

As a truly game-changing system, SlingShot gifts the user the tactical edge by enabling high tempo operations; enhancing force protection; and facilitating complex, multi-agency interoperability. All with a system that is simple, reliable and cost-effective.

Spectra's SlingShot is undoubtedly a force multiplier.

With no reliance on additional infrastructure, SlingShot enables high tempo operations in remote locations.

BLOS communications have traditionally been complex and time-consuming to establish, particularly when operating without recourse to conventional fixed infrastructure. Until now, military satellite technology and High Frequency Radios have been the principle means used to establish BLOS communications. However, the UHF TACSAT antennae required are large and must be pointed towards the satellite to establish a communications link, compelling the user to remain stationary in order to communicate.

With discrete, lightweight, omnidirectional antennae, optimized to be man-portable or easily fitted to vehicle, maritime and aviation platforms, SlingShot allows teams, right down to the tactical level, to communicate instantly and while on the move. SlingShot's unique

capability enables a significantly increased tempo of operations: commanders provided with access to fully up-to-date situational awareness to support swift decision-making; users empowered to deliver decisive tactical action by the ability to communicate instantly at multiple levels without the shortfalls and constraints of traditional communications systems.

SlingShot's tactical reliability and discreet signature ensures that the user can maintain a low tactical profile in order to establish communications.

The combination of SlingShot's ability to work with existing encryption equipment and a non-specific electronic signature (it is indistinguishable from commercial satellite traffic) makes the system more difficult to trace than when using military radio frequencies, providing the user with enhanced force protection and affording the confidence to maintain communications throughout all phases of operations. In addition, unlike many traditional communications systems,

SlingShot is not limited by terrain or degraded by weather and darkness; meaning that operationally critical lines of communication can relied upon 24 hours a day and from virtually any platform or location. By overcoming the traditional operating limitations of BLOS communications imposed by weather, terrain and emissions, SlingShot once again provides the user with the upper-hand.

Plus, complex, multi-national, multi-agency operations are supported by SlingShot's ability to create a network linking groups using nationally discrete equipment.

Spectra's 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. By creating a unified L-band net using the existing in-service tactical radios of coalition partners, whether VHF or UHF, SlingShot can provide the foundation for complex operations supported by any number of discrete agencies.

SlingShot has a proven record of providing a reliable and easily implemented communications network for multiple agencies worldwide. Already in use with numerous Special Forces, border security and disaster-relief agencies, SlingShot is rapidly becoming the capability of choice for multi-agency operations. Simply established interoperability has never been so easy to achieve and with SlingShot is now a reality.

Simplicity, reliability and versatility ensure that SlingShot provides maximum utility with minimum cost, time and training burden.

With a small external appliqué that connects directly to the users' existing radio and requires no configuration, SlingShot eliminates the need for re-equipping the force and demands minimal training, reducing the cognitive burden on the operator. SlingShot's reliability as a communications system stems from the provision of critical voice; when the user transmits, the assigned channel instantaneously transfers the message to an all-informed network, exactly like a radio net.

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.

SlingShot's simplicity enables reliable communications immediately on deployment, eliminating delay in establishing communications networks and increasing the speed of reaction and efficiency of the deployed force. Spectra's SlingShot is undoubtedly a force multiplier.

spectra-group.co.uk

Spectra Specifics

Spectra Group (UK) Ltd is a renowned specialist provider of secure voice, data and satellite communications systems, specifically optimized for use in remote and challenging environments. The company provides high-grade information security and communication capabilities and has more than 15 years of experience in delivering solutions for governments around the globe, elite militaries, Special Forces and private enterprises of all sizes. Spectra was recently awarded the prestigious Queen's Award for Enterprise in the Innovation Category for SlingShot.

Launched in 2013, over 3,000 SlingShot systems are now in operation world-wide. The system is used by more than 20 different organizations, in mostly NATO countries. Spectra continues to expand its SlingShot business into new markets. Multiple world-wide exhibits at Africa Endeavour (Cape Verde), Land Forces (Australia), DVD (UK), AUSA (USA), the Africa Security Symposium (Senegal), Global SOF (USA), IDEX (UAE) and Satellite 2019 (USA) 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 October 2018, following contract successes in North America, Spectra Group (UK) Ltd established new offices in Fairfax County with Spectra Group (US) Inc. Spectra Group's permanent presence in the USA enables them 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.

SlingShot was selected to participate in the U.S. Army Expeditionary Warrior Experiments (AEWE 2019) by the US DoD. The AEWE, fielded by the US Army Maneuver Battle Lab at Fort Benning, focuses on small unit modernization, providing capability developers, the Science and Technology community, and industry with a repeatable, credible, rigorous, and validated operational experiment, supporting both concept and material development.

The AEWE places cutting edge prototype technologies into the hands of soldiers, providing bottom up input to capability development through early and iterative feedback in a tactical setting. During AEWE 2019 SlingShot was successfully used and evaluated in a range of operational and tactical scenarios.

Spectra Group is now seeking to expand the firm's already substantial international sales into new sectors not currently covered by their existing U.S. partners; a significant development as, globally, the U.S. offers the largest Defence, Emergency Response and Homeland Security market.

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.