Next Generation Space Defense

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July / August 2021

A United Launch Alliance (ULA) Delta IV Heavy rocket carrying the NROL-44 mission for the National Reconnaissance Office (NRO) lifts off from Space Launch Complex-37 on December 10, 2020.
Photo Credit: United Launch Alliance

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GOING... GOING... GREAT! THE USSF'S GPS III SV05 SATELLITE EXPERIENCES A SUCCESSFUL SPACEX FALCON 9

The Falcon 9 liftoff of the GPS III SV05 satellite from Cape Canaveral Space Force Station. Screen capture is from the SpaceX live stream of the launch.

PUSH TO ORBIT

On June 17, *SpaceX* successfully launched the upgraded *Global Positioning System* (GPS) satellite into orbit for the *U.S. Space Force* (USSF).

The flight — the 19th launch this year for SpaceX and its workhorse ***Falcon 9*** rocket — lifted off from Space Launch Complex 40 at Cape Canaveral Space Force Station during a 15-minute window that opened at 12:09 p.m. EST (1609 GMT). Perched atop the rocket is the GPS III-SV05 satellite, which was built by ***Lockheed Martin***.

This is the fifth launch of an upgraded, next-generation, GPS III satellite to date. Built by Lockheed Martin in Colorado, these upgraded GPS satellites are some of the most sophisticated spacecraft ever built.

They're equipped with anti-jamming capabilities that are more robust than previous iterations and more powerful signals for increased accuracy, according to Lockheed Martin representatives.

GPS III SV05 @ Lockheed Martin prior to shipment to Cape Canaveral AFS.

GPS III SV05 is the 24th Military Code (M-Code) signal-enabled, GPS space vehicle on-orbit, completing the constellation's baseline requirement to provide the nation's military forces a more-secure, harder-to-jam and spoof GPS signal.

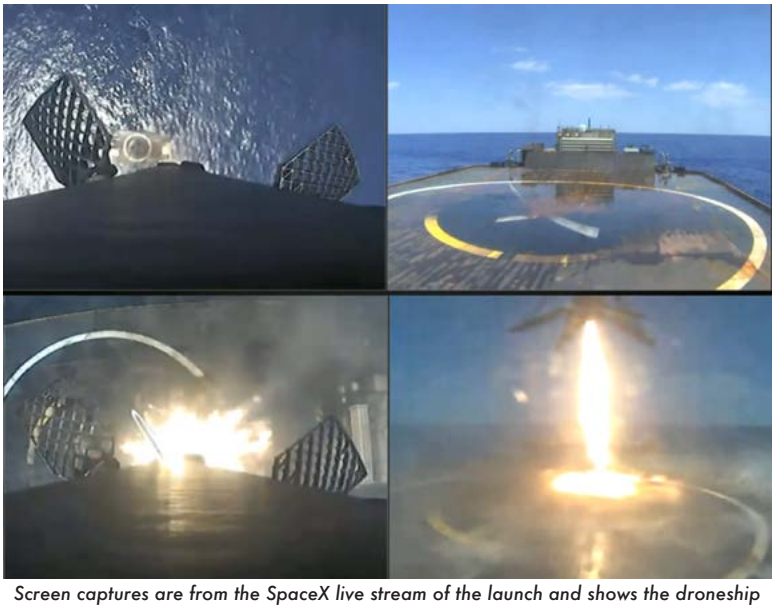
This launch featured the fifth in a series of ten, upgraded, GPS III satellites for the military that will join the current constellation of satellites already on-orbit.

These crucial satellites help to provide positioning, navigation and timing services for more than four billion users worldwide. GPS III-SV05 will replace an aging predecessor that was launched two decades ago.

Last year, Space Force officials announced that the U.S. military had granted SpaceX permission to launch national security payloads on previously flown rockets. That news followed on the heels of another recent decision to allow SpaceX to recover the first stages of Falcon 9 boosters used on national security missions, something that was previously not allowed.

This mission was the first to fly on a veteran Falcon 9. After ferrying the GPS satellite into space, the rocket will then land back on Earth on a floating platform at sea, the "*Just Read the Instructions*" droneship. The star of this mission is a previously flown Falcon 9 first stage, known as **B1062** to SpaceX.This first stage is embarked on its second mission, after lifting another GPS satellite last year.

The current GPS constellation is composed of 31 operational spacecraft. GPS satellites operate in *Medium Earth Orbit* (MEO) at an altitude of approximately 20,200 km (12,550 miles) in six orbital planes. Each satellite circles the Earth twice per day. This latest generation of GPS satellite boasts a 15 year design life, which is 25 percent longer than the previous generation of GPS satellites on-orbit.



Screen captures are from the SpaceX live stream of the launch and shows the droneship before and after the Falcon 9 first stage completes a successful landing.

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About 90 minutes after liftoff, U.S. Space Force and Lockheed Martin engineers at the company's Denver GPS III Launch & Checkout Operations Center declared GPS III SV05 separated from its SpaceX Falcon 9 rocket and "flying" under their control.

Over the next several days, GPS III SV05's onboard liquid apogee engine continued to propel the satellite toward operational orbit. After arrival at the designed slot, engineers sent the satellite commands to deploy solar arrays and antennas and prepare GPS III SV05 for handover to ***Space Operations Command***.

Part of U.S. critical national infrastructure, GPS drives an estimated $300 billion in annual economic benefits and is responsible for $1.4 trillion since its inception. Globally, more than 4 billion military, civil and commercial users depend on GPS' positioning, navigation and timing signals.

Lockheed Martin is part of the GPS III team led by the Space Production Corps Medium Earth Orbit Division at the U.S. Space Force's Space and Missile Systems Center, Los Angeles Air Force Base. The GPS Operational Control Segment sustainment is managed by the Enterprise Corps, GPS Sustainment Division at Peterson Air Force Base. The 2nd Space Operations Squadron, at Schriever Air Force Base, manages and operates the GPS constellation for both civil and military users.

"*With GPS III SV05, we continue our focus on rapidly fielding innovative capabilities for the Space Force's Positioning, Navigation and Timing Mission*," said ***Tonya Ladwig***, Lockheed Martin vice president for Navigation Systems. "*With each satellite we bring to orbit, we help the U.S. Space Force to modernize the GPS constellation's technology and to imagine future capability. Our next three satellites, GPS III SV06, SV07 and SV08, are already complete and just waiting for a launch date.*"

"*We are building on the successful booster recoveries of GPS III-3 and GPS III-4 last year and making a historic step with the GPS III-5 mission using a previously flown vehicle*," said Colonel ***Robert Bongiovi***, Launch Enterprise director. "*The affordability and flexibility provided with SpaceX's reused launch vehicles open additional opportunities for future NSSL missions and provide our nation's warfighters with the advanced capabilities they need.*"

"*The GPS III program office, in partnership with our contract teammate,s continues to push the envelope on the capabilities they deliver to users, both civil and military around the globe*," said Mr. ***Cordell DeLaPena***, Jr., U.S. Space Force program executive office for Space Production. "*Our latest GPS III satellites' nearly 70 percent digital payload provides the Space Force with greater operational flexibility, as well as cutting edge capabilities while continuing to support legacy users. Fueled off the success of our latest GPS III SV04 launch, I look forward to the successful launch of SV05 just 7 months later.*"

"*Our GPS program team overcame numerous challenges presented by the COVID-19 pandemic to safely and successfully launch GPS III SV04. Their resilience and ingenuity validated a new concept of operations which has paved the way for the launch of GPS III SV05 just seven months later*," said Colonel ***Edward Byrne***, MEO Space Systems Division chief. "*SV05 will continue to modernize our GPS constellation by increasing our capabilities with advanced features for both our civil and military users across the world.*"

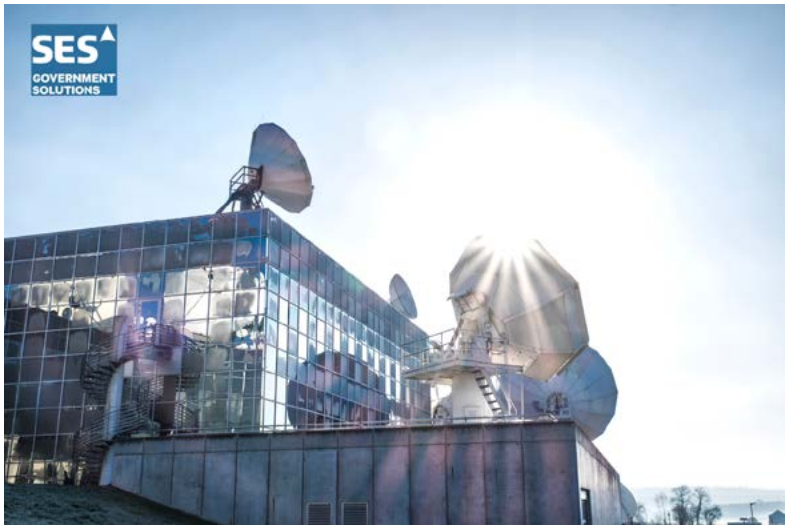
The Space and Missile Systems Center, located at Los Angeles Air Force Base in El Segundo, California, is the U.S. Space Force's center of acquisition excellence for acquiring and developing military space systems. Its portfolio includes the development of advanced space and launch capability and systems, global positioning systems, military satellite communications, defense meteorological satellites, space launch and range systems, satellite control networks, space-based infrared systems, and space situational awareness capabilities.

NORTHROP GRUMMAN SUCCESSFULLY LAUNCHES USSF / SMC'S TACRL-2 PAYLOAD

Northrop Grumman **successfully launched the TacRL-2 payload into orbit for the U.S. Space Force's Space and Missile Systems Center using the company's Pegasus XL rocket.**

Pegasus, the world's first privately-developed commercial space launch vehicle, is an air-launched, three-staged rocket carried aloft by Northrop Grumman's specially modified "Stargazer" L-1011 aircraft.

SES GOVERNMENT SOLUTIONS WINS $14.5 MILLION CONTRACT TO SUPPORT THULE AIR BASE



SES Government Solutions (SES GS), a wholly-owned subsidiary of SES, today announced it was awarded a contract of USD 14.5 million to support Thule Air Base in Greenland with critical communications capabilities.

The SES GS solution leverages C-band technology, which is highly resilient to weather effects, and provides a dedicated reachback beam leveraging single hop connectivity directly to the user site.

The SES GS solution also provides redundancy at all levels, to include antennas, uplink and downlink telemetry, ground infrastructure, and restoration capabilities.

This award is an example of the company's proven track record of providing reliable services in harsh climate conditions in the Arctic, while ensuring the mitigation of physical antenna degradation.

SES GS has been the sole provider of commercial satellite communications to Thule Air Base for over 20 years. It has extensive experience overcoming the challenging conditions of operating in Arctic locations, including the extreme cold-weather environment, unpredictable weather patterns, near-horizon location, and logistical challenges.

"*We are proud to provide satellite communications support for this critical mission*," said President and CEO of SES Government Solutions, Brigadier General **Pete Hoene**, USAF (retired). "*Thule Air Base is the Department of Defense's northernmost installation, and this program continues to serve as a great example of the importance of our capability to deliver the critical intelligence data to military decision makers*."

SES combines its operational experience with its GEO and NGSO global capabilities to deliver multi-band, multi-orbit communications to customers' remote locations like Thule, where resilience and reliability are non-negotiable.

U.S.A.F. ISR PRIME CONTRACT ISSUED TO LEIDOS

Leidos **(NYSE: LDOS) has been awarded a prime contract by the U.S. Air Force to provide solutions for a broad spectrum of aviation requirements.**

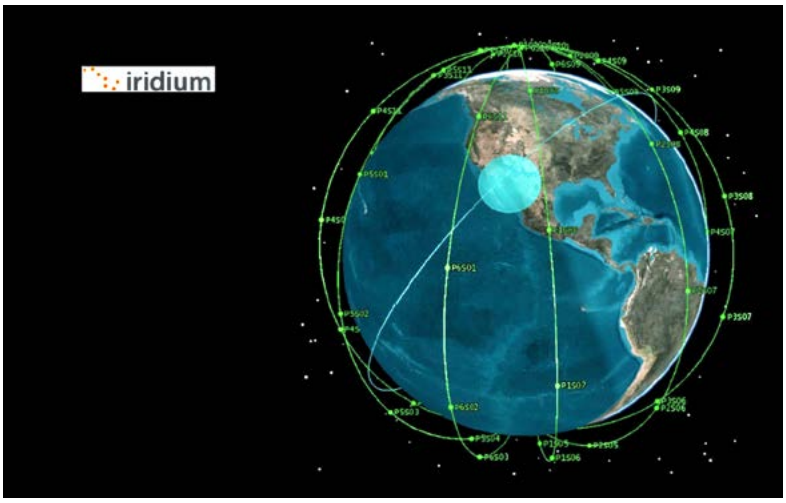
Leidos will support the Air Force's Intelligence Surveillance Reconnaissance & Special Operations Forces (ISR/SOF) Directorate (WI), Sensors Division (WIN) Non-Standard Foreign Military Sales (FMS) branches. The multi-award, indefinite delivery/indefinite quantity contract has a total estimated value of $950 million. The period of performance for the contract is 13 years total, with a 10-year ordering period and an additional 3 year performance period. Work will be performed at locations worldwide.

The Leidos team will bring a cadre of professionals and tools from across the industry to improve both U.S. and allied ISR capabilities. Leidos will also provide full aircraft and ISR sensor integration, procurement of hardware and spares, sustainment support and inspections for airworthiness/configuration.

ISR/SOF provides support to all weapons systems in its portfolio. The ISR functions are principal elements of America's defense capabilities. They include a wide variety of systems for collecting, processing and disseminating intelligence for national security decision makers and military commanders.

"*This award underscores Leidos' strong performance leveraging decades of operation and technical integration expertise for the Air Force*," said ***Mike Chagnon***, Leidos Senior Vice President and Operations Manager. "*We look forward to supporting the Air Force and its mission to maintain multi-domain dominance*."

IRIDIUM RECEIVES AN R&D CONTRACT FROM THE U.S. ARMY



Iridium Communications Inc. **(NASDAQ: IRDM) has been awarded a research and development contract worth up to $30 million by the United States Army to develop a payload to be hosted on smallsats that support navigation systems, guidance and control for the global positioning system (GPS) and GPS-denied precision systems— the new experimental Iridium payload is intended to be hosted by another LEO commercial satellite constellation, complementing the Iridium® constellation's capabilities.**

Through this contract, the Army intends to develop this payload to support the concept of a rapidly deployable smallsat constellation to provide more effective sensor-to-soldier data transmission when in the field. The development of this new payload is based on ***Iridium Burst***® technology, a service that can transmit data to millions of enabled devices at a time from space.

The U.S. Department of Defense (DoD) and Iridium have partnered for more than 20 years, with hundreds of thousands of U.S. government subscribers using Iridium push-to-talk (PTT), voice, IoT, L-band broadband and Iridium Burst services. The continuing growth in adoption of Iridium services also brings increased collaboration between the government and Iridium's ecosystem of partners, that bring their knowledge to help further complement and advance the DoDs SATCOM capabilities. For this contract, Iridium partners ***Satelles*** and ***SEAKR*** will bring their expertise as subcontractors to assist with development.

This research and development project was enabled through an "Other Transaction Agreement" (OTA) in support of the Army and was entered into between ***Advanced Technology International*** (ATI) and Iridium under the authority of the Aviation and Missile Technology Consortium (AMTC). The OTA was developed through the authority of the Department of Defense to carry out these types of prototype projects and to further streamline the process for adopting new technology solutions from various industries.

"*Iridium has always been focused on providing innovative, reliable and high-value services to the U.S. warfighter*," said ***Scott Scheimreif***, executive vice president, government programs, Iridium. "*This program can help add to warfighter readiness to conduct a full range of military operations at a tactical level. This includes the ability to enhance effectiveness of military units, weapons and equipment during combat against near-peer adversaries*."

"*This is one of the largest engineering contracts in Iridium's history, and we're pleased to once again bring the value of Iridium and our partner ecosystem to the fore at the request of the United States Army*," said ***Matt Desch***, CEO, Iridium. "*It also represents another phase in the evolution of our growing relationship with the DoD, and we're excited to engage on this experimental multi-constellation adaptation of our service*."

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Shortly after the rocket's release from Stargazer, at approximately 40,000 feet above the Pacific Ocean, Pegasus ignited its first stage, beginning its successful flight carrying TacRL-2 to its intended orbit.

This is the 45th successful launch of Pegasus, which uses solid propulsion to offer maximum responsiveness by enabling launch to a wide variety of orbits on short timelines. This capability provides customers with the flexibility to operate from virtually anywhere on Earth with minimal ground support requirements.

Pegasus has launched more than 90 satellites into LEO from five separate launch sites in the United States, Europe and the Marshall Islands.

"*This Pegasus launch was a clear demonstration of our team's ability to provide rapid and responsive operation needs*," said ***Rich Straka***, vice president, launch vehicles, Northrop Grumman. "*Our team was able to execute the design, integration and testing of the TacRL-2 launch vehicle in less than four months from contract award.*"

ACQUISITION: GENERAL ATOMICS IMPORTS SYNOPTA INTO THEIR OPERATIONS

General Atomics **(GA) has acquired** ***Synopta GmbH,*** **a leader in the development and production of complex opto-electronic instrumentation for space and terrestrial applications.**

Founded in 2004 in Eggersriet, Switzerland, Synopta develops opto-electronic instrumentation and provides strategic and technical consultancy services. Synopta's customers include a wide range of European organizations, national agencies, and international corporations active in the fields of defense, space and capital goods.

"*Synopta's pioneering expertise and innovative developments in communication, beam control, pointing assemblies, and stationary and transportable optical ground systems will supplement the diverse portfolio of laser communications, sensors, and ground systems which enable delivery of dependable solutions to government and other customers*," said ***Scott Forney***, President of General Atomics Electromagnetic Systems Group. "*Synopta will continue to serve its European customer base but will expand now also to customers in the United States and other countries, while contributing to GA's systems and strategic objectives. Under its new name General Atomics Synopta GmbH, the company will form a technical center of excellence within the General Atomics group of companies.*"

"*We are excited about the perspectives resulting from this acquisition. While continuing to operate in the Canton of St. Gallen as a Swiss company, we now have the opportunity to demonstrate the potential of true transatlantic co-operation in the hi-tech field,*" said ***Jens Kunde***, General Manager of GA Synopta.

NORTHROP GRUMMAN DEMONSTRATES ADVANCED NETWORKING AT NORTHERN EDGE 2021

During the Northern Edge 2021 joint exercise, ***Northrop Grumman Corporation*** **(NYSE: NOC) successfully demonstrated advanced communications and networking systems technology to connect warfighters in contested environments.**

Validated on three separate platforms, one demonstration was conducted in partnership with the Air National Guard and involved the company's Freedom Pod — a derivative of the ***LITENING*** advanced targeting pod that incorporates a ***Freedom Radio*** and an infrared search-and-track sensor for passive surveillance and targeting.

F-15 Eagles and Strike Eagles from the 53rd Wing and 96th Test Wing sit on the ramp at Joint Base Elmendorf-Richardson, Alaska during exercise Northern Edge 21. Approximately 15,000 U.S. service members participated in the joint training exercise hosted by U.S. Pacific Air Forces. The exercise was conducted on and above the Joint Pacific Alaska Range Complex, the Gulf of Alaska, and temporary maritime activities area. U.S. Air Force photo by 1st Lt. Savanah Bray.


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*Source: GovWin IQ Total Federal Market Overview – Top Contractors 2016-2020 – NAICS 517410 Satellite Telecommunications
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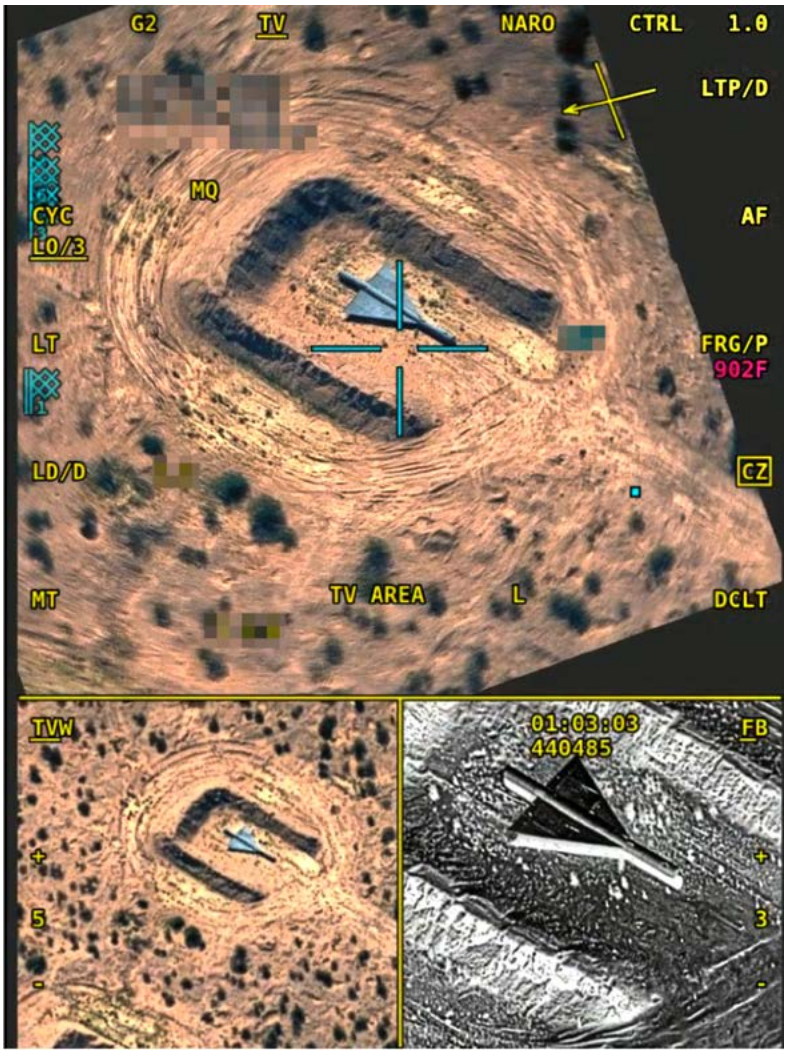

LITENING is an electro-optical infrared sensor system for targeting and surveillance that enables aircrews to detect, acquire, identify and track targets at long ranges. LITENING enables a wide range of missions, including precision targeting, close air support, intelligence, surveillance and reconnaissance, and humanitarian assistance.

"*Northrop Grumman's Freedom Pod provides swappable, multi-function capabilities to a range of aircraft, including unmanned, to provide a greater level of sensing and connectivity for the warfighter*," said ***James Conroy***, vice president, navigation, targeting and survivability, Northrop Grumman.

Northrop Grumman's advanced networking technologies, including the Freedom Radios and Freedom Pods showcased at Northern Edge, help warfighters and branches of the military easily communicate and securely share actionable information across air, land, sea and space. The company's advanced networking technologies are designed to interconnect the missions of today and will provide the functionality needed to support the network-centric operations of tomorrow.

In addition to Freedom Pod efforts, other variants of Northrop Grumman's Freedom Radios, which enhance situational awareness for a range of manned and unmanned aircraft, were involved in two platform demonstrations centered on advanced 5th generation communications. These demonstrations leveraged the Freedom Radios' cyber-secure, software-defined, multifunction, open architecture solutions designed to support a wide range of integrated communications and networking capabilities across multiple domains.

"*The Freedom Radio product line enhances situational awareness for a range of manned and unmanned aircraft—through 5th generation communications capabilities*," said ***Jenna Paukstis***, vice president, communications solutions, Northrop Grumman. "*We have the capabilities needed to connect advanced platforms with functionality necessary to adapt to emerging all-domain mission demands to help the DOD realize its vision for JADC2*."

"*Northern Edge is an essential event for operational tests*," said Col. ***Ryan Messer***, 53rd Wing commander. "*It is one of only a handful of exercises that combine great power competition-level threat complexities with the joint interoperability necessary to realistically inform our test data. The individuals in the 53rd Wing continue to inspire me with how they challenge themselves and their programs in complex environments, ensuring we deliver the most lethal, ready and capable force for our nation*."

Northrop Grumman has participated in every Northern Edge exercise over the last decade.

MILLION$$$ CONTRACT FOR GILAT SATELLITE NETWORKS FOR APAC MILSATCOM CUSTOMER

Gilat Satellite Networks Ltd. **(Nasdaq: GILT, TASE: GILT) has been awarded a multi-million-dollar contract to provide satellite communication (SATCOM) equipment to a large system integrator for a company customer in Asia.**

Gilat's SkyEdge II-c, Capricorn VSATs and TotalNMS will serve the needs of the defense forces to provide tactical SATCOM solutions for mobile platforms and enable efficient communication channels during emergency and disaster response besides the critical C4I needs.

Multiple hubs and hundreds of VSATs will be deployed in redundant configurations to meet the critical security needs, as well as the high quality and key regulatory requirements.

"*Gilat was chosen to answer the defense needs due to Gilat's superior technology, highly secure solution, proven global track record and commitment to the local market*," said *Vinod Kaul*, General Manager, South Asia, at Gilat. "*Together with the local partners we see a large potential for our technology in additional Defense projects, as well as other segments such as Education, Banking, Oil & Gas and IFC*."

"*We are proud that Gilat's SkyEdge II-c platform answers the most stringent requirements and thus provides the technological capability to enable realizing today's demand of digital warfare, wherever and whenever digital information is required*," said Res. BG. **Eyal Zelinger**, Gilat's Vice President of Defense. "*This contract is an additional significant step in implementing Gilat's strategy in the global Defense market*."

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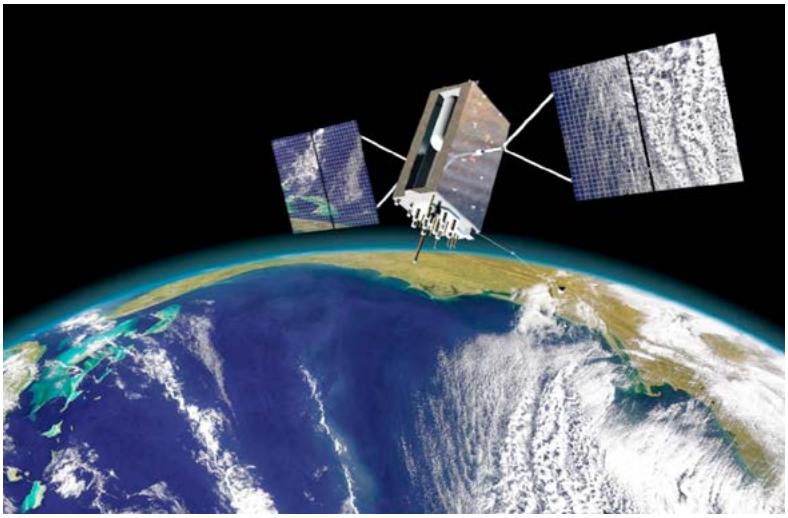
USSF'S SMC TRANSFERS SATELLITE CONTROL AUTHORITY FOR GPS III SV 05 TO 2ND SPACE OPS

The SpaceX Falcon 9 liftoff of the GPS III SV 05.

The *United States Space Force*'s *Space and Missile Systems Center* has transferred Satellite Control Authority (SCA) of the Global Positioning System III Space Vehicle 05 to the *2nd Space Operations Squadron, Schriever Air Force Base*.

Less than one day after SCA, on June 29, 2021, GPS III SV05 received Operational Acceptance approval, marking the first GPS III SV to receive SCA handover and Operational Acceptance within 24 hours and decreasing the time from launch to on-orbit operational capability by 97 percent and expediting delivery of GPS capabilities to the warfighter.

The partnership with ***Lockheed Martin*** and confidence in the GPS III SV design has enabled near, real-time delivery, thanks to the collaboration and integration between the acquisition team, industry, and the operational community.



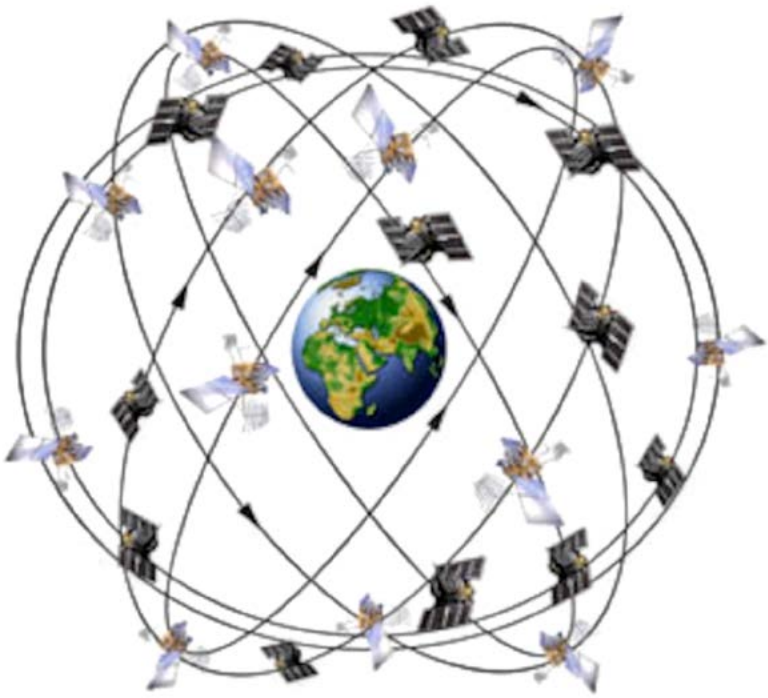
Artistic rendition of the GPS III SV 05 satellite on-orbit. Image is courtesy of Lockheed Martin

In 2020, the GPS enterprise launched two GPS III SVs in the midst of a global pandemic. Despite the challenges presented by this pandemic, the enterprise continued to streamline the process from launch to Operational Acceptance by continuously shrinking the delivery timeline.

The innovation and teamwork across the GPS enterprise has enhanced the rapid identification and elimination of redundant on-orbit verification steps.

SV05, nicknamed "***ARMSTRONG***," was launched on a ***SpaceX Falcon 9 Block 5*** vehicle on June 17, 2021. This marks the first National Security Space Launch on a previously-flown Falcon 9 booster. In fact, SV05 reused the same booster that delivered GPS III SV04 to orbit in November of 2020.

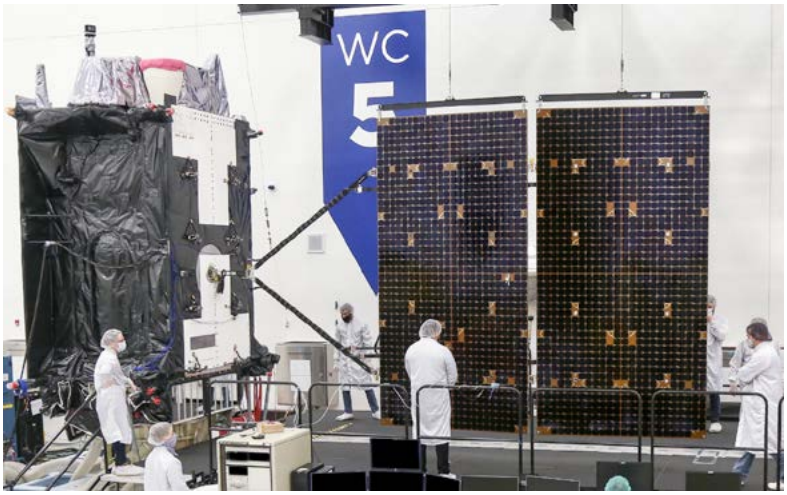
GPS III SV05 is joining the GPS positioning, navigation, and timing constellation of 31 operational satellites.



Artistic rendition of the GPS constellation is courtesy of the U.S.A.F.

The Lockheed Martin-built GPS III SVs provide improved accuracy, advanced anti-jam capabilities, and increased resiliency for the GPS constellation and the 4 billion users worldwide. GPS III SV05 will be set healthy to all global users in September 2021, following the completion of on-orbit testing.

"*The inclusion of GPS III SV05 into the operational constellation marks another significant milestone for the enterprise with 24 M-Code capable satellites*," said Colonel **Heather J. Anderson**, Transition Director.



GPS III Space Vehicle 05 in Highbay at Lockheed Martin. Photo is courtesy of the company.

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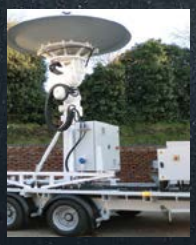

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Space & Component Technology

AVANTI COMMUNICATION'S OKAYS ULTRA'S PORTABLE + FLYAWAY SATELLITE TERMINALS

***Ultra*'s range of advanced man portable and flyaway satellite terminals, designed to meet the demands of secure government and military SATCOM, have been accredited for operations on *Avanti Communication*'s fleet of high-throughput satellites.**

Avanti's high-capacity, Ka-spectrum satellites provide fixed beams covering the EMEA region and steerable beams spanning from the Americas to Asia. Merging this capability with Ultra's range of terminals, specially designed to operate in the harshest environments, means that end users will have continuous access to reliable communications regardless of where they are operating.

Using Avanti's high throughput beams, trials across Ultra's line of terminals showed outstanding throughputs in excess of 150 Mbps in the Forward and Return routes. This capability means government customers now have the ability to provide headquarters-levels of capacity through a terminal that can fit on their back.

The efficiency of these terminals, coupled with the high capacity of Avanti's high throughput steerable beams, will allow government customers to deploy multiple terminals operating simultaneously on one of Avanti's steerable beams – all delivering in excess of 100 Mbps per terminal.

Donald Walker, Director of Government Sales at Avanti Communications, said, "*Avanti's high throughput satellites deliver high levels of capacity making them ideally suited to maximise the benefit of small terminals. Utilising Ultra's ULV-45, MicroVSat and Fa100 terminals, users can achieve connectivity levels far in excess of that available on conventional satellite networks. We're delighted that together we can deliver the capacity and reliability that early entry forces and first responders need.*"

NORTHROP GRUMMAN DEVELOPING C5ISR + CONTROL SYSTEMS FOR USCG OFFSHORE PATROL CUTTERS

***Northrop Grumman Corporation* (NYSE: NOC) was recently awarded a newly expanded role as systems integrator for C5ISR and control systems on the U.S. Coast Guard Offshore Patrol Cutter (OPC) by *Eastern Shipbuilding Group* (ESG), the prime contractor for the OPC program.**

In a newly expanded role as C5ISR systems integrator, Northrop Grumman is responsible for integrating all cyber hardened C5ISR systems, including command and control, communications, navigation and the shipboard computer networking systems.

Northrop Grumman's responsibilities for the OPC platform include the integrated bridge, navigation, command and control, computing network, data distribution, machinery control, and propulsion control systems, cyber/information assurance, testing and integration work.

"*With C5ISR and control system test and integration underway, the ESG-Northrop Grumman team hasn't missed a beat,*" said ***Todd Leavitt,*** vice president, maritime systems and integration, Northrop Grumman. "*The effort and resiliency shown by our teammates at Eastern Shipbuilding Group has been outstanding.*"

INNOFLIGHT'S CFC-400X SELECTED BY L3HARRIS FOR THE SDA'S TRACKING LAYER PROGRAM

Innoflight has been awarded multiple contracts from L3Harris Technologies (NYSE: LHX) for the delivery of key avionics for four satellites produced by L3Harris Technologies under the Space Development Agency's (SDA) Tracking Layer Tranche 0, consisting of eight space vehicles in total.

This program will be the first generation of SDA's Tracking Layer, an important step towards the development of a National Defense Space Architecture. The Tracking Layer satellites will provide global indications, warning, tracking, and targeting of advanced missile threats, including hypersonic missile systems.

This capability encompasses space-based sensing, as well as algorithms, novel processing schemes, data fusion across sensors and orbital regimes, and tactical data products able to be delivered to the appropriate user.

"*Innoflight's high performance and low Size, Weight, and Power (SWaP) CFC-400X hardware platform was a perfect fit for L3Harris' system architecture for SDA Tracking Layer*," said **Anthony Wade**, L3Harris Technologies' SDA Tracking Layer Program Manager. "*The versatility and flexibility of Innoflight's CFC-400X allowed L3Harris to utilize the CFC-400X for three different functions in our space vehicle design with the same hardware configuration.*"

Under its contracts with L3Harris Technologies, Innoflight will be delivering a total of 24, CFC-400X. Each space vehicle will be equipped with thee CFC-400X covering the black side processing, red side processing and *Battle Management, Command, Control, and Communications* (*BMC3*) processing functions.

The CFC-400X uses qualified parts and on-board mitigation methods to provide a reliable space-processing platform for small spacecraft in all orbits. It is equipped with a variety of Input Output (IO) interfaces, including Ethernet and SpaceWire interfaces.

"*Innoflight is pleased to welcome L3Harris as a new customer*," said **Vincent Gagnon**, Innoflight Vice President, Business Development & Contracts. "*Innoflight's collaboration with 3 out of the 4 SDA Transport and Tracking Layers Tranche 0 prime contractors is a confirmation that our technology, across our 3 product lines, is well aligned with the SDA National Defense Space Architecture objectives for Tranche 0 and beyond.*"

JOINING THE U.S. ARMY'S ABCT SOTM PILOT PROGRAM IS KYMETA

Kymeta **has been selected to participate in the U.S. Army's Armored Brigade Combat Team (ABCT) Satellite Communications-On-The-Move (SOTM) pilot program — this program will assess communications solutions on select vehicles to enhance battlefield network and command post communications.**

The ABCT pilot program will be led by ***General Dynamics Mission Systems*** and Kymeta will supply eight ***u8 terminals*** for integration and testing on a variety of ABCT vehicles. According to Kymeta, the company is the world's first and only metamaterial-based SOTM terminal and its electronically steered flat panel antenna platform uses satellite and cellular connectivity for SOTM and on the Communications-On-The-Pause (COTP).

Today, the u8 terminal is the only electronically steered antenna available and capable of supporting both LEO and GEO satellite constellations. The u8 includes future-proof capabilities with the ability to automatically switch back and forth from GEO satellite constellations with linear polarization and LEO constellations with circular polarization.

Kymeta's advanced SOTM terminals automatically acquire and track satellites, join associated networks and establish communications without moving parts or operator intervention. In addition, the u8 supports multiple modems and network architectures, ensuring that legacy systems are interoperable and that they have the highest levels of security, encryption, and authentication.

"*Kymeta's advanced technology has become an operational asset in many Special Operations units. We are honored to support the U.S. Army in its efforts to modernize ABCT communications*," said ***Rob Weitendorf***, Vice President, Business Development, Kymeta. "*On-the-move tactical connectivity is essential for combat teams during mission-critical operations, and we are proud to support PEO C3T and PM Tactical Network in its efforts to improve communications in the armored brigades*."

XENESIS ACQUIRES MINORITY INTEREST IN ASSURED SPACE ACCESS TECHNOLOGIES

Xenesis, Inc. **has taken an additional step toward vertical integration in space tech by acquiring a minority interest in *Assured Space Access Technologies* (ASAT).**

ASAT is led by ***Sean McDaniel***, also CEO and co-founder of ***Atlas Space Operations*** (ATLAS). This move is the result of a mutual vision for advanced space communication technology shared between McDaniel and ***Mark LaPenna***, the CEO of Xenesis. While each company focuses their operations in different areas and applications for satellite and space technology, the union will allow for certain synergies to be developed across the teams, as well as lead to better alignment on government and military solutions.

McDaniel spun off ATLAS Space Operations from Assured Space in 2015. Recently, Assured Space was awarded a Phase I SBIR through ***AFWERX*** to commercialize their dual purpose RF Lens based antenna technology, while adding value to ***US Space Force*** SATCOM and Space Domain Awareness missions. This announcement comes on the heels of another recent acquisition by the Xenesis team of a minority equity position in ***Space Micro Inc.*** (SMI).

"*We are excited about our equity share in Assured and look forward to further co-development of intellectual property for Air Force as well as Space Force and other Xenesis customers that can benefit from the same cutting-edge IP*," said *LaPenna*.

"*Mark and I have a shared vision for advancing the art of the possible in satellite communications technologies since we met in 2016. ASAT's 20 year history working on advanced US Government satellite programs coupled with our recently acquired RF Lens and Compressed Sensing technology brings interesting possibilities to the satellite communications stage for RF and optical*," said *McDaniel*.

ENHANCED, MILITARY-GRADE ENCRYPTION TO BE INTEGRATED INTO VIASAT'S FIRST-EVER, LINK 16-CAPABLE, SMALLSAT

Viasat Inc. (NASDAQ: VSAT) will integrate their In-line Network Encryptor (INE) into the world's first Link 16-capable LEO satellite, which the company is developing for the U.S. Air Force Research Laboratory Space Vehicles XVI program. Viasat's KG-250XS HAIPE Encryptor, the firm's lowest SWaP, rugged, HAIPE.

Viasat's INE will be the first crypto deployment on a Link 16-capable LEO satellite, and will provide communications security (COMSEC) and additional enhanced cybersecurity capabilities initially associated with mission data transfer, with future evolutions expected to simultaneously secure user data; telemetry, tracking and command (TT&C) management; and inter-satellite communications—at multiple security levels.

Viasat's INE, which was designed for a very low Size, Weight and Power (SWaP) constrained system, is expected to provide radiation-tolerant network encryption aligned with the LEO space environment and will be capable of supporting speeds exceeding 100 Megabits per second (Mbps) aggregate throughput, which makes it an outstanding encryptor to secure Link 16-to-LEO communications. The INE will also be able to secure the data flow between an unclassified spacecraft bus and the classified processing domain.

Over the past two decades, Viasat's information assurance business has achieved a number of industry milestones. The Company's PSIAM-based rugged, compact Type-1 cryptographic product portfolio already includes a ground-based satellite TT&C crypto (the KS-252) — which is currently deployed in the U.S. Air Force's satellite communications ground station architectures. This crypto is the foundation for providing the same innovative, multi-functional, programmable value proposition to the space segment.

"*In addition to building and testing the first-ever Link 16-capable LEO satellite prototype, Viasat is also focused on delivering the first high assurance, fully-programmable crypto deployed in space*," said **Craig Miller**, president, Government Systems, Viasat. "*Our focus is on revolutionizing space-based cryptographic and cybersecurity solutions by moving away from embedded, fixed single-application ASICs and moving to 'plug and play,' fully-programmable, multi-functional and highly-efficient military-grade cryptos that can be rapidly deployed by supporting commercial off the shelf technology enhancements for small satellites.*"

Learn more about Viasat's network encryption devices at this direct link.

SPACE REPORT REVEALS FIVE YEARS OF GROWTH FOR THE GLOBAL SPACE ECONOMY

Commercial space grew 6.6% in 2020, representing nearly 80% of space economy — the US, China and ESA remain the top three investors in global space economy— US military space spending increased 6.1% in 2020, reaching new height of $26.6 billion.

Space Foundation, a nonprofit advocate organization founded in 1983 for the global space ecosystem, has just released "***The Space Report 2021 Q2***," which examines global space economy growth and trends in 2020, the continuing growth of commercial space activity, notable shifts in the global space economy, and U.S. military space spending in 2020.

"The Space Report 2021 Q2" found that in 2020 the global space economy rose to $447 billion, an increase of 4.4% from a revised 2019 total of $428 billion. This $447 billion space economy is 55% higher than a decade ago and part of a five-year trend of uninterrupted growth.

Commercial space activity grew 6.6% to nearly $357 billion in 2020, still representing close to 80% of the total space economy. Global government space spending fell 1.2% in 2020 to $90.2 billion from a revised 2019 peak of $91.4 billion. Nearly 58% of this total was allocated to space activities by the U.S.

Reflecting on the newly released data, Space Foundation CEO, ***Tom Zelibor***, said, "*The global space ecosystem is an emerging force for continued growth and expanded opportunity worldwide. The Space Report's Q2 findings verify that the global space economy not only weathered but actually emerged stronger from the worldwide pandemic that spanned three quarters of the year. It also validates the strength and resilience of the space ecosystem and illustrates why it's well positioned for growing investment, market development, and employment opportunities across multiple sectors.*"

Globally, the top three investors in the global space economy remained the same in 2020: the United States, China and the European Space Agency. Collectively, these three entities constituted more than 81% of government space spending in 2020.

This year's analysis also revealed notable shifts in the global space economy. Japan's 3% space budget increase in 2020 played opposite Russia's 37% reduction to make Japan the fourth-highest contributor to the global space economy.

France increased its domestic funding by more than 40% in 2020, leapfrogging Germany and India to become the seventh-largest contributor to the global space economy in 2020 after Russia and the European Union. Lastly, Italy's 37% budget reduction shifted its 2019 ranking of 11 down to 12 in 2020, beneath Canada.

"The Space Report 2021 Q2" edition also investigates changing trends in global space spending between 2019 and 2020, revealing surprising spending decreases in traditionally dominant and developing space nations.

The Q2 edition also delves into military space spending in 2020, estimated at $31.4 billion, which constituted the smallest share of global government space spending in a decade — only 35%. Military space spending in the United States, however, increased by 6.1% in 2020, reaching a new height of $26.6 billion and comprising more than 80% of global military space spending for the first time since 2011.

Also included in this informative report are additional insights, such as the trends in global space workforce employment, an analysis of President Biden's FY2022 space budget, a midyear update on 2021 launch activity plus Q2 investment and market analysis.

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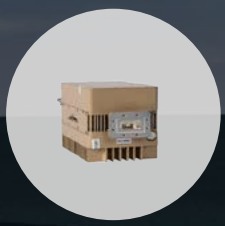
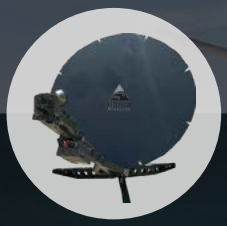


X-Band SSPAs/BUcs
GaN & GaAs configurations



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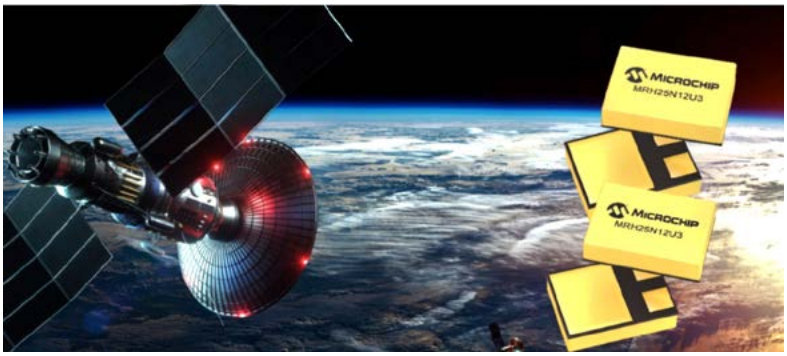
NOW QUALIFIED FOR MILITARY SATELLITES + SPACE POWER SOLUTIONS IS MICROCHIP'S RADIATION-HARDENED MOSFET



Power supplies in space applications operate in environments that require enhanced radiation technology to withstand extreme particle interactions and solar and electromagnetic events. These events degrade space-based systems and disrupt operations.

To meet this requirement, ***Microchip Technology Inc.*** (Nasdaq: MCHP) has qualified their ***M6 MRH25N12U3*** radiation-hardened 250V, 0.21 Ohm Rds(on), metal–oxide–semiconductor field-effect transistor (MOSFET) for commercial aerospace and defense space applications.

Microchip's radiation-hardened M6 MRH25N12U3 MOSFET provides the primary switching element in power conversion circuits including point-of-load converters, DC-DC converters, motor drives and controls and general-purpose switching.

The MOSFET withstands the harsh environments of space, extends reliability of power circuitry and meets all requirements of MIL-PRF19500/746 with enhanced performance.

Microchip completed testing for Defense Logistics Agency (DLA) review and qualification, for the device's sourcing in the U.S. military supply chain (expected JANSR2N7593U3 certification in June 2021).

The M6 MRH25N12U3 MOSFET is designed for future satellite system designs as well as serving as an alternate source in existing systems. The device can withstand total ionizing dose (TID) up to 100 krad and 300 krad and single event effects (SEE) with linear energy transfer (LET) up to 87 MeV/mg/cm2. It provides 100-percent wafer lot radiation hardness assurance in validation tests.

"*Microchip's entry into the radiation-hardened MOSFET market reflects our long-term commitment to support our customer base and provide aerospace and defense OEMs and integrators with high-performance solutions and continuous supply*," said ***Leon Gross***, vice president of Microchip's Discrete Product Group business unit. "*In addition to our proven quality and reliability, the M6 MRH25N12U3 provides a value pricing option for developers and offers them full application support.*"

The M6 MRH25N12U3 is part of Microchip's broad portfolio of aerospace, defense and space technology that includes field programmable gate arrays (FPGAs), microprocessor integrated circuits (ICs), linear ICs, power devices, discretes and power modules that integrate both SiC and Si power solutions.— Microchip teams with space manufacturers and integrators to secure supply chains for existing and future systems.

IT'S SILVER FOR SPACE DYNAMICS LABORATORY — CELEBRATING 25 YEARS AS A GOVERNMENT RESEARCH CENTER

Twenty five years of becoming a significant part of the Department of Defense's efforts to maintain essential engineering, research, and development capabilities through long-term, strategic relationships with university laboratories across the nation is noteworthy and are celebrated.

This year marks the 25th anniversary of Utah State University's ***Space Dynamics Laboratory*** formally becoming a significant part of the Department of Defense's efforts to maintain essential engineering, research, and development capabilities through long-term, strategic relationships with university laboratories across the nation.

In May 1996, SDL and five other university research centers were designated as *DOD University Affiliated Research Centers,* or *UARCs*, established to operate in the public interest rather than in the interest of corporate shareholders. UARCs have become crucial partners in the development of advanced defense technology, while sustaining critical national engineering and scientific expertise.

As a UARC and a nonprofit organization affiliated with a university, SDL's core competencies span a variety of technical areas. SDL has benefitted from a long-term strategic relationship, for over 25 years, with the Missile Defense Agency, who acts as SDL's DOD UARC sponsor. From researching and developing small satellite systems and subsystems to sensor technologies and cyber capabilities, SDL has played a vital role in defending the U.S. and protecting our military service members. As a UARC, SDL rapidly develops and deploys mission-driven capabilities to support an array of DOD user needs.

"*Research institutions such as Utah State University's Space Dynamics Laboratory have long been catalysts for innovative breakthroughs, and the UARC designation enables the DOD and other government organizations to advance a variety of game-changing technologies within the defense and space industry*," said ***H. Scott Hinton***, president of SDL. "*For example, SDL developed the sensor for the Midcourse Space Experiment that resulted in the first-ever demonstration of a space-based sensor for ballistic missile defense mid-course surveillance, tracking, and discrimination. Today, SDL is an integrated member of the MDA team leading the Hypersonic and Ballistic Tracking Space Sensor program, where SDL provides decades of experience and expertise in space-based infrared sensing phenomenology and sensor systems design, test, and calibration.*"

Each UARC provides core capabilities to the DOD Research and Engineering community—including the Office of the Secretary of Defense, Army, Navy, Marines, Air Force, Space Force, Defense Agencies and Combatant Commands. UARCs receive funding from multiple government organizations, by virtue of their strategic relationship with the DOD. The Government leverages UARC expertise in their core competency areas to quickly develop government-owned solutions for problems of national security importance.

SDL and other UARCs serve as trusted government agents, providing objective, unbiased expertise. UARCs develop and maintain capabilities designated as essential, while preserving independence from for-profit stakeholders and freedom from conflicts of interest.

SDL has been solving the technical challenges faced by the military, science community, and industry for over six decades and supports NASA's mission to drive advances in science, technology, aeronautics, and space exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth. As one of 14 DOD UARCs, SDL serves as a subject matter expert in its core research areas to the U.S. Government, ensuring that essential engineering and technology capabilities are maintained. SDL is a research laboratory headquartered in North Logan, Utah, and has offices in Albuquerque, New Mexico; Bedford, Massachusetts; Colorado Springs, Colorado; Dayton, Ohio; Huntsville, Alabama; Houston, Texas; Los Angeles, California; Stafford, Virginia; and Washington, DC.

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ACQUISITIONS @ THE SPEED OF SPACE

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SSC Standup will continue to streamline, expedite space systems acquisition process, officials state

Author: USSF's Space and Missile Systems Center

The coming transition of the Space and Missile Systems Center (SMC) to the U.S. Space Force's (USSF) soon-to-activate Space Systems Command (SSC) Field Command will further enhance SMC's ability to conduct space acquisition more efficiently, more economically and at operationally relevant speed, SMC officials said.

UNITED STATES
SPACE FORCE

At SMC, "*acquisition*" includes everything from developing and buying satellites and launch services, to the computer software that controls the satellites and processes the data. It's a complex process. Designing a satellite that can survive the stress and vibrations from launch and perform very specific functions under the harsh conditions of space can take years, with hundreds of pages of detailed specifications and multiple reviews by different agencies before the contract is even put out to bid.

"*Our primary goal is to get the best deal for the taxpayers' dollar and to make sure we're meeting the requirements in the most cost-effective manner possible, within the time frame and the schedules that we need,*" said **JOY M. WHITE** *(photo, right)*, executive director of SMC.

"*That's been the criticism in the past — the length of time it has taken to develop these capabilities, or that the costs have been too much,*" White said. "*We were building unique, very difficult-to-deliver technologies so the timelines reflected that and were often long. If you look at our satellites for protective communications — these satellites could operate through a nuclear catastrophe to provide comms services for the President of the United States. These satellites are the size of a small high school gym! They are big and they require time and cost. Do they pay off in the capabilities they deliver? They sure do!*"

Companies vying for a government contract to build these systems also must follow detailed ***U.S. Department of Defense*** rules and regulations designed to ensure that businesses are competing on a level playing field, White explained. A *U.S. Government Accountability Office* report from December of 2015, "*DOD Should Streamline Its Decision-Making Process for Weapon Systems to Reduce Inefficiencies*," found that in some cases, the DoD's review process could include as many as 56 organizations at eight levels, and some acquisition programs spent more than two years completing numerous information requirements.

It's that kind of red tape that SMC has been working to reduce, first with a 2019 reorganization for greater efficiency, and continuing this summer with the coming stand up of SSC.

"*If you read the federal acquisition regulations — the DoD 5000 — risk aversion is just built into those policies,*" White said. "*Trying to ferret out where risk aversion is versus common-sense good program management is key — not living and dying by the regulations, but by understanding what needs to get done and then applying accordingly,*" and continued, "*We're removing the layers of bureaucracy so the focus is more on understanding the requirement and the acquisition rather than making sure it fits within all the existing policies. We all need to be closer to the program execution, and I think SSC will achieve that.*"

"*SMC 2.0 was the first major step to flatten the organization and put decision-makers closer to the programs to improve decision speed and more rapidly develop capacity,*" said Colonel **DAVID LEARNED** *(photo, right)*, acting director of SMC's ***Portfolio Architect.***

Under the reorganization, SMC shifted from program offices dedicated to specific programs to a horizontal structure organized around the lifecycle: ***Development Corps*** for innovation and prototyping; ***Production Corps*** for producing the hardware and delivering systems; ***Enterprise Corps*** for launch services, cross-mission ground and communications; and ***Atlas Corps*** for contracting and financial management as well as manpower and personnel and talent management.

"*SMC 2.0 laid a foundation for capability development that is directly informing the U.S. Space Force acquisition processes and decisions by focusing on prototyping that supports development, leverages past lessons to improve future program management, and identifies solutions from novel sources,*" *Learned* said.

The changes have produced quantifiable results, Colonel Learned shared. SMC has seen a more than 60 percent reduction in the time required to make major program milestone decisions. The *SBIRS GEO 5* and *6* satellites are running ten percent below the ***Acquisition Program Baseline*** cost objective and the ***Next Gen Overhead Persistent Infrared*** (*OPIR*) program has met every milestone and is scheduled to launch the first satellite in Fiscal Year 2025, only seven years from the development of the concept.

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The ***Protected Tactical SATCOM*** (*PTS*) program is expected to deliver capability three years sooner than a traditional DoD Series 5000 program, due to streamlined *Middle Tier Acquisition Authorities*. Using block buy economies of scale, SMC also reduced the costs of the final two ***Advanced Extremely High Frequency*** (*AEHF 5 and 6*) satellites by 53 percent, bringing them back into alignment with initial cost projections, *Learned* added.

SMC officials said they expect to see cost savings and efficiencies continue under the newest ***USSF Field Command*** construct.

"*Under the U.S. Air Force, acquisition efforts had to focus on both Air and Space capabilities, complicating decisions and creating challenges to determine the best allocation of resources across two domains*," said Brigadier General **D. JASON COTHERN** (*photo, left*), SMC vice commander. "*As Space Systems Command, operating under the U.S. Space Force, we will have a singular focus on the development of space capabilities.*"

In addition, the transition to SSC will further align missions and organizations and will push authorities down from the three-star level to lower echelons to reduce cost as well as shorten the amount of time it takes to make decisions, Learned noted.

With innovation comes risk, but SSC is being designed so that it can try new approaches and prototypes without jeopardizing mission success, said Lieutenant Colonel **JUSTIN OVERMYER** (*photo, right*), a member of the ***Space Systems Command*** planning team at SMC.

"*We'll have the full capability delivery chain covered within Space Systems Command — either directly aligned under the SSC Commander, or supporting the organizations that are doing the early leading-edge science and technology, such as AFRL Space Labs, the Space Development Agency and Space Rapid Capabilities Office*," *Overmyer* said. "*It's going to provide a solid bedrock for the USSF's capability acquisition organization.*"

Another big change will be bringing the two space launch deltas into Space Systems Command, "*which allows us to better manage the full end-to-end launch capability in terms of both acquisition and the operations*," *Overmyer* said.

"*Bringing Space Launch Delta 45 at Patrick Space Force Base and the Space Launch Delta 30 at Vandenberg Space Force Base under Space Systems Command just makes sense*," said Brigadier General **STEPHEN G. PURDY**, Jr. (*photo, left*), Commander, Space Launch Delta 45 and Director, Eastern Range, Patrick Space Force Base, Florida.

"*We're going to have the entire launch lifecycle — including Launch Enterprise —under the deputy commander of SSC, so we can maximize all aspects of launch and continue to deliver the gold standard in space launch, from the initial requirements to the final delivery of the payload to the constant improvement of the range capability and throughput.*"

The new command also will be focused on enterprise-based solutions that will incorporate a mix of U.S. government, allied and commercial capabilities.

"*Historically, we've built point space solutions for very specific military requirements and then we've augmented those dedicated DoD-built systems with commercial capability when we need them — for example — commercial SATCOM service leasing during Operation Iraqi Freedom and Operation Enduring Freedom*," said

Lieutenant Colonel **TIMOTHY TRIMAILO** *(photo, right)*, program manager/materiel leader for SMC's ***Blackjack/ CASINO*** program. "*For some missions, it might make more sense to take a 'commercial first' approach. We should 'adopt' and 'buy' commercial services and capabilities and apply them directly to warfighter needs.*"

Events such as ***Space Pitch Days*** — in which companies who haven't previously worked with the military get help pitching their ideas to the USSF — and entities such as the ***Space Enterprise Consortium*** (*SpEC*), as well as new DoD acquisition regulations like *Other Transaction Authorities* (*OTAs*), are creating greater flexibility in the way space systems are acquired and also bringing in new, non-traditional business partners.

"*SMC's streamlined acquisition process is opening doors for organizations across the Department of Defense to accomplish the mission faster*," said Major **KATHLEEN BISCOTTI**, mission partner Program Manager for the ***Defense Intelligence Agency***. "*The Defense Intelligence Agency's Science and Technology Directorate was able to establish a support agreement with SMC in record time. Last summer, they awarded a project through SMC's Space Enterprise Consortium. Enabled by the Other Transaction paradigm, the small business vendor successfully achieved prototype performance objectives 60% faster than planned, saving over three million dollars and two years of the program's critical path schedule.*

"*Streamlined acquisition through SpEC is a game changer. It allowed our team to invite industry partners into our problem set and tailor their unique capabilities to craft a solution. The industry-government team focused on producing immediate technical capability through prototyping while reducing risk for future developments. The result: mission objectives accomplished easier, faster, and cheaper- ultimately, providing new defense capabilities for our nation, years ahead of schedule.*"

While it looks for new and innovative technology, SMC also has uncovered some civilian uses for legacy systems. For example, SMC was able to help California firefighters by using its missile warning capability to detect hot spots in wildfire areas and get that information to firefighters within 15 minutes, instead of up to two days, when using aircraft.

"*You'll hear criticism in Congress about the funding of legacy programs and they've wanted us to pivot — we're pivoting with caution*," White said. "*We recognize that we have a whole architecture we need to build out and some of that architecture is going to rely on legacy systems at least in the near term, because we can't make rash decisions and risk leaving our warfighters in the lurch. When we're talking about capabilities, it's not just space for space itself – it's for the Navy, it's for the Marines, the Army troops out in the field… they all need space. We avoid mission failure for them.*"

"*It's in our national interest not only to make sure that we're delivering capability affordably, but that we're delivering it reliably and at what the Chief of Space Operations (Gen. John W. "Jay" Raymond) calls 'operationally relevant speed,'*" *Overmyer* said. "*When the operators need it, it needs to be there for warfighters to use. China and Russia are not going to slow down, they're not going to wait for us to get our capabilities up into orbit*," *Overmyer* said. "*They're going to take action when it suits them, regardless of whether we're ready or not, and that means we need to be ready.*"

"*Our nation is crossing through a pivotal moment in history. We are seeing incredible growth in the space industrial base and a rapidly evolving space domain*," said Lieutenant General **JOHN F. THOMPSON**, SMC Commander. "*Our adversaries are iterating and evolving every day and it is SSC's responsibility to continue to deliver resilient space capabilities at the speed of relevance for the nation, our warfighters, and allies. SSC is specifically designed to do just that and I am excited to watch our teams and partners succeed.*"

The U.S. Space Force's Space and Missile Systems Center, located at Los Angeles Air Force Base in El Segundo, California, is the center of excellence for acquiring and developing military space systems. SMC's portfolio includes space launch, global positioning systems, military satellite communications, a defense meteorological satellite control network, range systems, space-based infrared systems, and space domain awareness capabilities.

*Contact Space & Missile Systems Center at **SMC@Spaceforce.mil** and follow on **LinkedIn**.*

ARQIT'S FEDERATED QUANTUM SYSTEM NOW INCLUDES INTERNATIONAL PARTNERS AND GOVERNMENT AGENCIES

Arqit Limited **("Arqit") has formed an international consortium of companies and government organizations to provide its quantum encryption technology to government customers in a federated system concept called Federated Quantum System (FQS). The UK, USA, Japan, Canada, Italy, Belgium, and Austria are now represented.**

Arqit has invented a unique quantum encryption technology that makes the communications links of any networked device secure against current and future forms of hacking — even an attack from a quantum computer. Arqit's product, called ***QuantumCloud***™, creates unbreakable software encryption keys, using satellite to deliver quantum information to data centers. These keys are delivered using a new patented protocol called ARQ19, which solves the "*Global versus Trustless*" problem that previously prevented the adoption of *Satellite Quantum Key Distribution* (*QKD*). Arqit further invented QuantumCloud™ to translate the benefits of this quantum key distribution to any form of endpoint or cloud machine without the need for any special hardware. The first version of QuantumCloud™ will launch for live service to commercial customers in 2021.

Government customers typically have more stringent requirements for control and are more inclined to buy "*Private Instances*" of cloud technology rather than managed services. Arqit has, therefore, designed a different version of its technology to meet this need and has recruited a strong community of partners from allied countries to collaborate in bringing the FQS system to use.

Collaboration partners include *BT*, *Sumitomo Corporation*, *Northrop Grumman*, *Leonardo*, *QinetiQ Space N.V.*, *qtlabs* and *Honeywell*. Additional western Allied countries are expected to announce their inclusion during 2021.

FQS has been developed with support from the ***UK Space Agency*** (UKSA through its ***National Space Innovation Program***. The system consists of dedicated satellites, control systems and QuantumCloud™ software. It will be provided to the UK's '*Five Eyes*' allied governments and other international partners, allowing sovereign protection of strategic national assets and interoperability for joint operations.

The first FQS satellites are to be integrated and tested at the *National Satellite Test Facility* in Harwell near Oxford and are expected to be launched on ***Virgin Orbit***'s ***LauncherOne*** from Newquay in Cornwall in 2023, after the launch of the first commercial Arqit satellites. The role of Virgin Orbit in providing responsive launch services for government customers from any location is additive to the plan to deploy many FQS satellites to support the needs of a growing list of allied country partners.

Arqit's Chairman and Chief Executive Officer, **David Williams,** said, "*FQS enables collaboration between NATO-allied governments around the world to form a federated version of QuantumCloud™ infrastructure. It also enables the Joint All Domain Command and Control vision to come to life. The FQS system is global in its nature, and there is now strong momentum in an international consortium joining forces to bring it into use.*"

General Stephen Wilson, Director of Arqit Inc. said, "*For Allies working together Joint All Domain Command and Control (JADC2) is essential. For JADC2 to work, we must have a real identity, credentialing, and access management solution. Arqit's technology makes trusted data security possible.*"

THE CONTRACT TO DEVELOP THE SICRAL 3 DEFENSE SATCOM SYSTEM WON BY THALES ALENIA SPACE + TELESPAZIO

Thales Alenia Space and Telespazio have signed a contract with the Italian Ministry of Defense, represented by TELEDIFE / Secretariat General of Defense, for the development of the SICRAL 3 secure satellite communications system, including its ground segment. Covering the development of phases B and C[1], the contract is worth a total of approximately €159 million, as result of an articulated and complete negotiation process.

SICRAL is Italy's satellite system for military communications, boasting unprecedented flexibility and versatility. Image is courtesy of Telespazio.

The *SICRAL* (Italian System for Secure Communications and Alerts) program deploys geostationary satellites for confidential strategic and tactical communications, to support defense missions both in Italy and abroad. The new SICRAL 3 system is designed to meet Italian defense communications and interoperability requirements.

It will ensure continuity with the current SHF and UHF-band telecom services provided by the *SICRAL 1A*, *1B* and ***SICRAL 2*** satellites, while expanding its suite of services by providing a Ka-band payload, as well as supporting security, public rescue and civil protection services.

SICRAL 3 will also capitalize on the ongoing developments within the ***ItalGovSatCom (I-GSC) program***, a pillar of the evolving "Space Economy" and the Programs of Military Research and will help expand NATO's current satellite capabilities.

To develop the SICRAL 3 program, Thales Alenia Space and Telespazio, via their ***SpaceAlliance***, have created a temporary consortium led by Thales Alenia Space, with Telespazio also playing a major role.

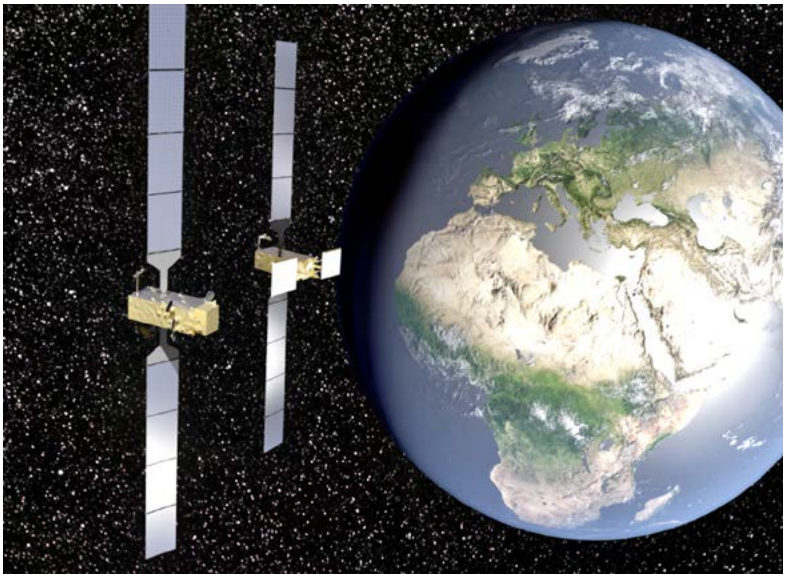
Thales Alenia Space will be responsible for the entire SICRAL 3 telecommunications system, the space segment (including system design and integration), and the design, production and integration of the innovative UHF, SHF and Ka-band payloads. The space segment includes two geostationary satellites, SICRAL 3A and SICRAL 3B. The platform, which features electric propulsion, is based on a modular and autonomous orbital transfer design using GNSS/GPS sensors and receivers for satellite positioning and attitude. Leonardo will supply the star sensors that enable SICRAL 3 to maintain the correct attitude in orbit through sophisticated algorithms.

Telespazio will manage the development of the highly innovative ground segment, drawing on synergies with previous SICRAL developments for the Vigna di Valle Control Center and the Fucino Space Center. The company will be in charge of the satellites' launch and early orbit phase (LEOP) and in-orbit tests (IOT).

Thales Alenia Space and Telespazio have already supplied to the Italian Ministry of Defense two first-generation SICRAL satellites (no longer in operation) and the second-generation SICRAL 2 satellite. Telespazio, having co-financed the SICRAL 1B and SICRAL 2 missions, has consolidated its role as a defense satellite operator.

Holding a share of these satellites' transmission capacity, the company offers telecommunications services to the armed forces of NATO member countries. The Space Alliance also contributed to the development and launch of the Athena-Fidus satellite for military and dual (civil-military) telecommunications for France and Italy and two SATCOM ***BW*** satellites for Germany. Thanks to Athena-Fidus and SICRAL 2, Thales Alenia Space and Telespazio form the cornerstone of European collaboration in defense.

"*The SICRAL 3 contract marks a major step forward for Thales Alenia Space and the entire space industry in terms of our ability to propose design solutions and technologies, not only for the Italian government but also for allied nations and international organizations such as NATO*," said ***Massimo Claudio Comparini***, Deputy CEO and SEVP Exploration, Observation and Navigation at Thales Alenia Space. "*This contract reflects the fruitful long-standing collaboration between our company and the Defense Administration.*



Artistic rendition of SICRAL satellites on-orbit.

"Thanks to the experience gained in conducting national programs such as SICRAL and COSMO-SkyMed, as well as expertise in both ground and space systems, the Italian space industry retains full autonomous capacity in the development and delivery of end-to-end solutions for large-scale integrated systems."

"*SICRAL missions have represented excellence in the implementation and management of complex space programs for over 20 years*," said ***Luigi Pasquali***, Telespazio's CEO. "The Space Alliance between Leonardo and Thales, through its companies Telespazio and Thales Alenia Space, works closely with the Italian Ministry of Defense to provide modern and effective satellite communications services for our country and NATO. By ensuring the continuity of the SICRAL program and expanding its services, especially through an added Ka band, our defense forces will have the operational capacity needed to further strengthen the country's international role."

Giuseppe Abbamonte, Admiral Chief Inspector of TELEDIFE (IT, Telematics and Advanced Technologies Directorate of the Ministry of Defense) added, "*Within the past three and a half years, as a Director of TELEDIFE, we have launched major space programs. Today, these efforts have culminated in the signature of the contract for the development of the future military SATCOM satellite constellation. Today's signature once again proves not only the enormous importance of space for defense, but also the very high level achieved by Italian industry, represented today by two of the most important companies operating in this sector, Thales Alenia Space and Telespazio. Italian industry not only produces systems capable of meeting the complex requirements imposed by national military needs, but is also asserting itself in a highly competitive international context.*"

[1] *Phase B is the detailed development of the project, while phase C is the production of the hardware up to the Engineering Qualification Models, with the related qualifications, up to the Critical Design Review.*

A FIRST FOR RUAG SPACE

RUAG Space has been awarded a satellite power subsystem program by the U.S. Air Force Research Laboratory (AFRL).

For AFRL, RUAG Space will develop a configurable Rapid Electronic Power Subsystem (Rapid EPS) for satellites that will dramatically cut the lead time and cost of the power subsystem.

This project leverages aspects of RUAG Space's overall Rapid EPS development and supports RUAG Space's ability to supply Rapid EPS to the U.S. Government/ DoD markets.

"*This project is a decisive door opener for further projects with the U.S. Government*," said ***André Wall,*** CEO RUAG International.

AFRL controls the entire United States Air Force Science and Technology ecosystem and budget and it leads the discovery, development and delivery of warfighting technologies for US air, space and cyberspace forces.

Electronic Power Subsystems are highly critical for the operation of satellites and AFRL expects the Rapid EPS concept to deliver a "*radical improvement compared to existing technological approaches*," said Dr. ***Robert Walters***, lead of the AFRL Advanced Space Power program.

"*This project is a great example for a collaboration across different product units and countries,*" said ***Luis De León Chardel***, Executive Vice President a.i. at RUAG Space. "With this technology development program, we are ultimately targeting a new *EPS subsystem offering. Moving up in the value chain by strengthening RUAG Space's subsystem portfolio offering is a key pillar of our strategy*."

Program management will be led by ***Kellenie Lopez***, Senior Project Manager based in Denver, under ***Mike Allen***, Director of Electronic Systems. The program will be supported from both Product Unit Mechanism in Zurich headed by ***Oliver Kunz***, with John Ransdell serving as Project Manager, and Product Unit Interface Electronics in Tampere, Finland, lead by ***Timo Hänninen***, with ***Juha Kuitunen*** as Project Manager.

Additionally, staff in Denver and Titusville, Florida, will provide engineering design and satellite manufacturing capability.

The Rapid EPS will be designed to enable rapid configuration and rapid delivery of systems in various sizes and, furthermore, at a cost point that makes reconstitution and upgrades for satellites in LEO an attractive proposition in comparison to the current systems that are typically highly optimized and the result of long, nonrecurring engineering-intensive projects.

In addition to studies, the hardware deliverables consist of a Solar Array Regulator demonstrator and a Solar Array Wing demonstrator. Both products will be assembled and tested in Titusville, Florida.

According to ***Mathias Burkhalter***, Team Leader of Systems Engineering at Product Unit Mechanism, "*The study will help RUAG to ascertain the exact degree of modularity achievable with the currently developed modular components for the Solar Array Wing and show the gaps for the future modular roadmap*."

The *photovoltaic array* (*PVA*) will be sourced by the Titusville facility from RUAG's consortium partner, ***SolAero Technologies, Inc***., in Albuquerque, New Mexico.

Finally, know-how and skills will be built up in the Titusville facility for future manufacturing of the needed solar array panels and *assembly, integration and testing* (***AIT***) of the complete *Solar Array Wing* (*SAW*) for US customers.

For each piece of this project, RUAG leverages innovations from previous research and development. ***Harri Myllymäki***, Lead Engineer at Product Unit Interface Electronics, explained the degree of innovation and said, "*For the Solar Array Regulator, this project overcomes limitations of previous developments for other missions by introducing a new level of configurability and flexibility in the design – yielding an ability to adapt to changing spacecraft requirements with reduced non-recurring costs and lead times*."

One of the ways this is achieved is through the modular design. The other is through the use of automotive grade *Commercial-Off-The-Shelf* (*COTS*) components.

SMALL ROCKET LAUNCH SITE GIVEN THE OKAY BY AUSTRALIA'S QUEENSLAND GOVERNMENT

Locals and tourists in the Whitsunday region of Australia could soon be watching rockets launching into space, with the Queensland government announcing their support for the local space launch industry. The announcement follows a technical and environmental study commissioned on Abbot Point last year, which concluded that the site is suitable for small-scale launch vehicles.

In a statement, Deputy Premier and Minister for State Development, ***Steven Miles***, said, "*Growing our space industry in Queensland will add billions to the economy and create thousands of local jobs. That's why we are committed the development of launch infrastructure. Our easterly facing position, proximity to the equator, and our leading launch and propulsion companies make Queensland the perfect place to invest in space*."

Enter ***Gilmour Space Technologies,*** a venture-funded rocket company on Australia's Gold Coast that is developing lower cost rockets to launch smallsats into LEO starting in 2022. "*Gilmour Space Technologies has expressed an interest in the site (and) we are keen to work with the team at Gilmour and local stakeholders*," said Mr Miles.

Launching on Gilmour's first ***Eris*** rocket next year will be several Australian payloads, including a 'space taxi' by Sydney-based ***Space Machines Company*** and a fire detection satellite by ***Fireball International,*** another Queensland company on the Sunshine Coast.

"*A launch site at Abbot Point in North Queensland would give our customers a range of valuable orbits, inclinations, and altitudes that they will require*," said Gilmour Space co-founder and Head of Launch Operations, ***James Gilmour*** The company is also looking at a proposed launch site in South Australia for complementary polar orbits, in line with their vision to achieve '*All Orbits, All Planets*.'

"*Our next step is to continue to work with key stakeholders to get all the necessary approvals we need to proceed on building and operating an orbital launch facility at Abbot Point*," said Mr Gilmour. "*With sufficient and timely support, I see no reason why we can't be demonstrating key, sovereign space capability next year, launching our first Australian-made rocket, with Australian payloads, from an Australian launch site*."

COUNTRIES RAMP UP CYBERSECURITY STRATEGIES

The latest Global Cybersecurity Index (GCI) from the International Telecommunication Union (ITU) shows a growing commitment around the world to tackle and reduce cybersecurity threats.

Countries are working to improve their cyber safety despite the challenges of COVID-19 and the rapid shift of everyday activities and socio-economic services into the digital sphere, the newly released 2020 index confirms.

According to GCI 2020, around half of countries globally say they have formed a national ***computer incident response team*** (*CIRT*), indicating an 11 percent increase since 2018. Rapid uptake of information and communication technologies (ICTs) during the COVID-19 pandemic has put cybersecurity at the forefront.

"*In these challenging times, the unprecedented reliance on ICTs to drive society, economy and industry, makes it more important than ever before to secure cyberspace and build confidence among users*," affirmed ITU Secretary General ***Houlin Zhao***. "Governments and industry need to work together to make ICTs consistently safe *and trustworthy for all. The Global Cybersecurity Index is a key element, offering a snapshot of the opportunities and gaps that can be addressed to strengthen every country's digital ecosystem*."

Some 64 percent of countries had adopted a *national* ***cybersecurity strategy*** (*NCS*) by year-end, while more than 70 per cent conducted cybersecurity awareness campaigns in 2020, compared to 58 per cent and 66 per cent, respectively, in 2018. Yet despite notable improvements, gaps in cyber capacity persist. Many countries and regions lag in key areas. These include:

Cybersecurity skills training, which must be tailored to the needs of citizens, micro-, small-, and medium-sized enterprises (MSMEs); Finance, healthcare, energy, and other key sectors, which require dedicated measures to close cybersecurity gaps; Critical infrastructure protection, which requires enhancement to meet new and evolving cyber threats; Individual data protection, which requires continual reinforcement as online activity expands.

- *Growing reliance on digital solutions necessitates ever stronger, yet also accessible and user-friendly, data protection measures.*
- *GCI 2020, the index's fourth iteration, measures the cybersecurity commitments of 193 ITU Member States and the State of Palestine [1]. It aims to identify gaps, serve as a roadmap to guide national strategies, inform legal frameworks, build capacity, highlight good practices, strengthen international standards, and foster a culture of cybersecurity.*
- *Amid interconnected commerce and communication, cybersecurity risks are increasingly borderless, with no single entity or stakeholder able to guarantee the security of the global cyber ecosystem.*
- *Countries with high cyber capabilities may therefore need to support others, such as Least Developed Countries (LDCs), Small Island Developing States (SIDS), and Landlocked Developing Countries (LLDCs).*

"*This snapshot of the world's commitment to cybersecurity is just a starting point for further discussions, interventions, and strides towards achieving global, regional and national cyber safety*," noted ***Doreen Bogdan-Martin***, Director of the ITU's Telecommunication Development Bureau. "I *invite all ITU Member States to continue updating us on their progress on cybersecurity-related commitments, so that we can effectively share experiences, research, and solutions to create a trusted cyberspace for all*."

About one billion people worldwide became Internet users for the first time between 2015 (*when the first GCI was released*) and 2019, according to ITU data. With global losses due to cybercrime expected to reach USD 6 trillion this year, according to third-party data, citizens count on governments to enhance cybersecurity norms and protect increasingly exposed personal and financial data.

ITU has produced four GCI editions to date, providing periodic global snapshots of a rapidly evolving industry. With each iteration, the methodology has been adapted to shed more light on countries' cybersecurity commitments.

Each country's level of development or engagement is assessed based on five pillars of the ITU Global Cybersecurity Agenda – legal measures, technical measures, organizational measures, capacity development, and cooperation.

GCI 2020 features data from more countries than any previous edition, with ITU receiving 150 updated questionnaire responses despite the constraints imposed by COVID-19. For the other 44 countries included, data was collected and validated through desk research.

Country commitment was assessed through online surveys for each pillar, which further facilitated the collection of supporting evidence. Survey questions were weighted in consultation with expert groups to reach composite index scores. ITU also undertook independent verification to ensure accurate and reliable results. ***Download the report at this direct link.***

Since the launch of the first edition six years ago, the Global Cybersecurity Index has been continually developed through a multi-stakeholder partnership, incorporating data provided by ITU members and additional contributions and support from a diverse range of countries, institutions and international organizations. Contributors include multi-disciplinary teams from ITU Member States and Sector members, the public and private sectors, industry stakeholders, academia, and interested individuals.

U.S. SPACE FORCE, NATIONAL SPACE COUNCIL AND THE CASE FOR PUBLIC-PRIVATE PARTNERSHIPS

Authors: Vincent Townsend, Associate, and Elizabeth Evans, Partner, K&L Gates

The *United States Space Force* (USSF) was brought into existence, with bipartisan support, on December 20, 2019. When asked at a press briefing in early February about the continuation of the USSF under the Biden Administration, press secretary *Jen Psaki* replied, "*Wow, Space Force. It's the plane of today*."[1]

That flippant comment raised some concern that *Biden* was going to revisit the newly-legislated separation between the U.S. Air Force and U.S. Space Force; however, before the end of the following day, he was quick to confirm that the newest military branch had his full support.

This is welcome news, as the "*guardians*"[2] of space are needed more than ever, with the steadily increasing number of projects (both civil and military) being conducted in space by a number of spacefaring nations. Although the ***Outer Space Treaty of 1967***[3] clearly states that outer space belongs to no nation[4], protection of U.S. interests is required when other nation states are seeking to exploit space.

Current USSF mission areas include keeping abreast of technological developments that could become threats, deriving solutions for Space Situational Awareness (SSA), tracking orbital debris (*an alarming problem for all of the new satellite constellations being in Low Earth Orbit (LEO)*), and managing the imaging and communications satellites required for successful missions.

On March 30, 2021, the Biden Administration also renewed the ***National Space Council***.[5] The purpose of this council (*which was reactivated under the Trump Administration*) is to assist in generating national space policies, strategies and synchronizing America's space activities. The Trump National Space Policy, acknowledged that the U.S. "*seeks a secure, stable and accessible space domain, which has become a warfighting domain as a result of competitors seeking to challenge United States and allied interests in space.*"

To the outsider, the connection between space and military ground operations may not be entirely clear, but one of the authors of this article has first-hand knowledge of the importance of space to the mission. Before becoming a lawyer, **VINCENT TOWNSEND** served in the U.S. Air Force for six years. As a *Joint Terminal Attack Controller* (*JTAC*), he operated in forward locations with Army and Marine combat maneuver units, where he was responsible for requesting and directing *Close Air Support* (*CAS*) against enemy targets in close proximity to friendly forces.

Between 2004-2007, Vincent deployed three times overseas: Kandahar, Afghanistan (25th Infantry Division); Mosul, Iraq (172 Stryker Brigade) and Ramadi, Iraq (3rd Infantry Division). As a JTAC, he operated a broad range of radio and satellite communications (SATCOM) equipment using a combination of voice, analog, data link and streaming video technologies to communicate with ground and air forces and relied on these technologies under austere conditions to accomplish the mission.

Throughout his deployments, Vincent can recall countless times where ***military satellite communications*** (*MILSATCOM*) served as the essential link between ground and air forces, a critical factor in the safety and success of ground operations. During the summer of 2004, Vincent was assigned to the ***Combined Joint Task Force 76 Quick Reaction Force*** (*QRF*) out of *Kandahar Airfield*, which would rapidly deploy to reinforce coalition forces under attack within the Kandahar region.

MILSATCOM served a particularly vital role in Afghanistan, where mountainous geography blocked *Line-Of-Sight* (*LOS*) communications, making satellite communications the only viable lifeline for requesting close air support during firefights.

On the evening of July 26, 2004, Vincent and the rest of the QRF team air engaged to reinforce a *Long Range Reconnaissance and Surveillance* team engaged in a firefight against Taliban forces. The QRF's helicopters took sporadic fire as they descended into a hot ***landing zone*** (*LZ*). Once the birds took off and the dust settled enough to see the area, Vincent joined a team of seven soldiers who ran up a mountainside to establish an observation post where the team could have eyes on the village and where U.S. and Afghan forces remained under attack.

Vincent quickly established communications (*using SATCOM*) with the ***Air Support Operations Center*** and requested close air support. Once aircraft arrived on station, he took charge of rotary wing integration and directed a deconfliction plan for the two *Army OH-58D Kiowas* choppers (*photo below, courtesy of U.S. Army*) on station.

Upon the subsequent arrival of two, ***A-10*** "*warthogs,*", he used an infrared pointer to facilitate target acquisition (*i.e., the Taliban's last known location*). The subsequent deployment of bombs on the designated target resulted in halting any further attacks on U.S. or Afghan forces.

One cannot overstate the vital role that MILSATCOM played in the successful outcome of the QRF's mission that day. Had any of these communications been damaged or obstructed, whether by physical damage to satellites, jamming equipment or cyber threat, the successful deployment of close air support would have been delayed (*or prevented altogether*), placing the lives of U.S. ground forces at significantly, greater risk.

Achieving a high level of security in space is (*now*) to be primarily implemented by the U.S. Space Force. This is why the USSF is no joking matter.

On May 7, 2021, *Acting Secretary of the Air Force*, **JOHN P. ROTH**, Chief of Staff of the Air Force, General **CHARLES BROWN**, Jr., and Chief of Space Operations, General **JOHN "JAY" RAYMOND** presented the funding needs to the *House Appropriations Committee on Defense*. Roth was direct: "*Long term strategic competition with China and Russia demands that we focus on capabilities we need today to win tomorrow. Our Nation's competitive strategic advantage relies on air and space superiority, which is underpinned by rapid technological advancement and the extension of space as a warfighting domain.*"[6]

One potential benefit to having a comprehensive national space strategy promulgated by *National Space Council* is to promote partnerships between private industry and governmental entities, including the U.S. Space Force.

On May 1, Vice President Harris was appointed to head the National Space Council. Early reports indicate that national security in space "*will continue to be a focus for the [National Space] council under Harris, as well as enhancing cybersecurity for US assets in space.*"[7]

In a time when funds are short, *National Space Council* may be able to develop national policy allowing (or requiring) the USSF to partner with (instead of procuring from) the expanding U.S. space industry in order to meet military needs.

NASA has already started to engage in the development of partnerships in respect to civil space operations. NASA selected ***SpaceX*** to land NASA astronauts on the moon.[8] More recently, it was announced that, in order to stimulate a LEO economy, NASA is enabling up to two, short-duration, private astronaut missions per year to the *International Space Station* (*ISS*,) beginning as early as 2022.[9]

These missions will be privately funded, fully commercial spaceflights for the purpose of enabling tourism, outreach and approved commercial and marketing activities on the ISS. Private astronaut mission providers have been invited to submit generic white papers in order to give NASA the opportunity to assess private astronaut mission concepts and provide technical expertise. The benefit of partnering with the private space industry in this fashion is that NASA can learn of the latest, novel technologies, while not denting the governmental budget.

Vice President *Harris* has indicated that she will put her own personal stamp on the *National Space Council*. She intends to promote sustainable commercial space flight and STEM educational programing, "*advancing peaceful norms and responsible behavior in space.*"[10]

We hope she will eventually explore each of these goals by including the many U.S.-based private space companies that are already producing disruptive technologies.

The Trump national space policy stated that "*synchronization*" with other agencies and "*economic strategies*" were expressly part of the national security space policy. To the extent that Harris' *National Space Council* can also encourage private-public partnerships between the USSF and private space technology companies, many goals can be simultaneously achieved.

The USSF can identify those emerging technologies which could be threatening to national security within the space domain. The USSF can work in a synchronized manner with the intelligence agencies to identify threats from other nations in respect of these technologies.

The USSF can also accelerate the development of needed disruptive technologies in a cost effective manner, and develop better instrumentation for the U.S. warfighter.

Finally, the USSF can adopt the most beneficial technologies into its operations to guard the space domain. In this way, the guardians of the U.S. Space Force can model responsible space behavior amongst all spacefaring nations.

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2 On December 18, 2020, Vice President announced that just as members of the Air Force are referred to as "Airmen," the "men and women of the United States Space Force will be known as "guardians."

3 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Mood and Other Celestial Bodies, entered into force October 1967.

4 The Outer Space Treaty states, inter alia, "Outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation or any other means."

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10 ***https://www.space.com/national-space-council-vp-kamala-harris***

www.klgates.com

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CYBERSECURITY IN MILSATCOM

Author: Roly Rigual, Vice President of Sales Engineering, iDirect Government (iDirectGov)

MILSATCOM networks present unique challenges in providing effective defense against adversaries and the multiple attack vectors available to them in a MILSATCOM network.

Similar to other networked environments, applying cybersecurity in a *military satellite communications* (*MILSATCOM*) environment requires a layered security approach. A *Defense-in-Depth* strategy supports *information assurance* (*IA*) in a networked environment that provides availability, integrity, authentication, confidentiality and non-repudiation.

Satellite's large geographic coverage and transmission medium makes it especially susceptible to everything from passive communications monitoring to active attacks on the communications channel and the computer systems that comprise the system. A strong and effective layered IA strategy in a MILSATCOM network can be achieved through the application of security services based on the "*protect, detect and react*" paradigm.

Protect

Protecting MILSATCOM systems from intrusions and disruptions requires an IA architecture that allows for the defense of the MILSATCOM network from multiple points of attack.

These defenses include network infrastructure, enclave boundaries and computing environment, to name a few. Preferably, the technology procured by the *Department of Defense (DOD)* will be validated by trusted, third-party entities and follow developed IA standards.

iDirect Government's ***Evolution Defense*** system serves as a good example of a MILSATCOM system that has been architected to offer protection from multiple attack vectors. In the *Evolution Defense* system solution, iDirectGov incorporates *transmission security* (*TRANSEC*) capabilities. This is important as the link and network layer encryption and traffic flow security need protection against bad actors who stand by to monitor, exploit and intercept communications.

Even a small spike in traffic can be a critical piece of intelligence. Therefore, concerning Defense network infrastructure, the need to mask any communications activity becomes apparent.

Another point of attack in a Defense network centers on enclave boundaries, where an internal network service layer links to an external network's service layer. Obviously, this can be a means for an active network attack method and exploiting new vulnerabilities as attack methods are constantly changing.

Applying security standards to continually monitor for major system vulnerabilities is a critically important part of any organization's tools and procedures.

Frameworks, such as *Security Content Automation Protocol* (*SCAP*), allow administrators to scan SATCOM network computer systems based on a security baseline. Since 1998, the ***Defense Information Systems Agency*** (*DISA*) *Field Security Operations* (*FSO*) has played a critical role in enhancing the DOD's security systems by providing SCAPs. These provide technical guidance to "*lock down*" information systems and software that might otherwise be vulnerable to a malicious computer attack.

iDirectGov's implementation of SCAP standards ensures that the highest level of compliance is met. In addition, it supports several manual configuration changes to meet additional SCAP guidelines, including *Red Hat Linux*-specific recommendations.

On the terminal side of the SATCOM network, maintaining a security baseline is just as critical as the systems in a physically secure teleport. iDirectGov conducts the ***SHIELD*** scans (*U.S. DOD approved Nessus scans*) to evaluate the company's ***9-Series*** remotes for vulnerabilities that hackers could use to access a system or network. The data is then used to design a *Remote Security Bulletin* (*RSB*) that is posted to the company's ***TAC*** website for SHIELD subscribers to load to their remote hardware.

These security update packages for remotes are available approximately twice per year and cover all current 9-Series modems and future variants.

Detect

In addition to implementing protections, organizations need to expect attacks and have the proper tools in place to detect and recover when they occur. In MILSATCOM networks, the ability to detect an attack starts with arguably its most vulnerable aspect — the *radio frequency* (*RF*) link.

Spectrum monitoring tools are a vital part of detecting hostile (or even accidental) interference. Effective tools should perform automatic and operator-directed monitoring to detect interferences and unauthorized users. They should measure carrier and transponder performance, and they should generate an out-of-tolerance alarm.

These tools allow the user to effectively measure and analyze the transponder spectrum. Spectrum monitoring products, such as iDirectGov's ***Model 1000 Series,*** can be used as stand-alone appliances, or as part of a larger spectrum monitoring network with a flexible architecture that allows for plug-and-play operation locally and/or remotely via a standard *local area network* (*LAN*)/ *wide area network* (*WAN*).

Once an attack has been detected, an organization should be prepared to react as quickly as possible while mitigating the impact of the attack. Detection alone is not sufficient in achieving IA. A MILSATCOM Defense-In-Depth architecture will include the ability to locate and mitigate any threats once detected with the maximum amount of flexibility and efficiency.

React

Finally, in addition to putting in place the proper protection and detection technologies and operational procedures, it is critical to have the ability to analyze, correlate and react to threats. To react effectively, technologies need to be implemented that allow "*operations*" staff to answer basic questions such as, "*Who is the source*?" "*Where is the source*?" "*What are my options for mitigation*?"

The ability to locate the interference source in a MILSATCOM network is critical to quickly identifying whether the interference signal is caused by intentional actors, human error or equipment failure. Identifying the geolocation of an interferer will help an operations team and its command to make decisions on which mitigation actions to take.

Fully featured geolocation technology allows operators to view real-time spectra for the detection and characterization of interference with speed and ease. iDirectGov ***Model 8000***, for example, seamlessly transitions from detecting the interference to geolocating the interference with the click of a button. It locates the interference by taking advantage of the weak replica of the signal that an adjacent satellite will receive.

Downlinks for the primary and adjacent satellites are acquired and analyzed to extract precision ***time difference of arrival*** (*TDOA*) and/or ***frequency differences of arrival*** (*FDOA*). These results are gathered, and each method can be used and/or combined to determine the location of the interference.

The key elements of MILSAT communications are the availability and use of the RF spectrum where the introduction of noise or interference — intentional or unintentional — can degrade a MILSATCOM network, rendering it completely unusable. Given that MILSATCOM is a critical communications asset for the military, the stakes can be very high indeed.

Simply detecting or even locating a geographic origin of the interference is not enough. Mitigation strategies that include interference removal and network resiliency and switching should be an integral part of the system architecture.

Interference mitigation is used to remove or avoid any potential network threats. iDirectGov addresses the concern of interference mitigation through signal excision technology, part of the ***Glowlink*** product line iDirectGov uses. ***Communication Signal Interference Removal*** (*CSIR*™) technology and automatic beam/network switching features mitigate threats to MILSATCOM networks.

CSIR eliminates an interfering signal from the authorized ***signal of interest*** (*SOI*). With only the SOI's center frequency, bandwidth and symbol rate information, CSIR will monitor and remove an interfering signal in real time and can remove a variety of unwanted signals, whether they are modulated carriers, unmodulated tones or interference that changes characteristics (such as burst or frequency hopping).

A mature digital signal processing solution, CSIR is designed to excise an interfering signal before it reaches the receiver's demodulator and decoder. Based on the SOI's information noted above, CSIR can monitor and remove an interfering signal with as little as 1dB of power separation from the SOI. Additionally, CSIR has little to no effect on the signal quality of the SOI.

Conclusion

Government and MILSATCOM organizations can connect and communicate with each other far more easily now than was ever before possible. Unfortunately, this ability to connect has made it easier for malicious actors to reach out and disrupt the flow of information and collaboration between users.

A strong and effective layered IA strategy in a MILSATCOM network can be achieved through the application of technologies architected to provide for Defense-in-Depth that includes defending the network infrastructure, the enclave boundaries and the computing environment.

The application of IA standards (*e.g., SCAP, SHIELD*), validated products (*e.g., FIPS-140*) and continual risk assessment will go a long way toward providing a robust protection strategy for MILSATCOM networks.

The capabilities and features embedded in the iDirectGov platform enhance and protect critical communications. The inherent security in iDirectGov's solutions protects and minimizes the attack surface from actors that may, intentionally or unintentionally, interfere with those critical lines of communications.

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iDirect GOVERNMENT

Author Roly Rigual is the Vice President of Sales Engineering at iDirect Government (iDirectGov), a U.S. corporation that is a trusted partner of the U.S. government and has been for more than 18 years. All its employees are U.S. citizens, with a third being U.S. military veterans and more than 60 percent holding U.S. security clearances. Rigual leads iDirectGov's team of federal sales engineers. All Defense-grade products sold by iDirectGov are designed, developed, assembled, programmed and verified within the United States.

*The **National Security Agency** (NSA) outlines vulnerabilities inherent in an IP-based time division multiple access (TDMA) transmission that must be addressed to provide true TRANSEC.*

These include:

***Channel Activity** —The ability to secure transmission energy to conceal traffic volumes and acquisition activity.*

***Control Channel Information** — Disguise traffic volumes to secure traffic source and destination. Federal Information Processing Standards (FIPS) 140-2 certified 256-bit keyed Advanced Encryption Standard (AES) encryption should be used for all Layer 2 and control information.*

***Hub and Remote Unit Validation** — Ensure remote terminals connected to the network are authorized users. Use X.509 digital certificates on remote terminals and hub systems to provide network authorization and non-repudiation.*

UMBRA RECEIVES $950 MILLION CONTRACT FOR DEVELOPMENT WORK ON JADC2

Umbra has been awarded a $950 million ceiling, indefinite-delivery/ indefinite-quantity (IDIQ) contract for the maturation, demonstration and proliferation of capability across platforms and domains, leveraging open systems design, modern software and algorithm development to enable *Joint All Domain Command and Control* (JADC2).

Photo of Umbra's satellite, courtesy of the company.

This contract is part of a multi-award, multi-level security effort to provide development and operation of systems as a unified force across all domains — air, land, sea, space, cyber, and electromagnetic spectrum — in an open architecture family of systems that enables capabilities via multiple integrated platforms.

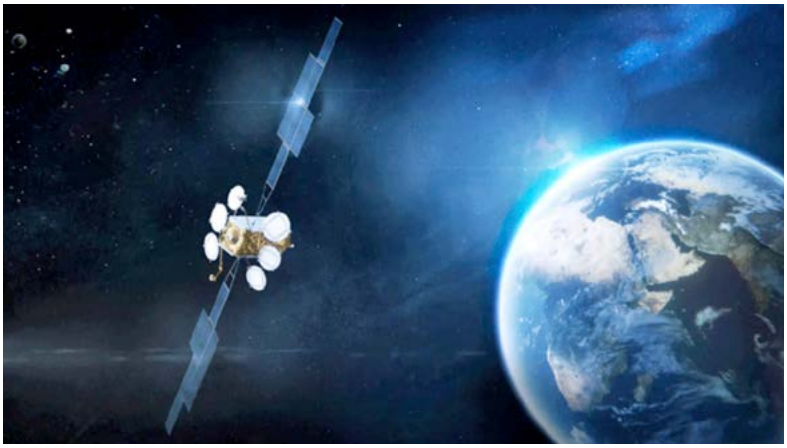
Umbra was awarded the contract alongside industry leaders including *Boeing* (NYSE: BA), *L3Harris Technologies* (NYSE: LHX), *Lockheed Martin* (NYSE: LMT), *Northrop Grumman* (NYSE: NOC), *Palantir* (NYSE: PLTR), and *Raytheon Technologies* (NYSE: RTX), who were previously awarded their own IDIQ contracts. Umbra was the only radar satellite provider announced in the most recent cohort.

An Umbra satellite is equipped with a powerful *Synthetic Aperture Radar* (*SAR*) payload, capable of seeing at night and through dense clouds to generate the highest-resolution radar images ever sold on the commercial market. Umbra is excited to participate in this multi-domain systems integration effort and hopes to make meaningful contributions to U.S. national security objectives.

"*The contract vehicle has a lot of potential and is a great opportunity for Umbra. The initial award is small compared to our other government contracts but this is a positive signal and it offers an avenue for the government to get familiar with our capabilities*," said Umbra co-founder, ***Gabe Dominocielo***.

AIRBUS' MILSATCOM SUPPORT STRENGTHENED WITH A UHF PAYLOAD GOING ABOARD THE EUTELSAT 36D SATELLITE

Airbus has announced the company will place a dedicated UHF (Ultra High Frequency) military communications hosted payload on board the EUTELSAT 36D telecommunications satellite.



Artistic rendition of the EUTELSAT 36D satellite on-orbit.

Airbus will be able to offer a new UHF communications service to the armed forces, particularly those of European countries and NATO allies. As the UHF frequency band is a relatively scarce orbital resource, this offering will make up for the capacity shortage around the world. Airbus has already signed the first firm orders for this capacity, well ahead of the satellite's scheduled launch in the first half of 2024.

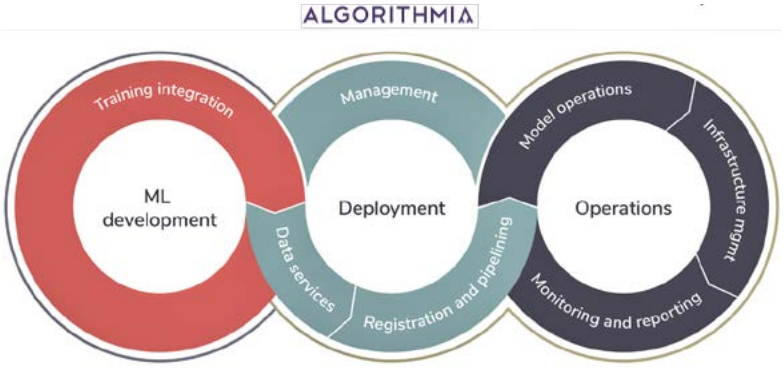
The UHF payload will be operated from Airbus's Network Operations Centre (NOC) in Toulouse. Its 18 UHF channels will enable as many as 200 simultaneous communications over Europe, the Middle East, Africa, large parts of Asia, as well as the Atlantic Ocean (to eastern Brazil) and the Indian Ocean (to western Australia).

Military UHF SATCOMs are used by the armed forces for operations on land, at sea and in the air. They have a high level of interoperability and are, therefore, very useful for multi-national and coalition operations. The UHF band is very flexible and is of particular interest to Special Forces units, as it offers a lightweight, robust and highly secure means of communication. An extensive range of terminals for use on land, at sea and in the air is available to meet the needs of the various armed forces.

Airbus noted that this new payload will enhance the firm's portfolio throughout the lifespan of the satellite. According to the company, Airbus is the only armed forces, private, SATCOM operator to cover the full spectrum of military (UHF, X-, Ka- Mil) and commercial (L-, C-/Ku-, Ka-) frequency bands and applications.

The EUTELSAT 36D satellite will be built by Airbus based on its Eurostar Neo platform. In addition to the UHF payload and will also be equipped with 70, Ku-band transponders for TV broadcasting.

ALGORITHMIA SELECTED FOR USE BY RAYTHEON TECHNOLOGIES



Algorithmia has been selected by Raytheon Intelligence & Space, a *Raytheon Technologies* (NYSE: RTX) business to support the team's development of the U.S. Army's Tactical Intelligence Targeting Access Node (TITAN) program. TITAN is a tactical ground station that finds and tracks threats to support long-range precision targeting.

Algorithmia, along with other leaders in AI and ML, will enable Raytheon Technologies TITAN team to deliver easily digestible data to Army operators. TITAN will ingest data from space and high-altitude, aerial and terrestrial sensors to provide targetable data to defense systems. It also provides multi-source intelligence support to targeting, and situational awareness and understanding for commanders.

Algorithmia's MLOps platform has been used by more than 130,000 data scientists in a wide range of organizations. The company's customers include large and mid-size enterprises, Fortune 500 companies, the United Nations and multiple government intelligence agencies. The company's momentum is a product of growing interest in AI-based applications and the need organizations have to efficiently manage cost and security for machine learning models.

Diego Oppenheimer, CEO of Algorithmia said, "*Our platform streamlines the deployment of machine learning models into production while providing important oversight, including review for ethical standards, to ensure models operate when and how they should, which makes Algorithmia a natural fit for sensitive applications. We are excited to join Raytheon in supporting its work with the U.S. Army.*"

MAXAR SUPPORTING AUSTRALIA'S NAT'L SECURITY WITH HIREZ SATELLITE IMAGERY + 3D DATA

Maxar Technologies **(NYSE:MAXR) (TSX:MAXR) has delivered 3D data products and high-resolution satellite imagery to the** ***Australian Department of Defence*** **under recent multi-million-dollar contracts.** Maxar's 3D data suite — created from the company's highly accurate satellite imagery—enhances situational awareness and decision-making for military applications. The 3D data suite includes a 3D Surface Model, which provides a high-fidelity, positionally accurate and photo realistic view of terrain and surface features and textures.

The suite's Digital Terrain Model product is a bare Earth elevation data layer generated with fully automated processing and delivered at speeds far beyond traditional technologies. The Maxar 3D Surface Model is delivered in a native data format, designed for efficient storage and streaming of large datasets.

The data format has built-in security measures, such as tampering control. The system is built for integration or stand-alone use, providing geospatial exploitation capabilities to existing systems.

With these latest contracts, Australia—a key U.S. ally and member of the Five Eyes intelligence alliance—demonstrates the increased adoption of commercial satellite imagery and derived data products for critical national defense and intelligence missions.

The Australian Department of Defence has been a Maxar Direct Access Program partner since 2018, with the ability to directly task and download satellite imagery from Maxar's current constellation in real-time to its ground station.

"*Maxar's high-resolution 3D data and satellite imagery are integral for high-confidence mapping, planning and operational support, which can help end users make better decisions and save lives, resources and time*," said ***Tony Frazier***, Maxar's Executive Vice President of Global Field Operations. "*Maxar is proud to expand our partnership with the Australian Department of Defence by providing our newest 3D data products.*"

DEEP SPACE DOMAIN AWARENESS IN THE MODERN ERA

Authors: Dr. Jacob D. Griesbach
and
Christopher J. Grant,
Ball Aerospace

During the last three years, the term and mission of "Space Situational Awareness" (SSA) was upgraded to become "Space Domain Awareness" (SDA) and the U.S. Space Force (USSF) was officially established.

This wasn't simple rebranding. This marked a comprehensive change in our nation's approach to managing and securing the increasingly congested and contested space domain. However, the evolution is far from complete. Continuing to improve, expand and advance SDA capabilities to be more threat aware and relevant can improve preparedness for critical space assets, in a battlespace environment.

The conversion to SDA stemmed from the realization that awareness must be actor/intent-cognizant and timely — not only focusing on tracking space objects, but also a necessary element of Space Control to support the core USSF mission of Space Superiority. That means emphasizing characterization, timeliness, and proactive (in addition to reactive) strategies.

As with any evolution, there are challenges and growing pains to overcome particularly in highly complex environments such as the space domain, where there are multiple agencies, companies, nations, and interests shaping the future. These entities must continue to work together and with industry partners to push capabilities beyond current levels.

The good news is that initiatives, investments, and doctrine are being regularly updated to acknowledge the increasing relevance of threat-based capabilities. But, because of the complexities in SDA in different domains (LEO and Deep Space) and the multiple entities working in this mission area, change can be slow. This makes industry partnerships even more vital and is a key reason we work as a mission partner with our government customers to be understand and support future activities.

As we work to achieve a future vision of a comprehensive and robust space superiority posture for the nation, leveraging a strong SDA foundation and priorities for the entire SDA community include increased investment to improve data sharing and mission management; achieve a deterrent presence; in mission-driven capabilities; and improving proactive characterization and anomaly detection.

Two specific high-priority areas that the SDA community can address in working toward a unified and shared common operating stance are: 1) committing to quality standards and parameters established through comprehensive performance modeling; and 2) observation timeliness and low-latency in all orbit domains, not just GEO and LEO.

Infographic is courtesy of the USSF's Space & Missile Systems Center.

Threat-Driven Missions Require High-Quality Solutions

As SDA broadens from simply knowing the location of space objects to a deeper understanding of what those objects are, who put them there and why, and the potential threat they pose to critical national assets and our nation's security, the quality of data and the speed with which it is delivered become paramount.

The risk in any evolving system is that the desire to make strides quickly often corresponds with a desire to do it economically, often sacrificing rigorous modeling and analysis in the process. There are certainly solutions out there that offer low costs and speed – and these benefits are understandably tempting in a government ecosystem.

However, while these technologies and solutions might meet the minimum standards of quality and risk tolerance, the SDA community must commit to a standard of quality equal to the threat potential. There is little disagreement that space will be the next hotly contested domain and that space-based threats are among the most significant risks facing our national security going forward.

During a recent panel discussion hosted by the *Armed Forces Communications and Electronics Association* (*AFCEA*), as reported in the its publication, *Signal*, **SEAN KIRKPATRICK**, deputy director of Intelligence and *Department of National Intelligence* (DNI), *U.S. Space Command* (SPACECOM), commented on the potential threats coming from the estimated 70 nations operating in space, including China and Russia.

SDA Analysis	Parameter Terms	Impacts
First Order	• RSO Size / Range • Aperture Diameter • Integration Time • Diffuse (Lambertian) Lighting • Signal/Image Processing (Frame Stacking) • Read / Electronic Noise • Shot Noise • Dark Current	• Standard/Basic optical modeling parameters • Relatively easy to simulate and specify
Second Order	• Specular (BRDF) Lighting / RSO Materials • Jitter (Pointing Noise) • Smear (Rate Track Error) • FPA Details (Well Depth/Gain/Quantization) • Quantum Efficiency / Transmittance	• Terms require detailed knowledge of sensor, target vehicle, and/or dynamic geometry • Jitter and smear strongly affect sensitivity especially for narrower iFOV systems
Third Order	• Stray Light • Pixel Ensquared Energy (ABP) • Radiation/Contamination Loss • Mirror Reflectivity / Lens Loss • Celestial/Galactic Background • Image Processing Residuals (Star Subtraction)	• Higher order analysis requires extensive testing to validate and have on-orbit considerations • Stray light affects ability to observe near bright light sources

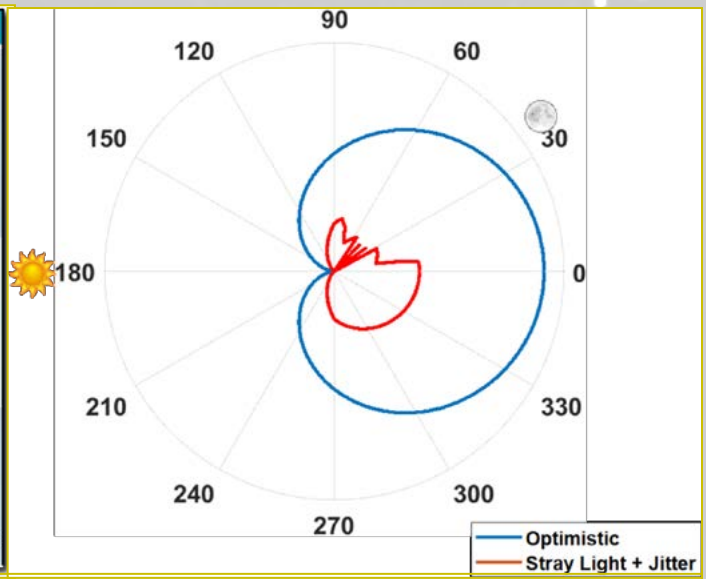


Figure 2: Higher-Order Space Domain Awareness Optical Modeling Effects are often omitted due to their complexities. However, such terms often present significant negative effects that can cripple mission performance. Red, higher-fidelity performance modeling shows significantly degraded performance in comparison to the first-order-only model, Blue.

"Their weaponization of space, in the space domain, and to space from the ground, has really progressed significantly over the last 20 years. They have pursued nearly every type of counterspace weapon that you can think of and they have built them. They have tested them, and they are proliferating them in an operational environment. Everything from ground-based lasers to direct ascent anti-satellite systems, to on orbit weapons, jammers, you name it, and if you can think of it, they've done it. And the fact that they are pursuing that really points to their understanding of the United States' reliance on space in our daily lives."

The increasing significance of these threats should be reflected in our investment in SDA as well as deterrence and defense.

Optical systems represent just one area where investment is wise. The fact is, when you move observation out to space, there are special design and performance considerations beyond the basic target size, aperture diameter, focal length, integration time, etc. High-quality optical instruments, such as those built by Ball, are designed to manage higher order effects, such as specular lighting, host jitter, target smear, stray light, as well as radiation, contamination and transmittance loss, and ensure that on-orbit performance meets expectations.

Figure 2: Higher-Order Space Domain Awareness Optical Modeling Effects are often omitted due to their complexities. However, such terms often present significant negative effects that can cripple mission performance. Red, higher-fidelity performance modeling shows significantly degraded performance in comparison to the first-order-only model, Blue.

These effects are present in optical systems regardless of environment or mission, but in the signal-starved space environment, they can significantly and negatively affect data quality if not accounted for correctly. The need for high-fidelity performance modeling driving design and manufacturing choices becomes even more evident as the mission moves farther from Earth.

And moving SDA farther from Earth is exactly what will be necessary as our own missions, not to mention those of our adversaries, move beyond GEO and LEO.

XGEO Space Domain Awareness

While SDA has historically been practiced in the LEO to GEO domains, the growing quantity of missions and traffic to cislunar space drives the importance and need for above — ***GEO (XGEO) SDA***.

As an example, ***NASA***'s ***ARTEMIS*** and ***CLPS*** programs, and the future planned Chinese activities, will lead to numerous assets and rocket bodies launched into the Earth-moon gravitational corridor in the coming years. Cislunar SDA systems will be critical to protecting and maintaining operational confidence for safe transit.

XGEO distances are generally an order-of-magnitude beyond those typically implemented for GEO sensing, driving the need for high-performance, long-range optical systems. The same sensors that may be adequate for proliferated LEO satellite systems will be insufficient to monitor the vastness of XGEO space.

Of course, it is not just the optical system that becomes more challenging in XGEO ranges. Additional complexities stem from data management and networking. Our national security relies not only on getting quality data from these higher orbits but getting it quickly.

While budget concerns must always be considered, the USSF and SDA community at large can work together to ensure that we align resources with the vision of improving our ability to protect our space assets and national security. To that end, in addition to developing high-fidelity optical sensors and communications technologies, Ball works hand-in-hand with our customers to develop performance modeling solutions and simulations to ensure that these technologies meet or exceed mission requirements.

The nation is well-positioned to achieve robust Space Domain Awareness. The technologies and solutions needed to maintain comprehensive domain awareness already exist today. But only by working together, as a community of government and industry partners, to define desired capabilities, performance standards and investment priorities will we be able to execute the shared vision for this critical mission.

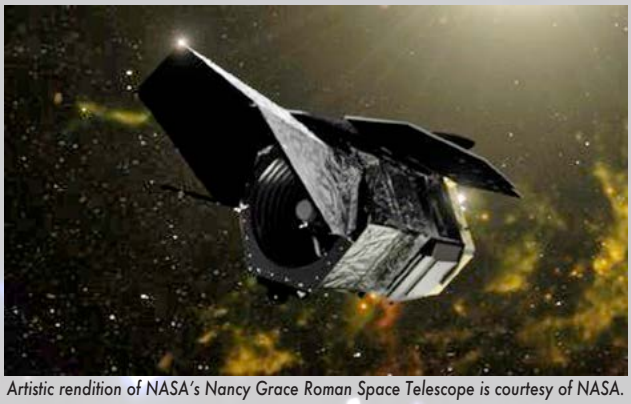
Christopher Grant is the Sr. Advanced Systems Manager responsible for Ball Aerospace's Space Domain Awareness system and technology developments, within the National Defense portfolio. Chris joined Ball in 2016, leading planned and active Space Domain Awareness programs and efforts. Before joining Ball, he worked in the USAF (AFRL/RV and NRO/AS&T) and industry on various space control and domain awareness programs, including GSSAP and related missions.

Dr. Jacob Griesbach (PhD EE 2000, MSEE 1997, BSEE 1995, Univ. of Colorado at Boulder) has 20 years of experience supporting space protection and related efforts. Currently at Ball Aerospace, he leads technical execution and internal research and development teams to support future space protection concepts.

Ball Aerospace pioneers discoveries that enable their customers to perform beyond expectation and protect what matters most. The company creates innovative space solutions, enables more accurate weather forecasts, drives insightful observations of our planet, delivers actionable data and intelligence, and ensures those who defend our freedom go forward bravely and return home safely. For more information, visit

www.ball.com/aerospace

Recently, Ball Aerospace, who partnered with NASA Goddard Space Flight Center, successfully completed the Critical Design Review (CDR) of the Wide Field Instrument (WFI), which will be the primary science instrument on NASA's Nancy Grace Roman Space Telescope, formerly known as the Wide Field Infrared Survey Telescope (WFIRST).



Artistic rendition of NASA's Nancy Grace Roman Space Telescope is courtesy of NASA.

Ball and NASA Goddard Space Flight Center are working in a close partnership to develop the WFI. Ball's primary responsibility is the Opto-Mechanical Assembly, which includes the optical bench, thermal control system, precision mechanisms, optics, electronics, and the relative calibration system that provide the stable structural and thermal environment necessary for wide field, high-quality, infrared observations. Ball will integrate the Goddard-provided 302-megapixel focal plane subsystem into the instrument and host instrument level verification and environmental testing.

The Roman Space Telescope is designed to unravel the secrets of dark energy, search for and image exoplanets, and explore many topics in infrared astrophysics. While its 2.4m telescope is the same size as Hubble's, the WFI enables a field of view 100 times greater than Hubble's at the same resolution.

Ball's work with NASA on the Roman Space Telescope continues a relationship that spans nearly 60 years. Ball built seven science instruments for the Hubble Space Telescope, as well as the advanced optical technology and lightweight mirror system for the James Webb Space Telescope.

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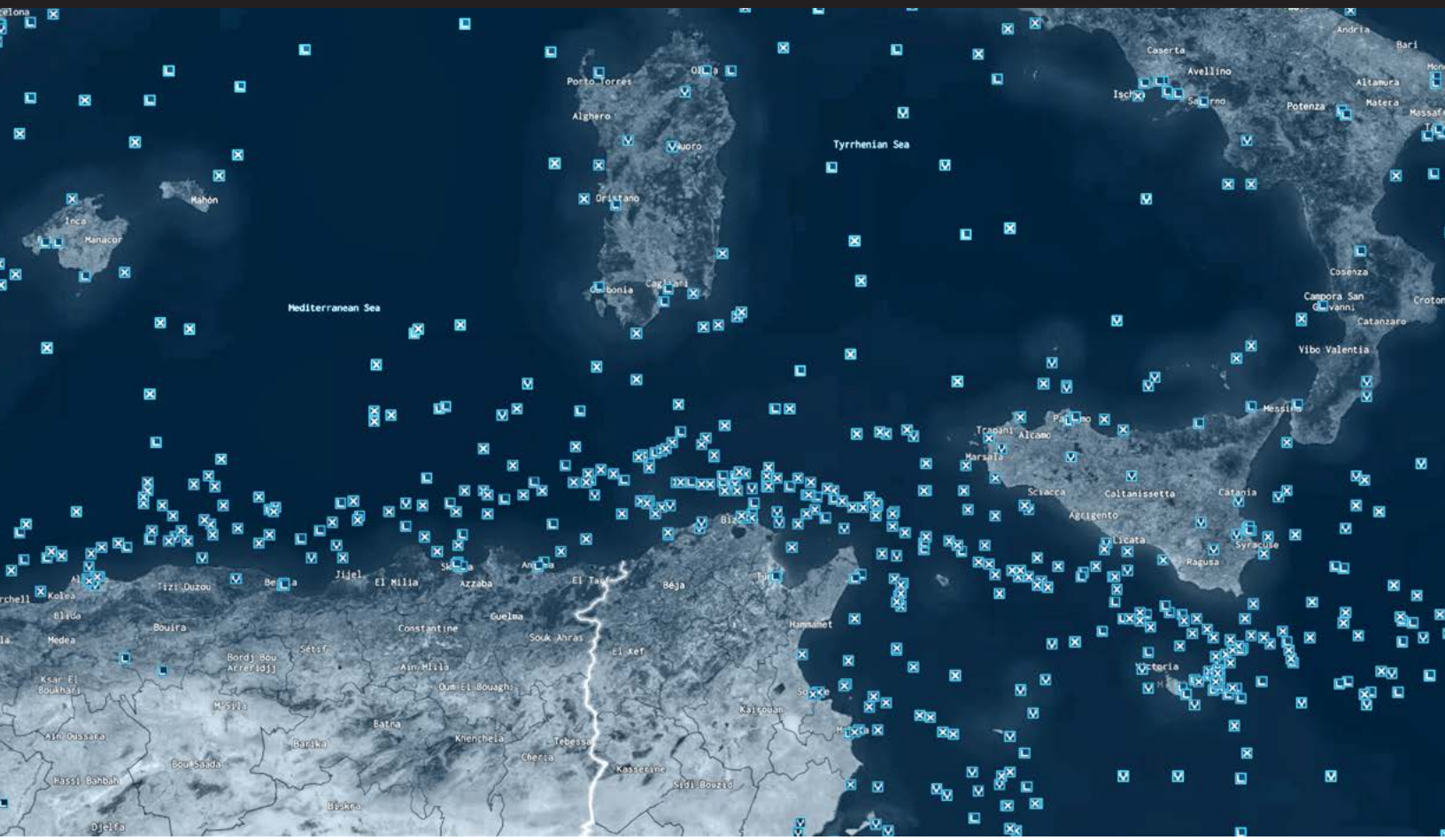
THE U.S. GOVERNMENT MUST PROVIDE BOLD LEADERSHIP TO ACCELERATE INNOVATION & ADOPTION OF U.S. COMMERCIAL SPACE CAPABILITIES

Author: Dr. Michael Mineiro, Vice President for Legal, Regulatory and Government Affairs, HawkEye 360

An artistic rendition of HawkEye 360's Cluster 2 smallsats on-orbit. Image is courtesy of the company.



The busy Mediterranean Sea shipping corridor is readily visible in the first radio frequency signals collected by HawkEye 360's Cluster 2 satellites, showing the location of vessel X-Band, L-Band and VHF navigation and communication devices. The data is displayed in HawkEye 360's Mission Space software over a Mapbox, OpenStreetMap and Maxar basemap. Graphic is courtesy of HawkEye 360.

Commercial space is a vibrant part of America's innovation ecosystem and is essential to the U.S. maintaining a competitive advantage in space and in all the areas of national strategy that depend on space. China, accordingly, seeks the same advantage and has designated space a top, industrial priority. The Chinese are playing to win, and the end result is far from settled.

Commercial innovations are quickly changing the paradigm as to how the U.S. government (USG) can operate and solve problems in space. The scope of the industry tells part of the story: the number of licensed, U.S. commercial satellite imagery providers has ballooned from three in 2003 to more than 119 today, with more than 1,000 imaging satellites in operation.

American companies are also building new classes of commercial space capabilities—such as radio frequency (RF) signal mapping — that, until recently, were solely the domain of government. A 2020 report from the Aerospace Corporation's Center for Space Policy and Strategy noted that, indeed, the U.S. and its competitors "*will soon be operating in an environment in which every emission, on Earth and in space, could be observed analyzed, and reported to unknown consumers in near-real time.*"

The proliferation of smallsats, a decrease in launch costs, commoditization of space data and the application of *Artificial Intelligence* (*AI*) are all underpinning commercial innovation, the benefits of which are legion. Commercial capabilities can support national security missions and users, are unclassified and sharable, add resiliency to government space architectures, provide fast fielding and technology refresh opportunities and conserve taxpayer dollars by leveraging private sector investment.

Today, the U.S. is a leader in many domains of commercial space and our nation enjoys those benefits. However, continued U.S. leadership is certainly not assured. The USG has an important role to play by establishing new policies and practices to facilitate and accelerate adoption of U.S. commercial space capabilities. Doing so will advance U.S. national and international security, international partnerships, economic prosperity and environmental accountability.

The government should first provide financial leadership by creating a demand signal and pathways for acquiring commercial data and services. No longer does the commercial space sector require government "*anchor tenancy*" as a precondition to private investment. Spurred by unprecedented investment and risk-shouldering from capital markets, the global space economy is now estimated at $423 billion, with an annual economic impact by the U.S. alone of $5 trillion. In order to shape and promote these investments, the USG must signal its demand and demonstrate a willingness to purchase commercial data and services.

The government should do this by updating the programming and budgeting processes to have the flexibility to keep pace with commercial innovators who deliver new capabilities every few months, not years. A traditional three to five year decision making timeline for budgeting and acquisition is both an insufficient mechanism for demand signaling to capital markets and an ineffective way of keeping government capabilities at the leading edge of available technologies.

A faster acquisition pathway, moreover, should focus on data and services, to the extent practicable, rather than the supply of certain "*end items.*" This has the double benefit of offloading the capital risk of developing, testing, demonstrating, and fielding new capabilities while accelerating domestic commercial capabilities.

An artistic rendition of HawkEye 360's Cluster 3 satellites on-orbit. Image is courtesy of the company.

Congress has taken steps in the correct direction: The *FY21 National Defense Authorization Act* directs the *Office of the Director of National Intelligence* (*ODNI*) and DoD to leverage, to the extent practicable, domestic, commercial, satellite data and GEOINT services as well as directs the *National Reconnaissance Office* (*NRO*) and the *National Geospatial-Intelligence Agency* (*NGA*) to consider and give preference to any cost-effective, U.S. commercial space capability or service that might meet government requirements. Continued firm policy leadership in these areas will help the U.S. to fully take advantage of commercial space innovations.

Next, the government should play an important role in speeding the development and incorporation of new operating concepts and trends by fostering a culture of experimentation and smart risk-taking. Exercises with new data distribution pathways, tasking models and integration between government and commercial data sources will be key to making sure the value of commercial innovation is not overlooked.

The convergence of proliferated space architectures, commoditized data, AI and global distribution networks is enabling deeper, timelier information and insights. Accelerating and implementing these innovations does not happen passively; on the contrary, open-ended assessments of new innovations can yield enormous value.

Another critical key to accelerate commercial innovation and cement U.S. leadership is international partnership. The data and services produced by commercial space innovators is inherently unclassified and shareable, creating new pathways for cooperation and interoperability with allies and partners.

Efforts to help allies understand their security environment, however, are often hindered by a slow and opaque export process. Chinese and other foreign players that have no such restrictions, meanwhile, are making it difficult for U.S. companies to compete for international commercial and government business.

Even if domestic demand is strong, a healthy U.S. space industrial base cannot persist without being able to compete in the international market. Though no small task, building global leadership in emerging technology areas is far easier than trying to wrest leadership from powers elsewhere.

There is great opportunity for the USG to leverage new, commercial, satellite capabilities to benefit its own mission requirements and to foster a world-leading, space industrial base. However, bold leadership is necessary to meet that goal; without such leadership, global competitors will be happy to secure those benefits for themselves and from suppliers that are not necessarily within the U.S. space industry base.

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HawkEye 360

Author Dr. Michael Mineiro is the Vice President for Legal, Regulatory, and Government Affairs at HawkEye 360. He leads the company's government affairs strategy, U.S. government contracting, regulatory licensing and compliance. He previously served as the Staff Director and Senior Counsel to the House of Representatives, Science, Space and Technology Space Subcommittee, and as Senior Policy Analyst and Liaison to the National Space Council at the White House Office of Science and Technology Policy.

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DEBRIEFING: JOSH MINER

Vice President of Land Mobile Services, Iridium Communications

How SATCOM plays a critical role in supporting NGOs and emergency responders

Josh Miner is the Vice President and General Manager for the Land Mobile line of business at Iridium Communications Inc., the only satellite communications company that offers truly global voice and data coverage. In this role, he is responsible for Iridium's Land Mobile revenue growth, product strategy, new product and service definition, demand generation programs, and major partnership support. His team manages products including Iridium® 9555, Iridium Extreme® PTT, Iridium GO!®, Iridium AxcessPoint devices, Iridium Core 9523, and Iridium 9522B. He also plays an instrumental role in Iridium Land Mobile market research, new product requirements, lifecycle management, and driving growth. Miner launched a new product company, portfolio for the Extreme and including Iridium AxcessPoint brought the Iridium portfolio to market.

Why are SATCOM tools so crucial to the work of first responders, scientists and emergency personnel?

JOSH MINER

For global aid workers, scientific researchers and emergency responders, the ability to communicate at all times is a top priority. During times of crisis or when deployed in conflict areas, having reliable communications tools not only helps with the success of each mission or emergency response effort, but provides a level of safety and security that should never be compromised.

Today, satellite communications (SATCOM) devices and solutions keep aid workers, researchers and emergency responders connected when it's needed most. The role of SATCOM during emergency response efforts and NGO missions is to be a reliable companion. No matter how dangerous or critical the situation, SATCOM should always be on hand to act as that safety net for those on the ground.

Oftentimes, NGO workers and emergency responders are deployed to remote regions of the world where terrestrial infrastructure has been compromised, is limited or is nonexistent. As satellite devices rely on a communications infrastructure in the sky, no matter what has taken place on the ground, end users can feel secure knowing that their ability to communicate with teammates or coordinate important operational details will remain intact.

When it comes to preparedness, the recommendation is that any organization operating in remote or areas of conflict equip their teams with some form of SATCOM. Whether that connectivity be a phone, a broadband terminal or a wearable device, these tools can act as either primary or backup modes of communications when cellular or HF radio is unavailable.

As an example, ***Iridium® Push-to-Talk*** (*PTT*) enables group communications anywhere on the planet, allowing teams of as many as 10 talkgroups to communicate over one network, even across multiple continents. The Iridium PTT suite of devices, including the ***Iridium Extreme®*** PTT and ***Icom IC-SAT100***, deliver highly mobile, low-latency group communications that are capable of enabling connectivity within buildings, vehicles or for handheld deployments.

Just like traditional *Land Mobile Radios* (*LMR*), Iridium PTT makes group communications possible at the push of a button; however, rather than relying on tower-based infrastructure, Iridium PTT leverages the global and reliable connectivity of the Iridium satellite network. It can be instantly deployed, eliminating the challenges and high costs associated with building out land-based infrastructure in remote areas and is reliable even in inclement weather.

In addition to its reliable as well as global coverage, for organizations such as NGOs and global governments, Iridium PTT offers a highly secure connection with *AES256* encryption, ensuring the safety of deployed teams and security of each mission.

What sets Iridium apart from other satellite providers when emergency communications for relief workers and first responders are not just needed, but absolutely and critically required?

JOSH MINER

First and foremost, our network is what really sets us apart from the rest of the pack. All ***Iridium Connected®*** satellite devices come with the inherent advantages of the Iridium network. Iridium's mobile satellite network is comprised of 66 *Low Earth Orbit* (*LEO*) cross linked satellites that create a web of coverage around the entire planet. Due to this unique network architecture, end users experience ubiquitous, low-latency communications — no matter where their work takes them. Additionally, our L-band signal is weather resilient and highly reliable, making it an ideal option for mobile communications applications, especially during an emergency, such as a natural disaster.

Secondly, our vast partner network is constantly innovating and creating new products and services using our network that are helping connect people and organizations across the globe. For instance, the ***Thales MissionLINK™*** is a lightweight, small form factor, rugged terminal that delivers reliable and critical communications capabilities no matter the landscape. This terminal can be mounted on top of a vehicle for comms-on-the-move or keep teams connected onsite when outside of the vehicle via its Wi-Fi capability, all while delivering the same level of service and reliability.

The terminal leverages ***Iridium Certus® 700***, our satellite broadband service that offers the fastest L-band speeds on the market today. MissionLINK terminals can serve as primary modes of communications or as complementary communications solutions. For example, organizations relying on *Very Small Aperture Terminals* (*VSAT*) as their main communication source should always have a backup. While VSAT terminals enable high bandwidth capabilities, they are notorious for being affected by inclement weather or difficult topography. A MissionLINK terminal can provide reliable connectivity, even in those challenging situations.

Can you offer any examples, even if general, of specific missions or organizations Iridium is supporting in the NGO space?

JOSH MINER

Iridium's satellite technology is supporting a variety of NGOs and emergency response groups around the world. For instance, our solutions helped a scientific NGO called the ***IK Foundation*** collect vital biologic data from a highly remote

island in Norway. This area of the world has been mostly untouched and is home to a variety of wildlife species and other scientific resources. Due to its remote location, harsh topography and lack of ground-based communications infrastructure, this region has not been studied often. In order to collect critical data, the IK Foundation deployed a Thales MissionLINK terminal to enable connectivity at the study site over the course of one year. Scientists were able to collect and distribute data and photos and remotely surveil the environment throughout the duration of their project, 24/7, even during extreme conditions like snow and ice storms.

The amount of raw biological data that was collected significantly bolstered scientific research around the world and has changed the way the foundation conducts research for the better. Additionally, the ***Republic of Indonesia***'s government recently adopted Iridium PTT devices to support communication efforts across the country.

The government fully deployed 500 Iridium PTT handsets to help support real-time communications across its diverse island landscapes, where building and maintaining terrestrial infrastructure is often costly and impractical. With Iridium PTT, the Indonesian government now has access to a "grab-and-go" satellite communications solution, to help enable reliable communications during emergencies and natural disasters, like earthquakes, volcanic eruptions, and tsunamis, which impact this region of the world.

Beyond these examples, our satellite solutions have helped aid workers administer vaccines, track and monitor critical health data and keep rescue and NGO workers safe while on missions in conflict zones.

How do you see the role of satellite communications providers evolving in the NGO and emergency response industries over the next five years? Can you elaborate on how you see Iridium's role expanding as well?

JOSH MINER

We believe that over the next five years, we will see an increase in SATCOM usage across all organizations, but especially within NGO and emergency response groups. With increasing natural disasters, an uptick in environmental and scientific research, and health crises across the globe, it will be critical for teams to be equipped with the best and most reliable communications tools. This is paramount to ensure all who need assistance can receive the help they need, and that those responsible for administering care are kept safe and connected.

Additionally, over the next five years we expect to see land-based and *High Frequency* (*HF*) radio usage phased out and replaced with SATCOM solutions such as Iridium PTT.

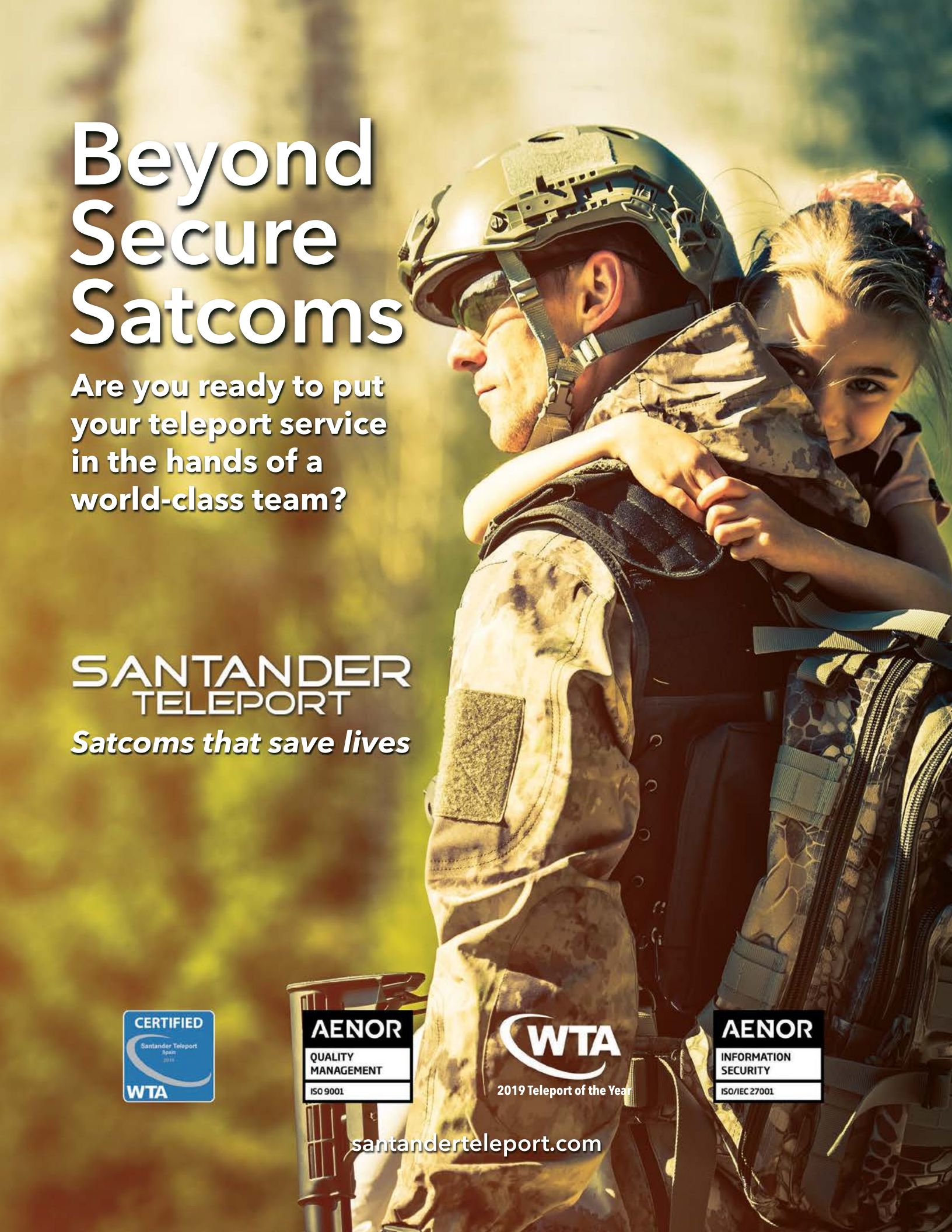
Currently, organizations relying on HF radios are limited in their reach and oftentimes hindered by the complicated training and cumbersome networking required to support the use of HF radios.

We are working with several NGOs that are moving toward using Iridium PTT as an HF radio replacement.

So far, the feedback has been stellar. Between the ability to rapidly deploy the service, its reliability and unmatched coverage, we expect to see an increase in Iridium PTT usage for relief and aid workers, superseding all other long-range radio systems in the coming years.

We are proud to support such critical work and look forward to continuing to provide connectivity and communications lifelines to those working on the front lines.

www.iridium.com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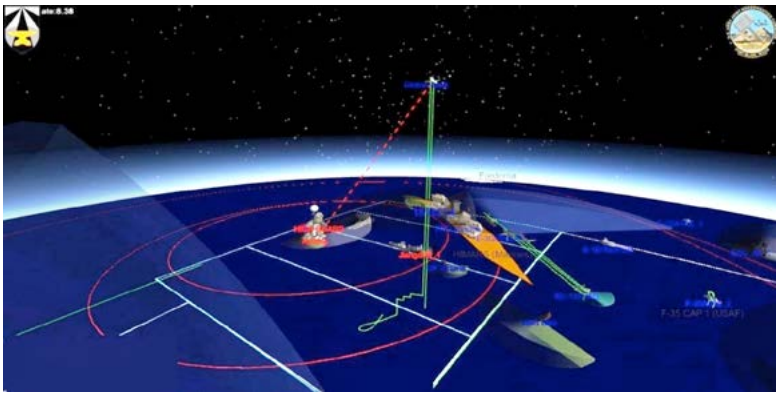
COMMERCIAL BASED, TWO-LAYER ENCRYPTION IMPROVES BATTLEFIELD MOBILITY

Author: Charlie Kawasaki, Chief Technical Officer, Curtiss-Wright Defense Solutions, PacStar

In order to achieve and maintain warfighting overmatch, coordinate deployed forces, and enable new capabilities, the US Army, Air Force and Navy are actively looking to new programs, such as *Joint All Domain Command and Control* (JADC2) to ensure warfighters have maximum situational awareness.



The Joint All-Domain Command & Control (JADC2) is the initiative to replace the current domain and control systems with one that connects the existing sensors and shooters and distribute the available data to all domains (sea, air, land, cyber, and space) and forces that are part of the U.S. military. Graphic is courtesy of Missile Defence Advocacy Alliance (MDAA) – info@missiledefenseadvocacy.org

While the Department of Defense (DoD) intends to rely more heavily on information resources, tactical and expeditionary networking and command post programs widely acknowledge the critical need to improve mobility. This necessitates the implementation of higher-capacity secure wireless, (including for classified networks) available farther out at the edge of the network and across multiple data transport types — to essentially untether communications.

The National Security Agency's (NSA) Commercial Solutions for Classified (CSfC) program approves organizations to transmit classified information (including Top Secret), via two layers of commercial encryption solutions. By using two sets of encryption technologies (from two different vendors or platforms), one tunneled inside the other, secret information can be transmitted over untrusted wired and wireless networks such as WiFi, LTE, 5G and SATCOM, including public, government, and partner networks.

The CSfC program enables a variety of use cases, but most important is the ability to use commercial wireless mobile devices for classified communications — as well as the ability to use commercial encryption devices for site-to-site transmission of classified information – without the use of Type 1 cryptographic equipment. In the past, the only means available to transmit classified information was via these expensive, controlled, military-grade encryption devices.

For example, with an email server in a classified network, when an email needs to be transmitted over SATCOM, if the email is sent through a VPN encryptor first, the data is encrypted once. Next, after sending that singly encrypted email through a second VPN encryptor — so that it's encrypted twice — the email can now be safely sent over wireless infrastructure. When the email reaches its destination, it must be decrypted twice. For mobile devices, this can be done using two software-based VPN clients. For remote installations, two gateways can be used, after which, the email can be read on a mobile device using a standard email program.

Figure 1 illustrates how classified information can be transmitted over untrusted wireless networks such as WiFi, LTE, 5G and SATCOM, including public, government, and partner networks.

The ability that CSfC provides to use commercial encryption methods for classified communications has the potential to enable a vast array of use cases. In the same way that consumers have been able to use mobile devices for literally millions of applications, DoD and Federal organizations are just now scratching the surface for how mobile devices can be used in defense and secure use cases. This promises to be especially helpful for supporting network mobility at the tactical edge of the battlefield.

Wireless Enables Mobility

Without wireless capability, setting up a network in a brigade command post typically takes hours and requires 17,000 feet CAT 5 cable, which weigh a total of 255 pounds. The cables have to be cut, laid out, configured and plugged in, taking hours for a battalion or brigade command post.

By going wireless, network set up and tear down time is instead reduced to minutes, enabling much greater flexibility so the unit can get up and go as needed. The US Army PM TN Secure Wireless program has had great success rolling out CSfC for WiFi enabled command posts to reduce setup time and reduce the duration during which they have no situational awareness — and ultimately, to improve command post mobility.

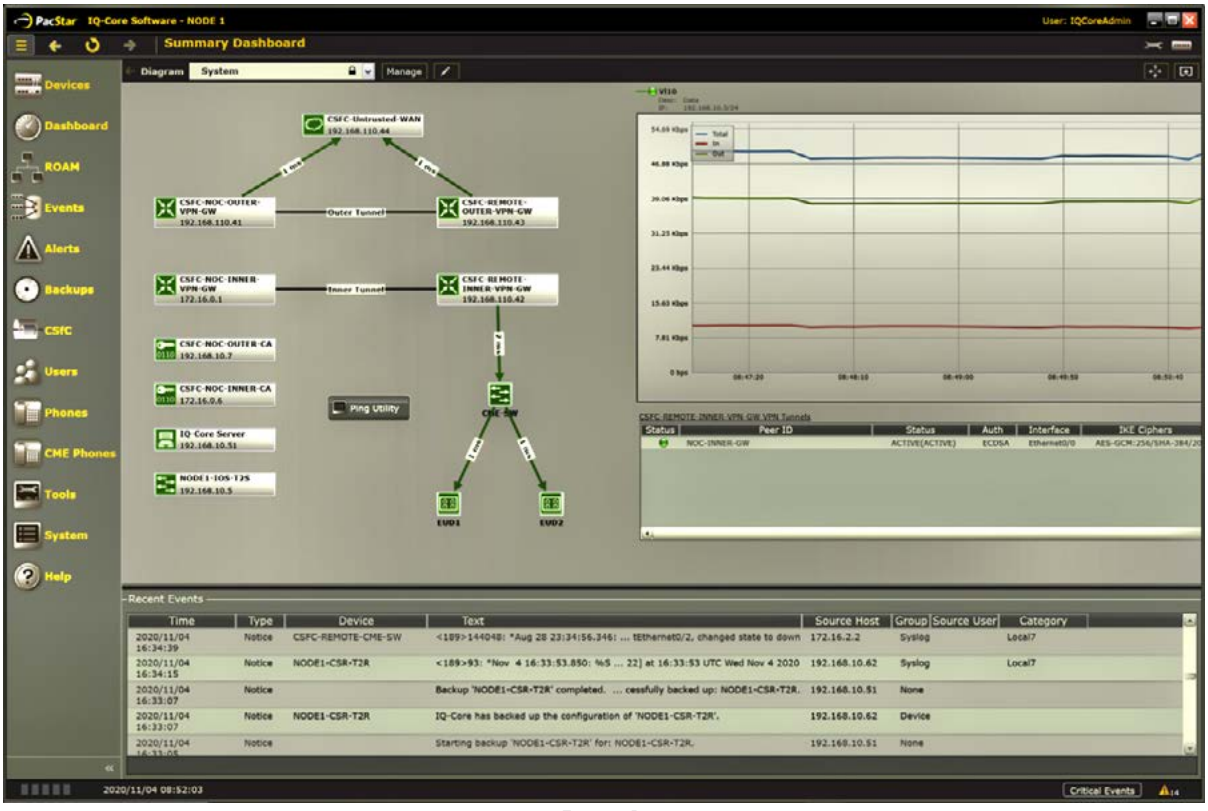


Figure 1.

Reducing the time it takes to set up and tear down a command post opens up new options for mobility, whereas in the past, commanders had little choice but to defend a static position.

While improving the setup and tear down time for tent-based command posts is an important improvement for US Army, the vision for next generation command posts includes moving the network infrastructure onto sets of vehicles that can be driven to a location, turn on wireless, and establish full communications between vehicles and in local secure WiFi bubbles. Pilots for these approaches are underway now, using readily available technologies already proven

in tent-based command posts, and adapted for vehicle mounted use cases.

Similar to what's happening in tactical programs, DoD enterprise organizations are increasingly looking to create enterprise gateways to support remote workers on mobile devices or at remote sites, for DoD and civilian applications, as well as for partner missions.

CSfC offers benefits for any organization that has classified or mission-critical secure communications requirements for remote sites, remote workers or partner organizations.

Though the concept of dual layered encryption is fairly straightforward, full CSfC implementations must include a breadth of technologies or components, including public key infrastructure (PKI), encryption gateways and clients, authentication systems, cybersecurity technologies, and secure network infrastructure. These components must first have their cryptographic implementations validated to FIPS 140 standards through the NIST Crypto Module Validation Program.

Next, the CSfC components must be Common Criteria validated against one or more protection profiles, such as VPN Gateway, TLS protected application, or WiFi access system. Additionally, certified PKI is required for certificate (or key) management.

These validations are typically sponsored by commercial vendors, and conducted by recognized testing labs. Once the validation step is complete, the products, such as a VPN Gateways, are placed on NSA's CSfC Components List, making them eligible for use, off-the-shelf, in CSfC Solutions.

It should be noted that while components on the list are eligible for use nothing in the component validation processes establishes interoperability or the ability of a product to meet NSA system-level requirement.

Integrators must select from the products on the components list to create solutions that conform to one of the NSA Capability Packages such as, for mobile device access, WiFi access or site-to-site transmission Once a solution has been assembled, they must validate that the solution functions as intended and meets Capability Package threshold requirement before the system is submitted for registration (approval) by NSA's CSfC PMO.

Curtiss-Wright's PacStar business has extensive expertise in CSfC, having designed, built and delivered numerous deployed CSfC solutions to protect critical data-in-motion over the last six years. The company does this with three categories of products:

Small form factor, rugged hardware — popular in many US and partner tactical network programs.

IQ-Core Software, a single pane of glass to manage tactical networking equipment. This is widely deployed, particularly across large numbers of programs in US Army.

PacStar Integrated Solutions — combining our hardware, IQ-Core Software, and vast arrays of 3rd party virtualized network functions, cybersecurity tools and application software — into turnkey solutions.

In addition to PacStar's CSfC solutions, ***Curtiss-Wright's Data Solutions*** business offers high-density storage solutions with CSfC approval for use in classified data-at-rest encryption. Curtiss-Wright's Parvus product line offers rugged CSfC-approved modules for data-in-transit — thus, the combination of products across the Curtiss-Wright Defense Solutions businesses enable CSfC use cases across nearly every type of application.

The combination of CSfC mobility and wireless solutions provides enormous potential to enable command post mobility, soldier-dismounted situational awareness, vehicle-to-vehicle communications and much more.

In order to satisfy CSfC and DoD guidelines for classified networking, it's important for defense programs, systems integrators, and technology developers to understand the extensive set of complex requirements and processes involved in realizing an NSA approved two-layer encryption solution.

Fortunately, the CSfC program has developed extensive guidance materials on the NSA web site, and the industry hosts annual CSfC-focused conferences for education and collaboration.

In addition, NSA has developed a vibrant eco-system of trusted integrators and technology developers, such as Curtiss-Wright, that can guide integration efforts and make CSfC implementations successful.

www.curtisswright.com/home/default.aspx

Charlie Kawasaki, CISSP, joined PacStar in early 2005. He is the company Chief technical Officer and leads multiple innovation initiatives including development of cutting-edge tactical computing systems. Charlie also serves as a Commercial Solutions for Classified (CSfC) subject matter expert.

Charlie is part of the PacStar team that won tactical networking equipment and software awards for numerous DoD tactical programs including the US Army T2C2, US Army SFAB, US Army ESB-E, PM TN Secure Wireless Gateway, PEO-C3T TCNO, and US Marine Corps NOTM vehicle-mount and deployable communications programs.

He has more than 40 years' experience in network engineering, machine learning/AI, systems integration, software engineering, and cybersecurity. Prior to joining PacStar, Charlie provided his expertise to early stage technology companies, where he created dozens of software and networking-based products. Charlie served as CEO of RuleSpace, Inc., which created AI-based technology for Internet parental controls used by companies such as AOL, Yahoo, SBC, BellSouth, and Microsoft.

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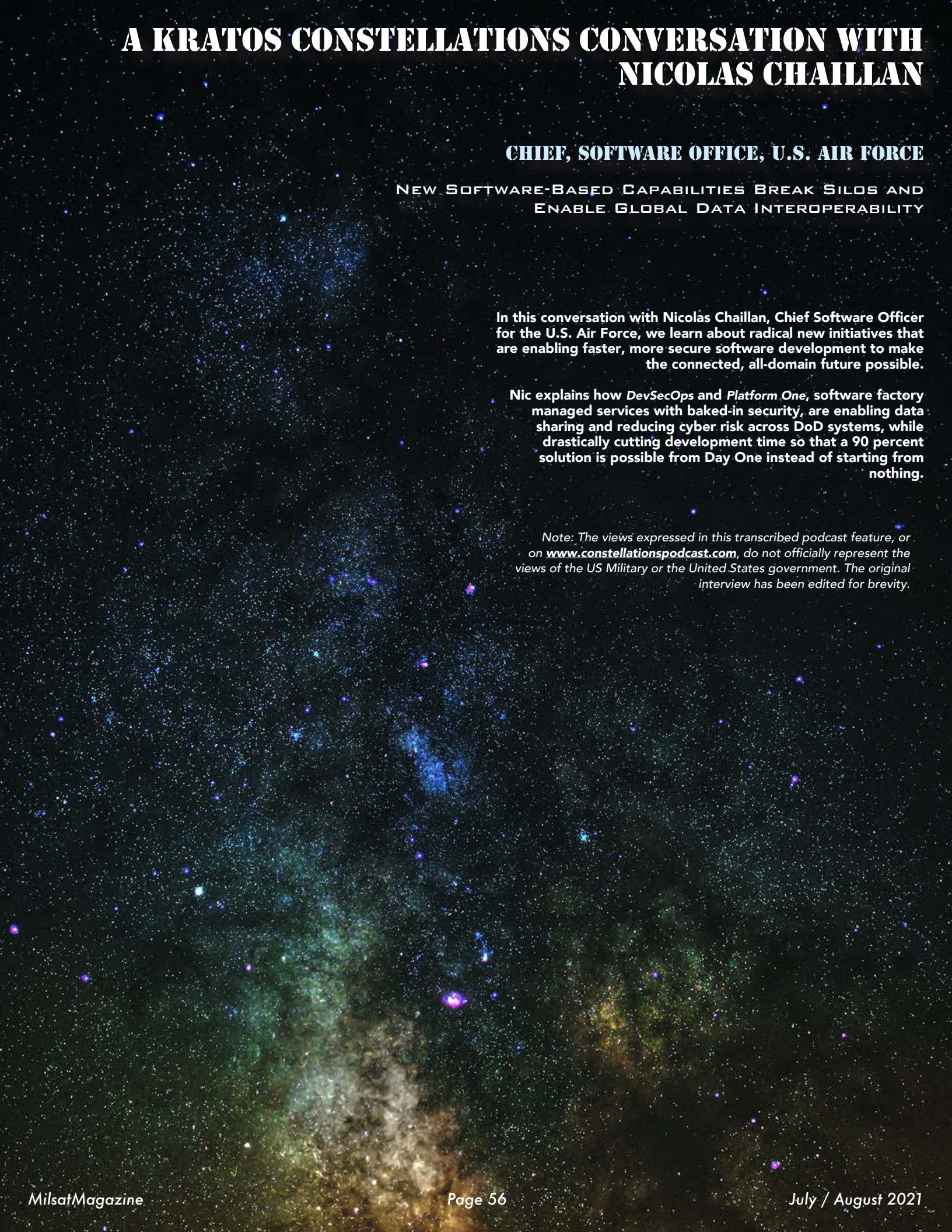
A KRATOS CONSTELLATIONS CONVERSATION WITH NICOLAS CHAILLAN

CHIEF, SOFTWARE OFFICE, U.S. AIR FORCE

New Software-Based Capabilities Break Silos and Enable Global Data Interoperability



In this conversation with Nicolas Chaillan, Chief Software Officer for the U.S. Air Force, we learn about radical new initiatives that are enabling faster, more secure software development to make the connected, all-domain future possible.

Nic explains how *DevSecOps* and *Platform One*, software factory managed services with baked-in security, are enabling data sharing and reducing cyber risk across DoD systems, while drastically cutting development time so that a 90 percent solution is possible from Day One instead of starting from nothing.

*Note: The views expressed in this transcribed podcast feature, or on **www.constellationspodcast.com**, do not officially represent the views of the US Military or the United States government. The original interview has been edited for brevity.*

Constellation Podcast Host, John Gilroy
Welcome to Constellations. Our guest is Nic Chaillan, US Air Force Chief Software Officer. Nic brings quite an unusual background to the DoD. He's a serial entrepreneur who started 12 software companies in his native France. Then the terrorist attacks in Paris happened and he decided he wanted to make a difference. He became a US citizen and got a job at the Department of Defense. Nic, that's a tough story to beat. Can you tell us a more about your background and how you ended up at the US Air Force?

NICOLAS CHAILLAN

Thanks for having me. As you can tell with my French accent, I was born in France and I created my first company back there when I was 15. I'm a software guy. I became a US citizen, and really wanted to make a difference at the time. I started first at DHS. I was a Chief Architect trying to solve some of the issues we're facing with terrorism and also cyber-security challenges across the critical infrastructure across the country. From there, I joined the DoD to help the government move at the pace of relevance with DevSecOps. It's been a unique journey moving from commercial startup industry to the Department of Defense.

John Gilroy
We hear you're bringing a lot of innovation to the government. In addition to your role as Air Force Chief Software Officer, you also serve as a co-leader for the DoD DevSecOps initiative along with the DoD CIO. What is DevSecOps and why would the DoD even need it?

NICOLAS CHAILLAN

DevSecOps is kind of breaking the silos between development, security testing, and operations, effectively shortening the life cycle of software so that you can release software multiple times a day and get feedback loops shorter and faster. You learn from your end-users, in our case the warfighters, so we can build relevant software for them. Obviously, you don't want to build software and features in a vacuum, you want to develop it with that feedback. The faster you can release it with more incremental change and progress, the more you can move at the pace of innovation and evolve to the next thing.

Having that timeliness, and security that's baked-into the life cycle, is why we call it DevSecOps and not just Dev Ops. And we use zero trust and all the most advanced cyber principles to do that. In just over a year now with 37 DoD programs moving to DevSecOps, we have saved a hundred years of plan time. That means effectively in one year we have saved a hundred years of what it would have taken if we were not using DevSecOps. That's game changing.

John Gilroy
It sounds like you're applying a mantra from startups to the vastly different environment of the DoD. To that point, the military is looking to have global data interoperability across all its domains, which would seem to imply a completely new data architecture. But you've said this does not necessarily mean changing the underlying technology. How you do one without the other?

NICOLAS CHAILLAN

It's a bit foolish to think you can completely modernize an entire enterprise of the size of the DoD. There are too many silos and legacy systems for that to happen. Instead we can aggregate and federate systems through abstraction layers to aggregate data across systems. The key is to protect the data.

Effectively, all these silos were initially created to avoid cyber or security risks, to prevent malicious actors from moving through the system. But by segmenting them, you obviously create silos. And to be efficient in fighting the next wars, you need to have data and a holistic view of what's happening. Silos are impediments to the leadership success of making the right decisions.

To move to that connected environment, to what we call zero trust, is going to be foundational to enable connectivity across systems, making sure people only have access to what they should have access to, and limiting malicious actors. You can implement your trust by adding abstraction layers to the existing systems. And you can federate or aggregate data across those systems rather than drastically changing them. With federation, you can connect things together and query the federated system and get results without even knowing where that query goes. As a user, you just get the results of that query without knowing you talked to maybe 50 systems behind the scenes.

John Gilroy
You use the word holistic for global data interoperability, and this concept to connect sensors from all the DoD services — the Air Force, Army, Marine Corps, Navy, and Space Force — into a single network. That's a big goal.

NICOLAS CHAILLAN

Yes, it's obviously foundational to the success of the Department and the future of all-domain. Space and cyber are big new domains and the next battles are going to really involve these, so it's important to have holistic access across all domains and be able to share data. And also to reuse code and software across these environments. So, effectively, a sensor could be used on a ship, on a jet, on the ground, all the way to space with the same piece of code that could be reused across teams, so we don't have to rewrite the entire stack from scratch. Enabling the use of code is one of my biggest priorities so we can be more efficient, and not rewrite every system each time we have a new idea.

John Gilroy
We're hearing the term open data architecture, but what does that really mean?

NICOLAS CHAILLAN

People often say open source, but what I think they really mean is open architecture. And so it's not always open source, but it's open in a way we're not getting locked into a single product and having to completely move the entire data structure into a one-size-fits-all product. Open architecture means you know exactly how the data flows. Many of these products are open source and we have access to the source code and can see exactly how these products are built and if they're secure or not. That gives us more visibility inside the supply chain and the quality of the code, and that obviously helps in making decisions and picking the right products. In fact, most of the Platform One DevSecOps stack is based on open-source products.

John Gilroy
There must have been challenges when you talk about open source or open architecture in the federal government?

NICOLAS CHAILLAN

Yes, obviously, you're facing not only the largest organization on the planet, but also the largest budget, and the most silos across teams. These were initially designed to make sure we're not creating more risk, but effectively that creates a lot of reinventing the wheel across teams. That's been a big challenge. People are not used to using enterprise services and quite honestly, in a move to DevSecOps and cloud, you cannot succeed as an enterprise if you don't have enterprise services.

You need to have a cohesive environment to do all this work so that each team isn't reinventing the wheel when it comes to the basics of cyber, of DevSecOps, of cloud adoption, and that you're not doing it in a vacuum. And so a big focus when I started was to create Cloud One and Platform One. As you know, Cloud One is the cloud office for my team, and Platform One is a DevSecOps team to help all these DoD teams move to DevSecOps.

John Gilroy
What is the role of industry in the success of Platform One?

NICOLAS CHAILLAN

I would argue that we cannot succeed without industry, but we also don't want to completely outsource all talent and all knowledge to industry without having proper oversight and understanding of the decisions, so we can do what's right for the taxpayer, both in terms of architecture decisions, and also hands-on coding. So it is very foundational that we also have a say inside of that software lifecycle construct. It's all about the right mix. We're trying to be in the 90/10 or 80/20 range, where 80% will be the industry partners and 20% will be government people, whether it's civilians or military. But that gives us the flexibility we need and the oversight we need to make the right decisions.

Jon Gilroy
Tell us more about the differences between Cloud One and Platform One?

NICOLAS CHAILLAN
Cloud One is providing access to the cloud. We have both Amazon and Azure, the government version of these clouds, both unclassified and classified. So that gives us the ability to have access to cloud in a matter of days for what used to take between 8 to 12 months for a team. That's again, why enterprise services are so important. Unfortunately, the department got so used to doing enterprise services badly that people almost have an aversion to it, and they don't want to use them even when it's good. So it takes a bit of convincing. Unfortunately, people too often say, 'Oh, you're missing this 5 percent thing here. So we're going to rebuild everything from scratch,' instead of just helping build the 5 percent delta.

So, that's been the number one problem we're facing. We need to really centralize the talent to go and tackle these deltas. Nothing is perfect and nothing can solve every problem on the planet, but by focusing on the delta and not reinventing the entire wheel, that obviously helps move faster. So that's Cloud One, the cloud office. And then Platform One is bringing the DevSecOps, continuous integration, continuous delivery of software with that agile construct to the department as well.

John Gilroy
If you look at the federal government in the last 15, 20 years, one critique has been with vendor lock-in, where it's almost impossible or too expensive to get out of a contract. So how does it avoid vendor lock-in with cloud migration? Is the answer standards or open architecture?

NICOLAS CHAILLAN
Yes, so the entire architecture of Platform One was designed to prevent vendor lock in. We abstract everything from the cloud provider standpoint so we're not getting locked into a cloud all the way to every piece of the stack. We use *Kubernetes*, which is a content orchestration tool. Everything we do is Lego blocks driven. So by cutting into small blocks effectively, you can move things around and swap them to try things out for different use cases. The entire stack is containerized and gives us the flexibility and the modularity that we need to be able to swap these Lego blocks and try things. So, we have a central team that's accrediting containers for the department part of Platform One. That team is effectively accrediting and updating and hardening commercial products and open-source software so they can be used inside of the DevSecOps universe. That gives us that central assessment and mitigation of supply chain risk.

That really streamlines the process for a startup or organization that wants to do business with DoD, to add a cool commercial product to be authorized for use in the department. That's exciting to see. We were able to get the 450 containers accredited in one year with Platform One, which is game changing. That also helps cyber because we can update these Lego blocks automatically across the departments and provide these updates in case there is a new vulnerability, a new zero day, or a new cyber issue that we need to fix immediately. We can do that within four hours. That's pretty game changing as well.

John Gilroy
I'm going to transition from Lego blocks to Iron Bank. Where does Iron Bank fit in this discussion about open source?

NICOLAS CHAILLAN
Iron Bank is a centralized repository of containers. Its where we put all these hardened Lego blocks we were talking about. That's where we scan them, harden them, and authorize their consumption. By the way, we open source this entire thing, so the entire industry is also using these containers, including financial institutions, healthcare, other government agencies and partners. So, it's a two-way street that's very exciting to see.

We have so much adoption by industry of everything that Platform One does because of that open-source vision. By being open and transparent and really putting more eyes on code and focusing on security we increased the cyber posture of the Department with more people being able to bring back value to us in a faster pace. Timeliness is foundational to cyber, to be able to move fast and react to challenges.

John Gilroy
We've talked about Platform One, Cloud One, and Iron Bank. How do you ensure all this is secure? What do you do to create a secure cloud architecture, and make sure the containers are secure, and therefore the architecture is secure?

NICOLAS CHAILLAN
There's two pieces to that. One is you want to secure your supply chain. Iron Bank and the container hardening process gives us visibility into risk, but the foundation of our security is about zero trust and behavioral detection because you have new findings and issues that can come up in zero days. So, we continuously monitor the stack and see if there's any change of behavior of the container. If it's doing something it's never done before, it's probably a sign of something malicious, so we will kill the container and alert the team.

Then we use zero trust to effectively reduce the attack surface. For container A to talk to B it has to be white listed, creating an encrypted tunnel to communicate between the two containers. That reduces the ability of a bad actor who gets access to a container to talk to other containers or move laterally across the environment. That reduces the attack surface and the ability to escalate privileges. By detecting behavior change and killing the container, and going back to immutable state of the container, the bad actor will lose everything and go back to zero. That drastically reduces cyber risk, and obviously improves the cyber posture of the systems.

John Gilroy
If Platform One can instantiate DevSecsOps in days at various classification levels, then what happened before?

NICOLAS CHAILLAN
Before you would end up having to deal with outdated systems, and product that might be 10 years old. And so by definition this is not a good user experience for the warfighter. You want to have a party between classification levels so that the work you're going to do you have the same cool tools, whether its AI, machine learning, deep learning, all the way to software development or cyber tools.

With the containers and the entire stack able to be instantiated automatically across classification level, that way, we always have the latest, most updated versions, and ability to instantiate a DevSecOps environment at the edge on a jet, on a bomber, or on a space system. We have that access with push button deployment to get the most updated version with our cyber fixes, which reduces cyber risk, but also is a drastic improvement in user experience too. Obviously, it all ties back to the timeliness, so we don't get behind. That's really critical for us.

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SAIC AWARDED U.S.A.F. CONTRACT TO SUPPORT DOD COMBATANT COMMANDS

Science Applications International Corp. **(NYSE: SAIC) won a new contract with the** ***U.S. Air Force Life Cycle and Management Center,*** **Force Protection Division to help the U.S. Department of Defense Combatant Commands mitigate small unmanned aircraft systems (sUAS) threats and protect U.S. forces.**

Under the contract, SAIC will provide a broad range of integrated logistics support and sustainment services necessary to modernize defenses against the rapidly evolving threat of sUAS in the U.S., host nations, and global contingency locations. The single-award contract has a one-year base period of performance with three one-year options, and is worth up to $90 million.

SAIC currently supports the U.S. Army's counter-sUAS programs and will continue its work through this new Air Force Contract.

SAIC technology innovations will be leveraged to enhance the ability to neutralize sUAS threats. SAIC will be primarily responsible for repairing and maintaining counter-sUAS systems, equipment, and software, including help desk support, logistics, corrective and preventative maintenance, training, and supply chain management. The company will also provide innovative ways to modernize systems.

SAIC will provide these services to several Combatant Commands, including Central Command, European Command, Indo-Pacific Command, and Strategic Command., as well as the U.S. Space Force.

"*SAIC's past performance with the Army for more than nine years demonstrates our ability to provide the Combatant Commands with a full range of support and sustainment services for modernization of counter-sUAS that will help contain this growing tactical threat*," said ***Michael LaRouche***, president of SAIC's National Security and Space sector. "*We are incredibly proud and honored to continue this important work.*"

OVZON RECEIVES TERMINAL ORDER FROM DOD

Ovzon **has received a significant $2 million order for satellite terminals directly from the *U.S. Department of Defense* (U.S. DoD) to be used with Ovzon's industry-leading Satellite-as-a-Service offering — this new order includes both On-The-Move (OTM) terminals for simple integration on mobile platforms, as well as the newly released Ovzon T6 terminal for On-The-Pause (OTP) communications.**

Ovzon's global satellite network enables the highest transmit and receive data rates to and from the smallest terminals. The Ovzon Satellite-as-a-Service offering is engineered to provide unmatched performance and resiliency.

Ovzon's ultra-small OTM and OTP terminals have a successful track record of dependability in the most demanding environments. The all new Ovzon T6 is the world's smallest, lightest, and easiest to use terminal with true broadband capability, providing data rates up to 50 Mbps transmit and 120 Mbps receive.

The rugged design and robust environmental protection provide a compact, fully integrated, solution without sacrificing size, weight and power characteristics. The Ovzon T6's patented, electronically polarized antenna allows an untrained user to adjust for only azimuth and elevation to establish communications in less than two minutes. Weighing only 13.2 lbs, the Ovzon T6's small, lightweight form factor makes it easy to transport to any location.

"*We are excited for this significant direct order from such an important customer, the U.S. DoD. This order confirms the relevance of our technology, the upcoming launch of Ovzon's new satellite, Ovzon 3, and the value of our high-performance global network to the U.S. DoD's global mission*," said ***Per Norén***, CEO of Ovzon.

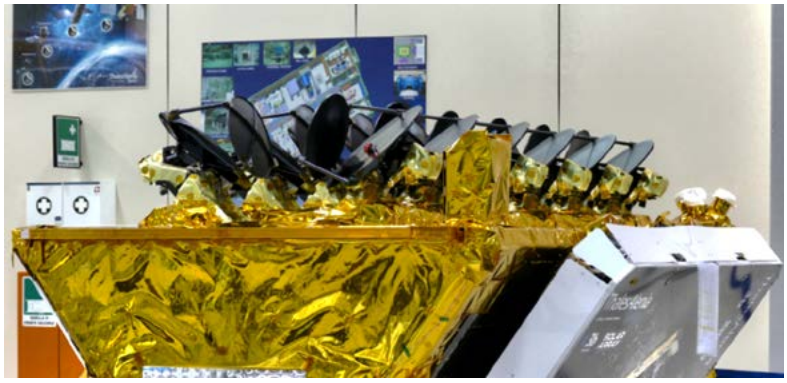
SES GOVERNMENT SOLUTIONS DEVELOPS MISSION-CRITICAL COMMS VIA O3B MEO CONSTELLATION

SES Government Solutions**, a wholly-owned subsidiary of SES, in close partnership with a key U.S. Government customer, designed, developed and fielded an *O3b Medium Earth Orbit* (MEO) reachback capability to provide mission-critical communications for a key combatant command. Four O3b MEO smallsats.**

The awarded task order for $11.8 million is against the single-award, $516.7 million, *Blanket Purchase Agreement* (*BPA*) for Medium Earth Orbit (MEO), low-latency, *High Throughput Satellite* (*HTS*) services. This is the 15th task order awarded to SES GS on this BPA.

With this agreement, SES Government Solutions expands its high-throughput, low-latency services in support of mission-essential combatant command requirements, as the customer needs evolve, by providing innovative, flexible and secure communications solutions.

Using O3b services, U.S. Government customers can take advantage of the field-proven capabilities to support the provisioning of enterprise services to deployed warfighters. The solution leverages the MEO constellation by providing fiber-like connectivity to austere deployed locations.



"*The Department of Defense has vast and expansive information at their fingertips,*" said President and CEO of SES Government Solutions, Brigadier General ***Pete Hoene***, USAF (retired). "*Utilizing reachback technology gives our warfighters the information and support needed for mission success. By leveraging the O3b MEO constellation, deployed U.S. military personnel have access to near real-time decision-making intelligence at the tactical edge.*"

AVANTI COMMUNICATION'S HTS FOR SECURE SATCOM GIVES THE USE OK TO ULTRA'S PORTABLE + FLYAWAY SATELLITE TERMINALS

Ultra's range of advanced man portable and flyaway satellite terminals, designed to meet the demands of secure government and military SATCOM, have been accredited for operations on *Avanti Communication*'s fleet of high-throughput satellites.

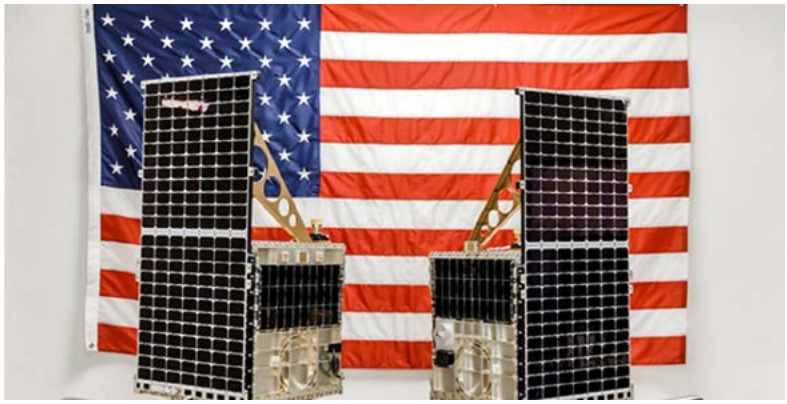
Avanti's high-capacity Ka-spectrum satellites provide fixed beams covering the EMEA region and steerable beams spanning from the Americas to Asia. Merging this capability with Ultra's range of terminals, specially designed to operate in the harshest environments, means that end users will have continuous access to reliable communications regardless of where they are operating.

Using Avanti's high throughput beams, trials across Ultra's line of terminals showed outstanding throughputs in excess of 150 Mbps in the Forward and Return routes. This capability means government customers now have the ability to provide headquarters-levels of capacity through a terminal that can fit on their back.

The efficiency of these terminals, coupled with the high capacity of Avanti's high throughput steerable beams, will allow government customers to deploy multiple terminals operating simultaneously on one of Avanti's steerable beams – all delivering in excess of 100 Mbps per terminal.

Donald Walker, Director of Government Sales at Avanti Communications, said, "*Avanti's high throughput satellites deliver high levels of capacity making them ideally suited to maximise the benefit of small terminals. Utilising Ultra's ULV-45, MicroVSat and Fa100 terminals, users can achieve connectivity levels far in excess of that available on conventional satellite networks. We're delighted that together we can deliver the capacity and reliability that early entry forces and first responders need.*"

DARPA'S BLACKJACK PROGRAM SUCCESSFULLY DEPLOYS TWO MANDRAKE 2 SATELLITES



DARPA successfully deployed two satellites on June 30 as part of the SpaceX Transporter 2 launch.

Both ***Mandrake 2*** spacecraft, ***Able*** and ***Baker***, are functioning well and progressing through checkout and commissioning.

Conceived as an early risk-reduction flight for DARPA's ***Blackjack*** program, the Mandrake 2 mission will prove out advanced laser communications technologies for a broad government stakeholder team that includes ***DARPA***, ***Space Development Agency*** (SDA), ***Air Force Research Laboratory Space Vehicles Directorate*** (AFRL/RV), and ***Office of the Secretary of Defense's (OSD) Joint Capability Technology Demonstration*** (JCTD) office.

During its on-orbit mission, Mandrake 2 will demonstrate the viability of low size, weight, power, and cost laser communications terminals that are interoperable.

"*This constitutes a game-changing advancement and a critical enabler for proliferated space architectures*," said ***Stephen Forbes*** who is program manager of the Blackjack program in DARPA's Tactical Technology Office. "*Mandrake 2 has already successfully demonstrated a rapid satellite development timeline, since the Blackjack program moved from contract award to delivery of space vehicles at the launch site in less than nine months.*"

The successful launch of Mandrake 2 represents the culmination of a rapid design and development effort by a large team of industry performers led by ***SEAKR Engineering***, as the prime contractor.

Astro Digital built the satellite buses for Mandrake 2.

Advanced Solutions (ASI) wrote the Mandrake 2 flight software and is supporting mission operations.

Maverick Space Systems performed integration and test analysis, as well as launch integration services.

Lockheed Martin provided integration support and launch procurement.

SA Photonics developed the *optical inter-satellite link* (*OISL*) hardware demonstrated as part of the Mandrake 2 mission.

SpaceX provided launch services as part of their *SmallSat Rideshare Program*.

GOVERNMENT SATELLITE REPORT (GSR)

Smaller Terminals, Higher Throughput, Enable True COTM

Author: Ryan Schradin, Editor, Government Satellite Report

Almost every new military vehicle, platform, or system that is created is in some way network-enabled. Whether the concept is to generate ISR data or user data to improve operations, drive military decision-making, or push advanced capabilities into the field for the warfighter, today's modern military systems operate optimally when there is connectivity.

However, the military has to operate in some of the most austere, remote, and geographically isolated locations on the planet. These are *Disconnected, Intermittent, Limited bandwidth* (DIL) environments, where the ubiquitous connectivity that Americans have come to expect – and even take for granted – at home is either unavailable, denied, or untrusted.

In these places with limited or no connectivity, making the most out of our next-generation, network-connected military platforms and systems means we need satellite communications. But not the satellite communications of the past — high-throughput, low-latency satellite communications that can deliver fiber-like connectivity to anywhere on the Earth. And we can't rely on old-school satellite terminals and antennas, either, if we're going to extend that fiber-like connectivity to every vehicle, ship, plane or warfighter for true *Comms-On-The-Move* (*COTM*).

The next generation of antennas and terminals needs to be interoperable, mobile and smart. They need to be capable of working with advanced satellite constellations in orbits other than GEO to deliver connectivity without interruption. Plus, they need to be innovative to make them dependable, easy to use, and automated in their deployment and operation.

One of the terminal manufacturers that has taken on this challenge is ***GetSat***, which provides the military with a slate of small, advanced, smart terminals capable of meeting the rigorous demands of today's military, and satellite services.

GSR recently sat down with **JASON STEPHENS** of GetSat, who was joined by **MIKE BLEFKO** of ***SES Government Solutions*** — one of GetSat's satellite service partners — to talk about the satellite requirements of today's military, and the revolutionary new services on the horizon.

GSR
Can you tell our readers about GetSat and its solutions? What different kinds of products does it offer to government and military customers?

JASON STEPHENS
GetSat is a privately held company, headquartered in Rehovot, Israel. We also have a North American headquarters in McLean, Virginia. The company specializes in the micronization of satellite communications terminals for on-the-move requirements. We operate on platforms such as unmanned aerial

vehicles (UAV), military vessels for land-based use, military vessels for maritime use, widebody aircraft for the U.S. military, and some commercial UAV operators.

Typically, the spectrum of terminals that we produce are anywhere from very small terminals that will operate on Class II and Class III UAVs, up to our largest terminal, which we call our Milli H or Milli HI. And that terminal is typically used for military land-based vehicles and Roll-On/Roll-Off requirements for special operation forces in the U.S. military. We are also seeing this terminal being installed on military maritime vessels around the world.

Primarily, our company prioritizes the development and manufacture of on-the-move terminals. We are also in the process of bringing to market our newest development efforts, which are Ka- and Ku-, *Electronically-Steerable Array* (*ESA*) antennas. These are for services such as ***mPOWER***, ***O3b Classic*** and other LEO and MEO architectures.

GSR
Why are small form-factor satellite terminals important for military users today? What trends are we seeing in the military that are driving a need for connectivity at the tactical edge?

JASON STEPHENS
At the very *Forward Line Of Troops* (*FLOT*), you see a requirement for a huge amount of data exfiltration and infiltration, whether it be *intelligence, surveillance, reconnaissance* (*ISR*), *personal location information* (*PLI*), or video streaming services.

We are to the point where the *Department of Defense* (*DoD*) is operating with surgical strike attack capability. Sometimes those approvals are at the very forward edge, coming from headquarters or other locations around the world. You may have someone in the U.S. commanding a task force operating in the Middle East, Eastern Europe or the Pacific.

And those approvals are coming from information that is being exfiltrated back to locations in the U.S. headquarters or around the world. The decision-making processes on whether to continue forward with a mission are happening in real-time. That real-time decision-making is only capable of happening with the data exfiltration and the data infiltration that is required at the FLOT.

What we're seeing at the FLOT is a requirement to go faster, smaller, lighter, with less power draw. There's no opportunity at the tactical edge to stop, pause, bring up a terminal, and spend 45 minutes bringing a land-based or a traditional parabolic terminal up onto the network.

With the requirement of that data exfiltration and data infiltration for the command and control of those troops, you're seeing exponential growth in small form-factor, on-the-move requirements for our U.S. DoD customers and military ministries of defense around the world.

MIKE BLEFKO
To supplement what Jason is saying regarding the terminals, that's essentially where the satellite companies like ***SES*** are heading as well. Our goal is to provide that air interface link in real-time to those terminals in the field at the tactical edge, with high-throughput and—ideally—low-latency connections. This is so they can essentially execute all those applications, all that analysis, and have the information available in real-time for both our existing O3b and our new constellation mPOWER that is going up.

O3b Classic, our MEO constellation of 20 satellites, does this very well today. But we have a limited number of beams on orbit. As we go into mPOWER, we'll have a huge paradigm shift in the number of beams that go up that could essentially point to all those individual GetSat terminals that get deployed on the ground. We are really looking forward to that jump in capability as we move into our next generation of mPOWER.

GSR
With terminals such as GetSat's MICRO SAT and Milli SAT deployed on military vehicles, what kinds of capabilities, solutions, and applications could the military make available to the warfighter?

JASON STEPHENS
The key here is to understand the exponential increase in data rate capabilities with mPOWER in small form-factor terminals. With the commissioning of mPOWER, and the qualification of terminals the size of MICRO SAT or Milli SAT on mPOWER, and the expected data rates that we are going to see over the mPOWER constellation with these small-form-factor terminals, [users] will have the ability to [perform] command and control functions from a vehicle.

They'll be able to push and pull real-time ISR, messaging, direct action approvals, and direct action planning material to-and-from the battlefield without having to pause and set up communications to exfiltrate that data — effectively enabling true COTM.

GSR
What new technologies or advancements in military solutions will this enable them to use? What advanced capabilities will this bring to the warfighter?

JASON STEPHENS
Everything. It would be everything. You're opening up a complete capability that hasn't been there previously. Previously with FLOT, if you did 256K or 512K or 1 MB full-duplex in the return, it was an accomplishment. With mPOWER and the small form-factor terminals, these terminals will enable comms on the move and do 20, 30, 40 MB forward and return. So, you're opening the architecture of "anything is possible" at the forward edge.

MIKE BLEFKO
Prior to that type of capacity — with those types of data rates Jason just mentioned — if there was a large file that needed to be transferred in the gigabyte range over a GEO satellite and large reflector parabolic-like antenna, it could take hours — if not days — to send really large files with that connection architecture.

Many times, military users would essentially pull hard drives out of computers and transport them by helicopter, as that was more efficient than over a satellite network. With the smaller terminals and the higher data rates, not only do these large 100 gigabyte or terabyte files send out in hours, these gigabyte files that get

sent back and forth no longer have to be compressed or scaled back. If they're going from the tactical edge to some analytic center, it can be sent in real-time and analyzed in real-time, enabling real-time decision-making on the ground. Then there are the advanced solutions making their way into the battlefield —things such as AR goggles and heads-up displays. You would need a robust connection to look at some sort of simulator or some sort of situational awareness in real-time. As Jason mentioned, if small-form-factor terminals deliver 500 K to 1 Mb, they were doing pretty well. We can get anywhere from 30- to 0 Mb duplex data rates today.

We've recently deployed this type of technology to maritime vessels. On maritime vessels, especially on hospital ships such as *Mercy* and *Comfort*, they were looking for it to be able to use what is called a *DaVinci* machine. This is a medical machine where a doctor at a land-based location can perform an operation at sea, all done remotely. This is managed by using a high-throughput, low-latency link over a GetSat terminal that delivers the link.

It has such a quick response time and feedback overtop of the network. They can do a precise, lifesaving operation in the field if the operation could not be delayed for the person who is injured to be returned back to a land-based hospital.

That type of capability exists today. Whether it be a simulator or a real-time situational awareness, or medical capability to help the warfighter in the field, all those types of applications are enabled.

JASON STEPHENS

The telemedicine requirement for the U.S. military has grown exponentially over the last three to five years. As Mike mentioned with the DaVinci machine and the hospital ships, it's not only on those vessels, but also at the forward edge.

We have medical personnel at the forward edge, and there is a huge requirement for bandwidth to support telemedicine to ensure that injured troops will receive the proper procedures with the proper guidance.

Additionally, from a warfighter perspective, we are seeing exponential growth in unmanned land-based vessels and unmanned surface vessels for maritime use. What that's allowing is for us to reduce risk for soldiers, sailors, and marines. By reducing that risk, we are able to reduce casualties, and, in most cases, we are able to gain more information and intelligence.

With the high data rate requirements for those platforms, we have multiple cameras on all of them. You have multiple collection capabilities on all of them. You are able to operate in a completely different and more covert environment. And then you can exfiltrate data from those devices while reducing risk and increasing situational awareness for decision-makers.

MIKE BLEFKO

What the network could handle prior to now was a single feed at a time. The U.S. government has a capability called *Unified Video Dissemination Solution* (*UVDS*) that requires multiple video feeds to be sent simultaneously over top of a link. But if you've only got a 500 K to 1 Mb link, it's difficult to execute such a task

However, with O3b today, and certainly mPOWER tomorrow, we've demonstrated and implemented multiple video feeds. We can go up to six videos over the same video channel. That greatly increases with mPOWER, with respect to the data rates.

For additional information on mPOWER and the constellation's ability to enable comms on the move, select this direct link to download, "***O3b mPOWER for U.S. Government Missions***."

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Ryan Schradin is the Executive Editor of GovSat Report. A communications expert and journalist with more than a decade of experience, Ryan has edited and contributed to multiple, popular, online trade publications that are 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.

Comms-On-The-Move (COTM) — Science Fiction Or Reality?

Author: Robert Rigsby, Senior Director COCOMs and Integrated Development, SES-GS

New technologies are considered "disruptive" when their introduction changes the fundamental way in which we live, work or accomplish day-to-day tasks. The past few decades have seen a lot of new, and arguably "disruptive" technologies enter the marketplace – from the Internet, to the mobile device, to the cloud.

When these new technologies are released and begin to gain mainstream adoption, the military begins to analyze and test them to see if there are potential use cases for them in combat. Can they make our soldiers better informed or more connected? Could it improve our soldiers' survivability or increase lethality?

In many cases, the answer to those questions are, "yes," and then the hard work begins. The military needs to figure out how they want to bring these new technologies to bear and enable fiber-like communications and how they want to harden those technologies for harsh battlefield environments. Finally, they will also need to understand how they can use the same equipment and technologies where the conditions are not as austere and leverage the same infrastructure they use at home or work.

For the military to deliver many of these new tools and capabilities into the fight, a high bandwidth, low latency network connection is a prerequisite for operational sufficiency. Today's network-centric military operators demand high bandwidth connectivity to deliver the new tools, applications and capabilities they need to fight.

Historically, high bandwidth and low latency has unfortunately been the eternal stumbling block in the domain of land-based combat operations.

The Dream Of COTM

Today's soldiers first encounter combat operations in barren, austere environments where the infrastructure we are accustomed to back home does not exist or is otherwise inaccessible or unreliable.

This creates a problem for the military. How can those network-enabled tools and capabilities be sent to military personnel at the tip of the spear if they can't connect? The answer has traditionally been through satellite. However, satellite has always come with its own challenges for the military.

Traditional military satellite (MILSAT) services were delivered via satellites at the *geostationary orbit* (*GEO*); examples of this include narrowband communications provided by UHF Tactical satellites or other 56 Kbps satellite data networks. These systems were, and still are, in high demand. They are only capable of delivering so much capacity and bandwidth because of the distant orbit location. Moreover, there is then the challenge of providing the correct ground infrastructure — the terminals and antennas necessary to use military and commercial satellite networks are often bulky and not exactly what anyone would consider, "*mobile*."

While deployed soldiers were in camp or on base, there wasn't a problem. There was the time and space to establish ground infrastructure and deliver communications to the soldiers while they were there. They were able to have comms at pause, but they couldn't take that connectivity with them, and that's what the military has been looking for — Comms-On-The-Move (COTM).

COTM @ Sea & In The Air

Luckily, there have been major advancements in the satellite and ground infrastructure industries that could start to make this dream a reality.

Newer satellites, such as those closer to the Earth in Medium Earth Orbit (MEO), have been flying since 2014. These satellites have high-throughput and low latency, the two key features enabling warfighters to do the most demanding tasks via network-enabled services, tools and interactive applications – from high definition ISR video to the highly detailed collaboration on GEOINT necessary for making informed troop movement decisions.

New antenna and terminal technologies have also been introduced that can enable access to this new generation of satellites and deliver comms on the move. Unfortunately, they still are not small and mobile enough to be carried by soldiers on foot but they are perfectly fine for trucks, ships and large transport airplanes.

Is COTM Coming For The Dismounted Warfighter?

Yes. Unequivocally, yes.

The first computers took up the better part of an entire room. Today, that same computing power is dwarfed by something that fits in our pockets. In fact, there is more computing power in a Fitbit than that used to land a man on the moon. New technologies come out all the time, and they're constantly getting better and smaller. Terminal and antenna technologies are not an exception.

Newer, commercially viable electronically steered, phased-array antennas are smaller and more capable of handling the technical requirements of MEO satellite constellations. These antennas and supporting electronics are in development and testing right now, and should be available in just two or three years.

When these new antenna and terminal technologies enter the marketplace, they're going to open the door for the military to embrace MEO satellite constellations – and the high throughput, low latency connectivity that they enable – for comms on the move across all requisite domains: air, sea and land.

That's when the dream becomes reality – when soldiers will get communications at low latency and high throughput. These critical qualities enable warfighters to enjoy the same fiber-like response times they enjoy at home, and use the same mission critical interactive applications as they do at home. This will revolutionize warfare.

SES Government Solutions currently offers a MEO satellite constellation called O3b that can deliver the bandwidth that's necessary for comms on the move. Moreover, we have funded – and will deliver by 2022 – its follow-on capability called O3b mPOWER, which will deliver up to 35,000 beams globally below 50 degrees latitude. That is an impressive 100 Gbps per spacecraft of capability into the tactical edge, adding an incredible solution to the military's tools base.

For additional information about O3b mPOWER and what it can do for the military, ***select this direct link***.

The preceding two articles first appeared on ***GovSat*** and are republished with permission.

Author Robert Rigsby is the Senior Director COCOMs and Integrated Development with SES-GS.

PATH DIVERSITY WITH SATELLITE CONNECTIVITY FORTIFIES COMMS FOR EMERGENCY RESPONSE

Author: Tony Bardo, Assistant Vice President of Government Solutions, Hughes Network Systems

After a record-breaking hurricane season in 2020, forecasters warn Americans to brace for yet another *active, above-normal season* this year. For government agencies coping with ongoing pandemic response amid the accelerating number and intensity of storms, this forecast is a call-to-action for emergency preparation and, as society has become so dependent on connectivity, a sobering reminder to shore up communications networks for whatever may come next.

For decades, satellite technology has been the go-to connectivity solution in disaster response, ensuring first responders and communities can communicate when land-based networks fail.

However, in an increasingly network-dependent world amid the threat of natural and man-made disasters, satellite systems at the ready may not be enough. In fact, as in commercial enterprise, path-diverse communications that include both terrestrial and non-terrestrial broadband enable businesses and governments to serve end users seamlessly in a wide range of scenarios, both planned and unexpected.

Satellite To The Rescue

It's no secret that, compared to land-based networks, satellite technology is considerably less susceptible to outages in times of disaster. From Hurricane Sandy to Typhoon Haiyan, when wireline connections were wiped out, satellite VSATs came to the rescue, enabling first responders, government and citizens to access critical information and supplies.

In fact, many state and local governments and federal agencies, such as the Federal Emergency Management Agency (FEMA) in the U.S., will pre-purchase VSAT terminals and satellite service in preparation for storm season as a safety measure. They may contract to have the equipment and capacity available on-demand or even pre-stage the VSATs near disaster-prone communities or along the predicted path of a coming storm.

Purchasing service and equipment early provides governments with the flexibility to engage satellite capabilities quickly to get online in the immediate aftermath of a storm. Similarly, many businesses utilize satellite as an ancillary, secondary or tertiary back-up network to ensure their locations stay online, even in times of natural or man-made disaster.

The value of satellite to connect business quickly was on full display in the aftermath of Hurricane Maria in Puerto Rico, enabling medical facilities and pharmacies to provide essential care to citizens.

As a matter of good business, major drug store and grocery store chains across the U.S. use satellite to back-up their networks. These networks can switch seamlessly to satellite broadband when necessary — ensuring customers can receive their vital prescriptions or medicine, have access to clean water and purchase groceries.

Plus, 40,000 ATMs across India depend on VSAT connectivity from Hughes for primary service — extending financial access to people who live in places beyond the reach of cable and fiber.

Beyond natural disaster response, satellite connectivity also allows governments and businesses to maintain essential operations when their primary broadband connection at a site or in the region fails.

In example, in 2020, amidst election season, a severed fiber optic cable shut down the state of Virginia's voter registration system, causing massive complaints that

exacerbated voter fraud concerns. Investing in a satellite back-up solution would have enabled the state to continue its registration operations seamlessly despite the terrestrial outage.

Multi-Transport Solutions

In addition to back-up systems, investing in a strategic and reliable, path-diverse, communication networks with satellite transport can guard against communications failure and supply first responders and essential businesses with the connectivity they need.

In an age when connectivity is as essential as electricity, governments and businesses alike increasingly depend on multi-transport network diversity to build resiliency and redundancy. Multi-transport solutions that use satellite and another form of connectivity keep mission-critical applications online when a disruption — be it a storm or fiber cut — compromises terrestrial connections.

One such multi-transport solution is a combined satellite/cellular "bubble," ideal for on-demand connectivity when terrestrial networks are compromised or don't exist. With a cellular pack and portable satellite antenna, first responders, law enforcement and government workers can have much-needed wireless connectivity for up to 100 "bring-your-own" devices (BYOD) within a 1.25 mile (2 km) range.

The rapidly deployable, LTE network bubble enables workers to connect reliably to one another and with the outside world, enhancing critical response capabilities no matter the impact to infrastructure. When terrestrial infrastructure is unavailable, the accessibility and ease of installation of the multi-transport satellite/cellular solution enables emergency response teams and communities to set up one or multiple command centers or locations for citizens to take shelter. The on-demand connection enables first responders to communicate effortlessly through radios, cellphones or other BYOD devices, supporting response and recovery efforts.

Another multi-transport solution quickly gaining traction in the government space is Managed Software Defined Wide Area Networks (SD-WAN). This type of multi-transport solution optimizes the network across sites and transport types, ensuring the right performance and price to meet the organization's needs and automatically applying data traffic rules and prioritization to keep essential locations online.

This intelligent prioritization of broadband types and application traffic at each site helps to deliver a more reliable, seamless user experience in a cost-effective manner.

Satellite connectivity as part of the SD-WAN network helps extend the network to hard-to-reach locations and ensures availability. Satellite can even support traffic prioritization/cost management when an organization may choose to reserve its satellite system for large data transfers and network back-up while directing other application traffic over cable or fiber connections.

Path Diversity In The Future Of Connectivity

Satellite connectivity and path-diverse networks play an important role in saving lives in the face of natural disasters and keeping essential operations running.

The bottom line is that no single transport technology can satisfy all the demand for seamless, reliable connectivity in times of disaster or any other time. Instead, the future of connectivity depends on a ubiquitous network that leverages all transport types – GEO, MEO and LEO satellites, plus cable, fiber, 4G/LTE, 5G, Wi-Fi and more. Satellite brings a unique set of advantages to that networking ecosystem, in large part as the only connectivity alternative that does not rely on vulnerable terrestrial infrastructure.

Looking ahead, path-diverse networks with satellite transport will play a critical role in building an always-on network vital to keeping government and essential businesses online and to enabling effective communications during disaster response and all the time.

With multi-transport, always-on networks, governments can keep serving the public — especially when they need it most.

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Author Tony Bardo has more than 30 years' experience with strategic communication technologies that serve the complex needs of government. Since joining Hughes in January 2006, Bardo has served as assistant vice president of Government Solutions, where he is focused on providing Hughes managed network broadband solutions and applications to Federal, State, and Local governments. Bardo also served as Chair of the Networks and Telecommunications Shared Interest Group (SIG) for the Industry Advisory Council, an advisory body to the American Council for Technology (ACT). Before joining Hughes, Bardo was with Qwest Government Services for nearly five years where he was senior director of US Government Civilian Agencies sales and marketing, senior director of marketing, and senior director of business development. Prior to Qwest, Bardo spent 14 years with the government markets group at MCI where he held the position of executive director for civilian agencies.

DEBRIEFING: BRIAN BILLMAN AND PETE HOENE

Transformational Antenna Trials Unlocking Next Generation Connectivity For Defense

Brian is the Vice President of Product development for Isotropic Systems
and
Pete Hoene is the Chief Executive Officer for SES Government Solutions

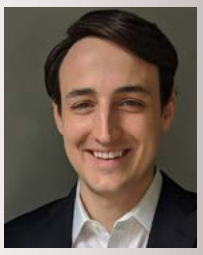
Isotropic Systems' new multi-beam antenna is set to redefine real-time comms across the battlespace and the company offered the following information before the conversation began in earnest.

Lower launch costs and new satellite technology has led to an explosion of capacity and capabilities in space. This is taking shape in the form of new orbits, HTS spot beams, flexible payloads, software-defined networks, cloud computing and countless other innovative technologies.

However, on the ground, users are stuck with terminal technology that was invented more than 130 years ago. ***Isotropic Systems*** is solving the missing link required to unleash the full capabilities of these new networks by developing the world's first multi-orbit, multi-beam terminal capable of linking with multiple satellites in multiple orbits at the same time.

In partnership with ***SES Government Solutions*** (SES GS) and the U.S. Army and U.S. Air Force, Isotropic Systems has completed milestone tests of transformational optics at the core of their new, multi-beam antenna that will enable delivery of high-speed, real-time data over diverse paths to frontline forces and central command.

That's a game changer for the military and defense sector, especially given the increasingly adversarial environment across the globe. Isotropic Systems' new antenna can instantly bypass intentional network jamming and interference attempts by automatically and simultaneously delivering traffic over another satellite in a completely different orbit. Phase two trials later this year will showcase the terminal's ability to link simultaneously with SES satellites in GEO and MEO orbits.



Brian Billman

BRIAN BILLMAN, Vice President of Product Development for Isotropic Systems, revealed more about how the innovation of this single, fully integrated terminal will enable the true power of SATCOM for government and defense initiatives around the world.

Isotropic Systems tested its breakthrough ground infrastructure in collaboration with SES Government Solutions over SES' ***O3b*** *Medium Earth Orbit* (*MEO*) satellites. SES GS CEO **PETE HOENE** also joined the conversation to share his insights into the significance of these first phase, next generation, connectivity trials. A retired U.S. Air Force Brigadier General, Hoene and his team certainly know firsthand the communication challenges facing the military around the world.

Fresh on the heels of these milestone trials, both Isotropic Systems and SES GS are excited about what the tests represent for warfighters, command, and even a broad range of other key markets, such as aero, maritime, and corporate networks, that will benefit tremendously from a new level of connectivity.

What do these multi-beam antenna trials with the U.S. Army, Air Force, Isotropic Systems and SES GS mean for the U.S. military and defense organizations across the globe?

BRIAN BILLMAN

The armed forces and defense agencies are incredibly good at acquiring actionable information, but they run into bottlenecks when they try to distribute that mission-critical data over single beam parabolic antennas and other outdated infrastructure.

These milestone trials with the U.S. military are successfully demonstrating the multi-beam, multi-orbit connectivity and capabilities that our high performance terminals will put ito the hands of warfighters and decision makers across the government sector and battlespace.

In a nutshell, Isotropic Systems is delivering the first full performance, multi-link, multi-orbit terminal that unlocks access to commercial and government satellites in any orbit. That's a complete game changer, especially in the mission-critical defense market.

Photo of Isotropic's multi-beam antenna, courtesy of the company.

PETE HOENE

This is absolutely transformational — the ability to combine the ultrahigh throughput of SES' next-gen, O3b mPOWER constellation with Isotropic Systems' very low profile multi-beam antenna that can see nearly to the horizon. That's absolutely something no one else can deliver to the military or any other bandwidth-hungry market.

Pete Hoene

SES will launch our new O3b mPOWER system late this year, and Isotropic Systems is set to have their new multi-beam antenna commercially ready by the time we initiate service in mid-2022. That marks a major milestone for the military, which will be able to avoid increasingly sophisticated efforts by adversaries to jam communications traffic over satellite.

We will now be able to instantly move traffic from one satellite in GEO, for example, to another spacecraft in MEO — completely eliminating the threat in real time. That's something no other terminal can do.

What makes this terminal so revolutionary, so different from other platforms?

BRIAN BILLMAN

We've seen a great many more advancements on the satellite side than ever before, all unlocked by lower launch costs and the ability to get new technology into space faster to support new services.

We are going to see this advanced capability coming online in new systems like O3b mPOWER, which is set to launch later this year. But these new ultra-high throughput satellites and constellations will need next-gen ground infrastructure to deliver next gen connectivity.

That's where Isotropic Systems' multi-beam antenna comes in — the only antenna fully capable of simultaneously linking with multiple satellites in multiple orbits. For defense, that means warfighters can have their primary comms on one satellite, back up communications on another at the same time.

That level of resiliency has never been available before, because never before has one antenna been able to communicate with virtually every commercial and government satellite in space. That is a milestone breakthrough for defense and the military everywhere.

PETE HOENE

During my time in uniform, I was constantly concerned we didn't have the bandwidth or throughput to provide a level of ISR data that we needed to proceed confidently with very critical decisions on key targets. By the time we reviewed the outdated data coming in from the field, the enemy had already moved on.

The ultra-high throughput that O3b mPOWER provides combined with this newage antenna's ability to unleash that bandwidth to its full potential means we can provide today's warfighter with ultra-high definition, full motion video surveillance feeds from the ground or aboard a UAV in the sky.

That level of truly real-time data and information from the field enables decision makers to make real-time choices with confidence. And that's absolutely critical when lives are on the line. We are going to be able to provide this mission-critical data at the speed of decision making. That's never been possible before.

What is Isotropic Systems doing to ensure your new multi-beam antenna will be commercially ready by early next year to meet the needs of new constellations and satellites coming online in MEO, LEO and GEO?

BRIAN BILLMAN

Isotropic Systems is laser focused on making sure everything is ready for the commercial rollout of our transformational multi-beam antenna.

2021 is our year of commercial readiness, as we doubled the size of our team, launched a new state-of-the-art technology center complete with clean and test rooms, anechoic RF measurement chambers and mobility testing facilities where we continue to refine our terminal solutions for defense and commercial customers.

And of course our commercial and government trials, most recently with the U.S. Army and U.S. Air Force through the innovative ***Defense Experimentation Using Commercial Space Internet*** (*DEUCSI*) program have proven we're on track to bring a completely new level of ground infrastructure to market.

Our phase two DEUCSI trials, to take place later this summer, will test our latest terminal prototype over links with SES satellites in GEO and MEO orbits. That will demonstrate simultaneous multi-orbit connectivity and open the door to a giant leap forward in resiliency and throughput for wartime communications.

Let's face it, information is absolutely critical across the battlespace and real-time data provides a real competitive edge when it matters most.

What's the very latest when it comes to the launch of SES' O3b mPOWER system, which will play a vital role in this new age of defense connectivity?

PETE HOENE

Our SES GS defense customers are incredibly excited about O3b mPOWER, as the launch of the initial satellites is set for late this year.

They are excited because O3b mPOWER will unleash 10 gigabits of throughput – enabling unprecedented intelligence, surveillance and reconnaissance capabilities for our warfighters and the entire defense network. It's a game changer and a real competitive edge for the military and government agencies looking to take advantage of real-time data sharing, top quality comms on the go, even live UAV surveillance of enemy positions in HD broadcast quality.

Boeing is building the mPOWER satellites for SES, and they've managed to stay on track throughout the pandemic. And by leveraing the multi-beam antenna from Isotropic Systems, we're on the verge of entering a whole new realm of communications possibilities for our men and women in uniform.

BRIAN BILLMAN

We've been incredibly honored to work closely with a number of defense organizations to understand their needs, pain points and overall goals so we can align our modular terminal technology with their unique requirements. In addition to the DEUCSI program with the U.S. Army and U.S. Air Force, we've also been working closely with the ***Defense Innovation Unit*** (*DIU*) to understand how our terminal can unlock high-powered bandwidth aboard next-generation naval vessels.

Isotropic Systems is looking forward to the second of these two antenna trials with SES GS and the U.S. Army to deliver this seismic shift in satcom capabilities in defense.

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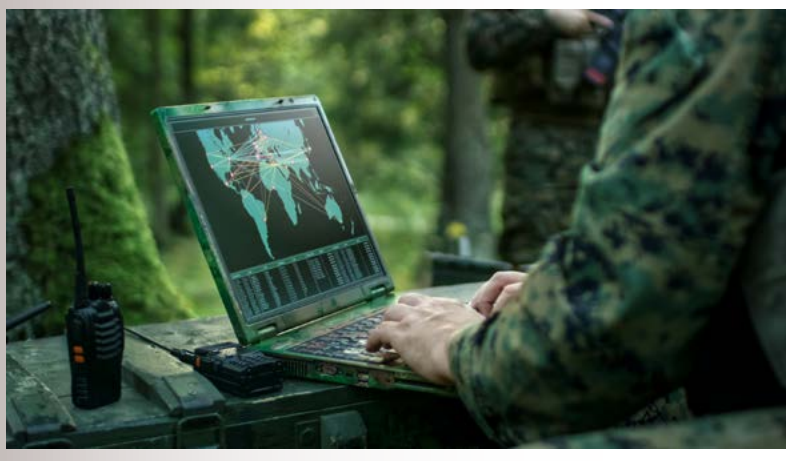

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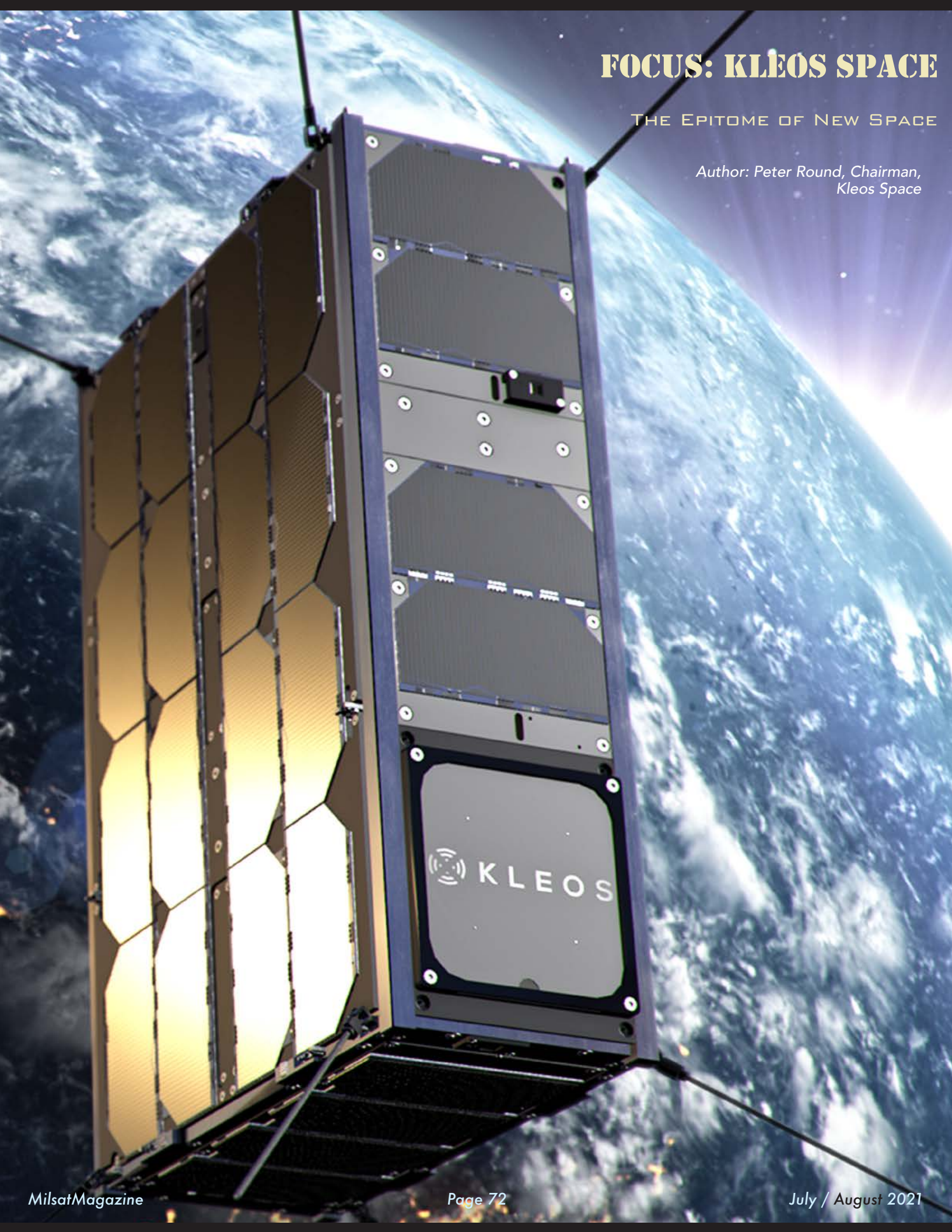
FOCUS: KLEOS SPACE

The Epitome of New Space

Author: Peter Round, Chairman, Kleos Space



Who are Kleos Space?

Kleos Space epitomizes '*New Space*.' In fact, we are not really a space company at all — or at least, that is how it should look to an end user — the warfighter, be they on land, at sea or in the air.

As a military guy myself with more than 33 years' service, I am only too aware of trying to make sense out of chaos and the hunger for more and more information to help you achieve that aim. Key to success is that the information comes from good, reliable and resilient data.

In practice, Kleos Space is a space company (*the clue is in the name*) engaged in Earth Observation (EO)... but with a difference. Kleos collects, processes and delivers data from the company's satellites and is offered as ***data-as-a-service***.

We use satellites in ***Low Earth Orbit*** (*LEO*) to detect and geolocate ***radio frequency*** (*RF*) transmissions to improve global ***surveillance, security intelligence and reconnaissance*** (*ISR*) capabilities. As Kleos' data doesn't rely on the presence of active tracking systems (***e.g., maritime Automatic Identification Systems (AIS)***), our sensor is always present and cares not whether the target is compliant or not.

Early data will give the position of the transmitting device (*including low powered handhelds*) as well as other information about the transmission. Later, as we build knowledge, more can be gleaned and there will be other users (*customers*) who will be able to extract much more from our data than we can.

I see progress with third parties as similar to app developers in the portable handheld world. Once gathered, the data can used for a myriad of things; simple mapping of transmissions, surveys on the use of the RF Spectrum, tip and cueing other (*in-space or air breathing*) assets and adding to other, existing datasets.

All we do is to support the warfighter and improve location of possible illegal activity, be that in the defence and security arena or drug and people smuggling, piracy, illegal fishing or border challenges. Our incredibly talented engineers use proprietary algorithms and data processing methodologies to derive information about a radio transmission.

Most importantly, our data products are unaffected by poor weather, unclear imagery or the location of target which can, so often, be out of patrol range for more traditional assets. Our data complements other data sources, mapping and GEOINT imagery, to provide improved situational awareness. Kleos' independent data is sold on a subscription basis to government and commercial analytics and intelligence entities around the globe. Anyone (*as long as they are friendly)* can use this data.

Kleos Space's data is suitable for a range of applications and markets, including defence, insurance, regulatory and environmental sectors. In my specialty, which is defence, our data can be used to establish a baseline and pattern of life, flag irregular activity, monitor strategic areas of interest, and tip and cue other assets to improve ISR programs and enhance border security.

Most importantly, if an event happens, we are likely to have data that actually leads up to the event — this valuable ability to look back is seldom available via other EO systems. In the insurance, regulatory and environmental sectors, Kleos' data can assist in the detection of ship-to-ship transfers, AIS spoofing and validation, navigational anomalies, regulation and enforcement of illegal fishing, and identification of complicated logistics chains that conceal cargo origins.

Talking Space

We successfully launched our first ***Scouting Mission*** satellites from India into LEO in November of 2020. This first cluster of four (***note: always four***) are in a 37 degree inclination orbit.

Our satellites provide coverage over key areas of maritime interest (***that is why we selected this orbital slot — an unusual choice for LEO***) such as the *Strait of Hormuz, South China Sea*, *East* and *West Africa*, and the *Southern Sea of Japan*. We call this the '***Scouting Mission***' and these satellites are being used to test and develop the systems required to deliver data to our early adopter customers.

The Scouting Mission satellites form the foundation of a high capacity constellation of as many as 20 clusters (of four). Our second and third satellite clusters, the ***Polar Vigilance*** and ***Polar Patrol Missions***, are both scheduled to launch in 2021 aboard a ***SpaceX Falcon 9***.

Kleos successfully launched the Scouting Mission satellites into LEO in November of 2020 — data delivery from these initial satellites will commence shortly. Image is courtesy of Kleos Space.

Both the Polar Vigilance and Polar Patrol Missions will launch into a 500 to 600 km *Sun Synchronous Orbit* (*SSO*), delivering coverage to the north and south of the Scouting Mission satellites, as well as more data in the 37 degree band. We will have complete, resilient, and frequent global coverage.

Why four satellites? Well, the techies will always say greater accuracy is received, but its more than that; four satellites ensure resilience as anyone can do the job with three, but not this well. If we lose a satellite, we are still in business. There are other reasons as well and all of them are good.

Each new launch will improve the quality and frequency of our global activity-based data, optimizing observation over multiple key areas of interest. As our constellation grows, data subscribers will be able to increase the '*areas of interest*' they can access as well as reduce revisit rates over these areas by purchasing data from more clusters.

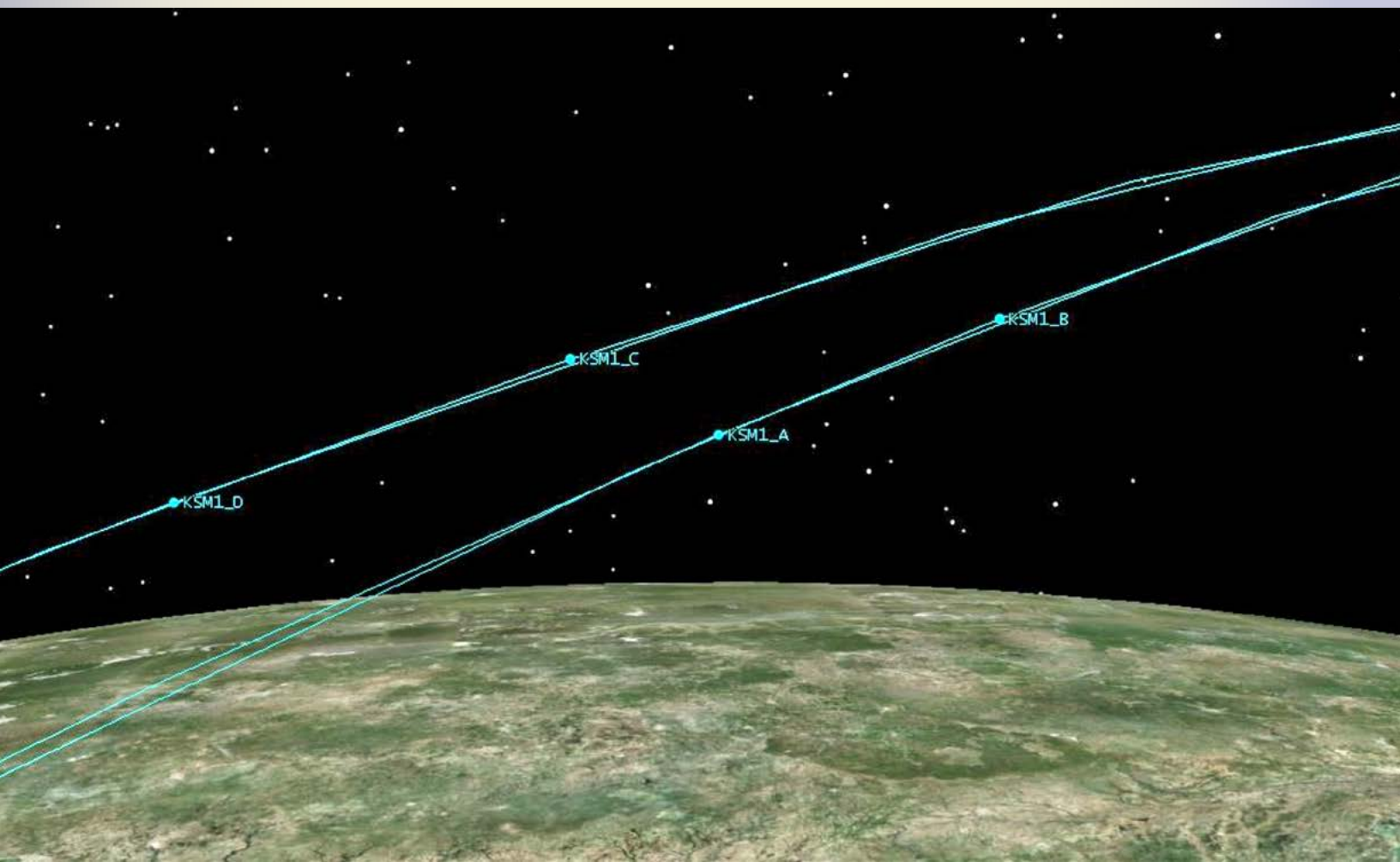
We can also vary future sensor payloads to fulfill specific customer needs. In fact, a key part of our relationship with the end-users is listening to what they want.

Who wants the data?

Well... ***everyone***! We currently have more than 160 government and commercial entities interested in our data products across the USA, UK, EU, Latin and South America, Middle East, South Pacific and Australia. Around 25 percent of these entities are resellers, providing us with cost-effective access to an even greater range of markets and customers.

As we prepare for the initial delivery of the commercial data from our Scouting Mission satellites, Kleos has already entered into contracts, agreements and discussions with subscribers from the pipeline. We're continuing to see strong interest in our geolocation intelligence data from defence entities, naval forces, coast guard and border control agencies, as well as national security agencies in many countries. This is evidenced by multiple governments and other customer organizations developing and issuing RFIs and RFPs that include requirements for the collection and analysis of radio frequency data.

Integrators and system vendors will use our data to enhance their own product offerings to end-user agencies and companies. Our initial deployments with these integrators and system vendors will provide greater insights into customer analytic environments and operational requirements, which in turn will inform future product and collection development for upcoming missions.



Artistic rendition of the last of the four Scouting Mission satellites (KSM1) undergoing final maneuvers to bring the smallsats into the operational formation. Data is downlinked, allowing the behaviour to be monitored and adjusted and this continues, as necessary, throughout the Scouting Mission lifetime. The Kleos clusters are a first in the commercial world using a combination of four satellites flying in formation with across and along-track positioning designed to optimize independence of cluster approach vector from target location over the areas of the highest value to our customers. The cluster enables as many as six antenna pairs to be used in the Kleos proprietary, multilateration algorithms – positively influencing dilution of precision and data accuracy. The Scouting Mission satellites allow the company to continually test and improve payload performance, operations and algorithms such that improvements can be easily and quickly rolled out to the rest of the fleet/constellation (the next Kleos Space cluster is launching mid-2021) with no/low risk to their operations while maximizing their data collection.

We've also recently entered into a multi-year distribution agreement with US Government IT solutions provider ***Carahsoft Technology Corporation***. This agreement provides us with direct access to Carahsoft's U.S. federal, state and local government contracts, including the *General Services Administration* schedule, *NASA's Solution for Enterprise-Wide Procurement* (*SEWP*), *Federal Information Technology Acquisition* (*FITARA*), and ***ITES-SW2*** — which supplies enterprise IT infrastructure for the *U.S. Army* and *Department of Defence*.

The US is the largest market for geospatial intelligence and reconnaissance data and we are actively targeting more than 30 government customers in this region.

I Am A Warfighter — What Will This Do For Me?

This is a great question and it's my job to continuously ask this of our tech teams and the business guys. Dealing with business first, it is our job to produce a reliable and available product at a cost that ensures all the warfighters (*the good guys, that is*) get the data. It must be affordable and available.

If the data never gets to the people at the sharp end, then there is no point. Turning to tech — this data is like none before — it covers a wide area. The target has no idea they have been detected and the data comes from a persistent sensor that is not limited by political constraints on air or sea space.

Many users will never have had access to space-based data before as that's been limited to a few, very rich countries and, even then, it's not shared with everyone who wants it — sometimes the source has to be protected.

With our data, when making the decision about where to send an *MPA* (*Maritime Patrol Aircraft*) we can answer the question *'is there anything there?'* before the crew risks their lives in, perhaps, a 10 hour mission 1,000 miles from land in poor weather.

The intelligence analyst is always looking for confirmation of what they think they know. More information and more data is their *cri de guerre*. The analyst must cross check, time and time again, and Kleos' data is a huge addition to the library from which they can select the information they require.

Our cost-effective global geolocation data can be used to validate or tip and cue other government or commercial datasets and has broad applications within defence and security, maritime intelligence, insurance, regulatory and environmental sectors.

The data enhances the detection of illegal maritime activity such as border and security challenges, piracy, drug and people smuggling, and illegal fishing.

Our geolocation intelligence data provides unprecedented situational awareness to support critical defence and security missions, reducing reliance on resource-heavy intelligence data.

As stated earlier, RF spectrum mapping can be used to establish a baseline and pattern of life, monitor strategic areas, send real-time alerts, or be integrated with multiple sources to improve deployment and automation. In addition to cost-effectively monitoring strategic areas of interest, it can be aggregated with other datasets to validate information accuracy and improve mission success rates.

Kleos' data enables surveillance over exclusive economic zones and when paired with AIS data can be used to verify and validate vessels to combat illegal and unregulated fishing. It can also detect ship-to-ship transfers, AIS spoofing, illegal port calls, and navigational anomalies to assist in the identification of illegal activity and enhance maritime compliance programs.

What Is The Kleos Strategy?

Unlike conventional GEOINT datasets that can be compromised by weather, distance or sea-state, Kleos' RF technology is able to detect transmissions independent of other systems and is effective, even when systems such as AIS is defeated, imagery is unclear, poor weather, or targets are out of patrol range.

The company's strategy focuses on enabling others' advanced analytic systems, tipping and queuing other ISR platforms to leverage our RF geolocation data to provide the practitioner with the insight into marine and other activity that remains out of reach for conventional ISR systems.

We're also working directly with key customers in government agencies around the world, who are looking to integrate radio frequency geolocation data into existing and future ISR platforms to support a wide variety of civilian and military use cases.

Uh, You're All At Sea?

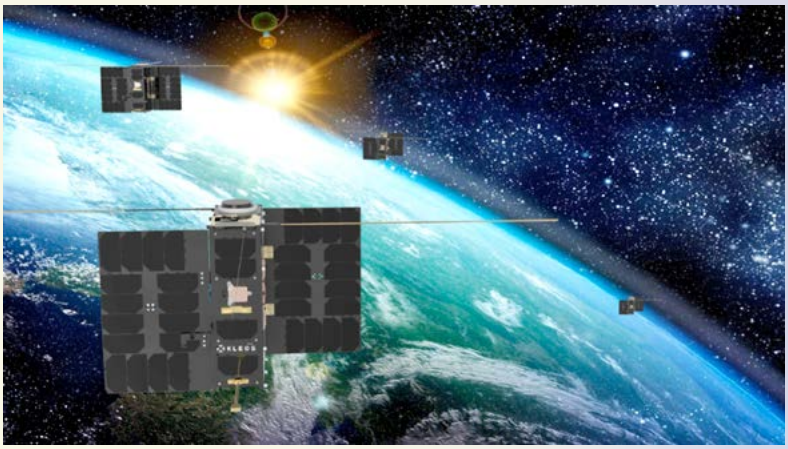
Our early data will be focused on the maritime domain. This is a good place to start due to the wide-open spaces, the availability of suitable *Software Defined Radios* (*SDR*) and the fact there are a lot of people at sea behaving badly.

However, the process works anywhere on the planet and in space (*hello SSA!!!*) and we will increase our frequency coverage as we launch more satellites. We are not worried about foliage, weather or daylight. Interestingly, marine band radios are used everywhere, they are inexpensive and effective, so we already have a land capability.

This is new, exciting work and Kleos Space is at the forefront of these capabilities.

Update

Our second satellite cluster, the ***Polar Vigilance Mission***, successfully *launched in June 2021 aboard a SpaceX Falcon 9. Launched into a 525 km Sun Synchronous Orbit (SSO). The Polar Vigilance Missions delivers coverage to the north and south of the Scouting Mission satellites as well as more data in the 37-degree band. The third satellite cluster, the* ***Polar Patrol Mission****, will launch in late 2021 into a 500 to 600 km SSO.*



Artistic rendition of Kleos Space's Polar Vigilance Mission smallsats on-orbit. Image is courtesy of the company.

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KLEOS

Air Commodore Peter Round MA BSc (Hons) FRAeS is the Senior Government and Military Advisor and Chair of the Kleos Space Group. He is an internationally renowned, strategic executive with extensive experience in the U.S., the European Union and NATO.

As a retired senior military officer and fast jet pilot, Pete has had a long and varied military career, including commanding operations and leading multiple contracts within Defence. He is a former Capability Director at the European Defence Agency and an expert in EU Defence issues and military affairs. He has extensive experience in inter- and intra-government policy development and communication.

Today, Pete remains a military reservist and is President Elect of the Royal Aeronautical Society (RAeS), the world's oldest, learned society for the advancement of aeronautics and space.

SPACECRAFT GROUND OPS BENEFIT FROM CLOUD ENVIRONMENTS

Author: Crystalyn Koch, Strategic Communications, Parsons' Space and Geospatial Solutions

Historically, space ground control operations evoke images of a bustling, fully manned room filled to the brim with expensive hardware. Every command would require the full attention of operators and an entire fleet of IT professionals to ensure each piece of hardware continued to run optimally.

While these images will likely always be the way Hollywood perceives ground operations, the landscape of satellite ground control is on the threshold of revolution. The ***Space Foundation*** issued a *2020 Space Report* detailing the rapid growth of the space domain, with spacecraft deployments tripling from 2019 to 2020 and a 477 percent increase of communications satellite deployments within the same period.

Modernization of legacy spacecraft ground control and mission data processing infrastructure is mandatory to adequately increase capacity for the control and data processing produced by new space systems. The rapidly expanding commercial space market has overtaxed existing government and commercial ground assets, resulting in financial, time, and availability constraints within all areas of mission control.

The implementation of cloud applications is one of the latest technical trends in the industry to alleviate these common operational issues. ***Parsons Corporation*** strives to modernize mission solutions and offers hybrid cloud environments, allowing the customer to distribute and scale their mission across on-premise hardware and cloud deployments to balance their budget and mission capabilities.

Cloud environments enable immediate scalability for rapidly growing programs and industries, allowing flexibility and operational agility while ensuring continued support for rapidly multiplying needs. Integrating existing ***Satellite Operations Center*** (*SOC*) capabilities into cloud environments provides comprehensive benefits to all commercial and government satellite customers. With large upfront capital and future recapitalization hardware investments nearly eliminated, cloud-based ground control solutions adequately fit inside notoriously limited smallsat budgets. Cost savings also include the implementation and maintenance costs typically associated with hardware and software purchases.

These savings result in predictable budgeting as it is billed as a service, taking the stress out of hardware ownership — there is no need to worry about additional funds that may be needed due to unexpected hardware failures. Cloud environments level the playing field for start-up space ventures by removing the large capital barrier previously required for on-premise solutions, allowing them to focus on disruptive cloud applications to enter the market, remaining lean and agile.

Parsons enables increased capacity for satellite operations by offering customers a commercial antenna service that operates in a cloud environment, using globally distributed commercial antennas to communicate with spacecraft. The ability to access antenna time through a service allows customers to pay by the minute versus the burden of financing and maintaining their own antennas. Legacy stove-piped systems required programs to build entire infrastructures for each mission; however, customers can now leverage ground control providers who take advantage of standardized architectures that are enabled by cloud applications.

Automation is a critical aspect of successful cloud environments for ground control. With the help of software, such as Parsons' ***Intelligent Resource Optimizer***, fully automated event-based scheduling operations, human-machine collaboration, mission planning, what-if analysis, and continuous deconfliction capabilities are enabled. Automation increases system resiliency and capacity, supporting lights-out 24/7 operations that may have not been financially feasible before cloud capabilities were introduced.

In a world of COVID-19 precautions, the flexibility offered by automated cloud applications has allowed critical space missions to continue largely uninterrupted by a global pandemic that has otherwise debilitated countless industries internationally. Perhaps the most valuable aspects of cloud-based applications are the resiliency and redundancy they offer over traditional structures.

Legacy operations require a minimum of two sets of hardware to serve as on-line backups in an instance of failure. In a cloud environment, redundancy is built in and allows operators to simply bring up another instance if a component were to fail. This ensures continuous availability of systems and prevents the need for multiple sets of expensive hardware components. Redundancy benefits also include automatic data backups for mission critical information, the revenue-generating function of most space systems, allowing a level of safety and security for an order of magnitude less cost than legacy resources.

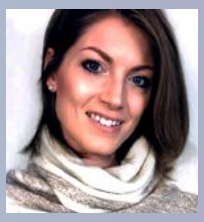
Test and validation are often overlooked in the smallsat world due to limited budgets but are becoming commonplace as cloud capabilities offer simulated environments that provide unlimited resources for test and validation. Parsons' mission solutions leverage cloud applications to provide multiple solutions for test and validation. These solutions range from a ***Factory Compatibility Tester*** that tests and validates the RF interface to spacecraft before launch, to a common simulation environment which simulates the ground control system, antennas, and spacecraft, allowing test, checkout, and rehearsal of all mission applications, procedures, and staff operations prior to launch.

Parsons' cloud environments for testing and validation provide ecosystems to prototype and validate technology while allowing operators and engineers to experiment with new technologies in a realistic environment without risking operational assets. To maintain pace with the explosive growth of the global space industry, it is often necessary to transition existing systems toward cloud architectures and take advantage of cloud-hosted applications that increase capacities while reducing costs and enhancing efficiencies.

The benefits of using cloud applications are exponential, improving competitive edge and redundancy while nearly eliminating significant financial, availability, and time constraints. Parsons fully supports the new age of space ground technology and has additional cloud-hosted applications being created throughout the year to support diverse customer and mission needs.

To learn more about Parsons' leading space capabilities, please stop by ***Space Symposium*** **booth #1036**, ***Satellite 2021*** **booth #2018**, or visit: ***hwww.parsons.com/capabilities/space/***

Author Crystalyn Koch leads strategic communications for Parsons' Space and Geospatial Solutions. She specializes in leveraging her marketing and communication skills with knowledge of Parsons' space capabilities to develop relevant material and direct solutions to meet challenges faced by the space and geospatial market.



COMMAND CENTER: MELANIE STRICKLAN

Co-Founder and Chief Executive Officer, Slingshot Aerospace

Melanie Stricklan

In 2017, Melanie Stricklan combined her military experience and indomitable spirit to co-found Slingshot Aerospace, a company that is empowering organizations with its decision intelligence technologies for space. Today, she is the company's Chief Executive Officer where she leads the strategic vision, product development, and growth strategy. Having proudly served in the United States Air Force for 21 years, Melanie possesses a unique blend of leadership and technical expertise that enables her to create and execute winning business and product strategies. During her Air Force career, she logged over 1500 flight hours onboard ground surveillance aircraft, commanded experimental spacecraft missions, and led the development of space control technologies for the Department of Defense. Her personal decorations include the Air Medal, Meritorious Service Medal (two awards), Air Force Commendation Medal (four awards), Air Force Achievement Medal, and the John L. Levitow Award for outstanding leadership.

Melanie holds a Bachelor of Science in Aeronautics from Embry Riddle Aeronautical University and a Master of Science in Space Operations Management with an emphasis in Space Systems Engineering from Webster University. She was named the 2019 Entrepreneur of the Year for El Segundo, California, and named one of Inc. Magazines 2019 Top 100 Female Founders in the United States. Melanie was named a Techstars All Star Mentor, a recognition from her peers within the prestigious aerospace accelerator for her gold standard of mentorship. A trailblazer in the industry, Melanie frequently speaks at conferences about the value of situational awareness and advancing space sustainability, and hosted a TED Talk discussing how images from space help us protect Earth. She is a champion for STEM initiatives, and enjoys inspiring youth to challenge themselves and pursue their dreams.

Good day, Ms. Stricklan… would you please tell our readers about your background and how you became involved with Slingshot Aerospace in the first place?

MELANIE STRICKLAN

Growing up in rural Texas, I was inspired by the night sky and looking up to see the Milky Way on a nightly basis. In 1986, I took a trip to McDonald's Observatory and became infatuated with space and all its grandeur. Haley's Comet was flying that year and we could see it through the telescope. It was really cool to watch knowing it wouldn't be visible for another 75 years.

With my new found love for space, I was naturally drawn to NASA's shuttle program and Christa McAulliffe as the first teacher in space. I recorded everything about the Challenger mission leading up to the launch on our family VCR, and I watched in devastation as the Challenger exploded. It was my first experience with death and loss, and because I was so inspired, I really felt it. That loss taught me what it meant to put service above self and what it meant to be mission-driven.

This moment in time led me to explore how I could be a part of something bigger than myself, and I eventually enlisted in the U.S. Air Force. During my service, I flew on a Joint Surveillance and Target Attack Radar System (JSTARS) aircraft and then later led experimental space operations as well as multi-million dollar space acquisition programs.

It was during this time that I realized how quickly the space domain was becoming increasingly complex with a growing number of satellites, vast amounts of orbital debris, and more nations competing for superiority.

To complicate things further, the data collected from objects in space had coverage gaps, was often conflicting, and nearly impossible to analyze at the speed of relevance. This problem has continued to intensify as space data continues to scale exponentially. Today, space operators are faced with high-risk decision-making because they don't have access to complete, interoperable, accurate, and real-time information. It is imperative they know what each orbital object is, where it's located, where it's going, and what is in its path to avoid collisions with non-reversible effects.

I joined forces with fellow Air Force Veteran Thomas Ashman and experienced entrepreneur and software architect David Godwin to combine our passions for Space sustainability, national security, and cutting-edge technologies. Together, we created Slingshot Aerospace to solve this critical problem for government organizations as well as the growing number of industry players.

Would you please tell our readers what is Slingshot Aerospace?

MELANIE STRICKLAN

At Slingshot Aerospace, we are building world-class space simulation and analytics solutions. Our company is driven by a vision of accelerating space sustainability to create a safer, more connected world.

Space is increasingly complex due to the exponential growth of global launch activity, the proliferation of new data sources, and the ever-growing body of new satellites and debris. Organizations are making mission-critical decisions in this high-risk environment and they need the right information at the right time. Slingshot Aerospace empowers government and commercial space organizations to better design, manage, and safeguard their assets, as well as mitigate risks, to ensure safe and reliable operations for all spacefaring users.

We achieve this by bringing the space domain into the digital environment and fusing data from different sources to provide a full, dynamic orbital picture. In doing so, our customers can make decisions at the speed of relevance and achieve clarity in complex environments.

Why do you believe Slingshot Orbital is a groundbreaking company?

MELANIE STRICKLAN

The innovation of Slingshot Orbital has helped our company cultivate a strong foundation of customers over the last four years including NASA, United States Air Force, United States Space Force, and more. It is the only product on the market that aggregates both public and private information collected from sensors on the ground and in space and applies analytics for reliable results. The product validates the accuracy of the information collected by comparing data from different providers ensuring its integrity while also facilitating a framework for consistent reporting. By bringing all the information together in one place, Slingshot Orbital enables quick and informed decisions in critical situations, which could help save lives during humanitarian response or military operations.

Slingshot Aerospace participated in numerous Department of Commerce and U.S. Space Force Sprint Advanced Concept Training (SACT) exercises. Slingshot Orbital assessed the accuracy of the space catalog with government and commercial data sources, as well as compared states of objects in orbit to an independent high-precision calibrated state to build data integrity. Slingshot Orbital created the world's first "streaming platform" for space situational awareness by fusing multiple data sources and visualizing timely and accurate maneuver detection and pattern of life. This is important to ensure safety of flight, consistency of operations and accountability. Slingshot Orbital provides intuitive, reliable, trustworthy data of what is happening in, and through space.

What problems are Slingshot Aerospace solving?

MELANIE STRICKLAN

As Space becomes more congested, organizations are making high-risk decisions without access to complete, accurate, real-time, interoperable information. At Slingshot Aerospace, we are building space simulation and analytics solutions that empower customers to make better decisions and optimize for next-generation space sustainability in the design, manufacturing, and operation of their assets. Our technologies are providing customers with a full picture of the space domain so they have all the right information, at the right time, all in one place, enabling them to make informed decisions at a record pace.

Who are Slingshot Aerospace's military/agency/government customers?

MELANIE STRICKLAN

We target both government and commercial organizations and are very fortunate that, in less than four years, we are generating revenue from some of the most notable government agencies, such as the U.S. Space Force, U.S. Air Force, and NASA.

What products are you currently offering these customers?

MELANIE STRICKLAN

Today, Slingshot Aerospace is offering two products: Slingshot Laboratory and Slingshot Orbital. These space simulation and analytics solutions bring the space domain into the digital environment so our customers can achieve clarity in space and make decisions at the speed of relevance. We are making the space environment understandable and intuitive by creating a digital baseline to assist the space user of today in space operations - and the space user of tomorrow in our education modules.

Slingshot Laboratory is a first-of-its-kind space simulation platform that teaches students and professionals the fundamentals of astrodynamics. The software provides a modern and engaging way to learn and train space flight and orbital scenarios.

Slingshot Laboratory is the only easy to use, immersive, and collaborative technology that enables the comprehension of complex astronautics. It provides visualization across space and time with an accurate physics engine while facilitating interactive participation. Students and professionals can govern their own virtual environment, empowering them to learn foundational theories that will lead to better and faster decision making in operational settings.

For example, Space Force trainees will use Slingshot Laboratory to visualize, manipulate, and analyze orbital characteristics and objects in order to understand the space domain. Intended to teach the most basic astrodynamics to grasping new and emerging space operations, Slingshot Laboratory will be "the" tool across the space community to understand, learn and communicate about this complex environment.

Slingshot Orbital creates trusted situational awareness information – providing an objective source of sensor data quality and providing tracking and prediction of objects' locations, events, and status in orbit – by combining and cross-referencing data from various sources. Accurate physics and a robust data archive are combined with advanced analytics to characterize objects, detect threats, protect assets, and manage space traffic.

The foundational element of operating in any domain - air, sea, land or space, is the same. You need exquisite information about what is around you, where things are going, what they are and what their intentions may be. It's the most basic and fundamental elements that ensure safety in operation. For example, Slingshot Orbital can be used to track the ever-growing number of satellites and debris that are increasingly filling Earth's orbits so operators can avoid catastrophic collisions that could trigger non-reversible effects.

Who is leveraging Slingshot Laboratory?

MELANIE STRICKLAN

Last year, Slingshot Aerospace entered into a contract with the U.S. Space Force to develop Slingshot Laboratory as a next generation space training tool. The technology

will replace outdated and complicated tools with a new, modern and engaging way to perceive, comprehend, and predict object relations in space and orbital scenarios.

Our company partnered with THE THIRD FLOOR, the world's leading visualization studio helping realize blockbuster films and shows such as Gravity, The Martian and The Mandalorian, to co-create a space visualization solution that is interactive and physics-based. We envision Slingshot Laboratory can be the tool to help people throughout their space careers - from learning the basics of astrodynamics, to negotiating terms of key policy parameters to ensure safety of flight, our tools can enable improved communication and interaction across all participants in the space community.

Without giving the "game away," how does the company improve operations for government and/or commercial entities that are involved in the satellite and space market segments?

MELANIE STRICKLAN

First and foremost, our team is uniquely positioned to solve the pain points of our government and commercial customers because of our military and entrepreneurial backgrounds. We understand the unique challenges of each industry which allows us to understand and solve specific problems.

As we navigate this new space industry revolution, we must prepare a global workforce for space operations for both the government and commercial sectors. This is perhaps the most first step in improving satellite and space market operations, and Slingshot Aerospace is solving this problem by flipping space education and training on its head with Slingshot Laboratory. The revolutionary tool will transform space education by making it more accessible, which will ultimately improve space sustainability and operations.

Additionally, we emphasize the importance of customer discovery which is a key component of improving operations for our customers. By doing so, we've learned the space ecosystem needs robust and scalable systems that fuse and aggregate the myriad data sources at near-real time speeds. Trust and accessibility are equally important in order to gain the global adoption needed for long-term safety and sustainability, and space data must be accessible with transparency and provenance such that consumers of the data have the trust necessary for decision making. We created Slingshot Orbital to address this problem. The tool is a real-time, web-based, streaming data platform for commercial and government operators that ingests multi-modal space data from multiple providers. This allows us to transform, curate, and verify data so it's ready for machine learning and artificial intelligence capabilities.

Would you please tell our readers about some of Slingshot's successes?

MELANIE STRICKLAN

Earlier this year, we enhanced our focus on the space industry and expanded on our space-related projects. We secured several substantial contracts including two with the U.S. Space Force. One contract was to develop Slingshot Laboratory, our easy to use, immersive, and collaborative educational tool that enables the comprehension of complex astronautics. The other contract was to develop a sophisticated tool that streamlines the visualization of enemy missiles and enhances data integration and mission-critical collaboration. The technology will give the Space Force efficient ways to view and interact with complicated data sets. With this technology, we are laying the groundwork to be able to support the Department of Defense's new, high-priority missile warning satellite program, Next Generation Overhead Persistent Infrared (or next generation OPIR).

Additionally, our company was one of 26 teams out of 800 participants selected at AFWERX Space Challenge where our Slingshot Orbital solution received a contract from the U.S. Air Force. Lastly, we were selected as a winner for International Space Pitch day and was immediately offered a first-of-its-kind, joint contract from the U.S. Department of Defense's Air Force and the United Kingdom's Ministry of Defence (MOD). The great work being accomplished for our company's high-profile space customers exemplifies Slingshot Aerospace's successes.

What do you believe are the top three concerns for companies that are involved in this industry? In your opinion, how should these be addressed?

MELANIE STRICKLAN

The top three concerns for companies in our industry are transparency, education and standardization. All three impact one another and are imperative for sustainable and safe space operations.

Hesitancy from companies and governments to share ephemeris or positional data of their satellites is a huge safety threat to space. By promoting transparency through data sharing, the space community will improve overall operations and reduce the risk of catastrophic events. At the same time, it will open the door for more innovation and long-term sustainability. Slingshot Orbital addresses this problem, though educational resources will also be key to achieving transparency so operators understand the domain and how it works. However, outdated education tools are also major concerns.

Educational tools and resources aren't scaling as space continues to revolutionize and become increasingly democratized, which means we can't promote transparent and sustainable space operations. It's critical that cutting edge tools and resources are available at scale as more and more players enter the space domain. We've created Slingshot Laboratory to bridge the gap in space education and promote a standardization of tools and resources.

Standardization, or the lack thereof, is the third major concern for organizations in the space industry. Today, a lot of companies create their own software to manage their space operations. This creates a barrier to transparency since everyone is not on a standardized system with cohesive reporting. Space is a shared domain and standardization will help minimize conjunctions and other irreversible events, as well as promote accountability amongst operators.

When you review your career, what project or missions truly bring a smile and sense of satisfaction to you?

MELANIE STRICKLAN

Founding Slingshot Aerospace truly brings a smile and sense of satisfaction to me. It is perhaps the greatest risk I've ever taken, which means it has also been the greatest reward. I truly believe in our vision to accelerate space sustainability to create a safer, more connected world. The work we are doing is so important and I'm excited to play a part in preserving space for generations to come.

I am also a proud Air Force veteran. During my time in the military, I flew on JSTARS and had the opportunity to lead those missions and save lives. I was also on the ground floor of Geosynchronous Space Situational Awareness Program (GSSAP), which at the time was a revolutionary space surveillance satellite program and many other next generation space technologies that are integral to national security.

We hope you will stay tuned as this is just the beginning for us. We have some exciting new commercial product developments that we will announce later this summer.

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SPACE AWAITS.

KYMETA AWARDED A $950 MILLION IDIQ CONTRACT FOR JADC2 COMMS SUPPORT

Kymeta **has been awarded a $950 million ceiling, Indefinite-Delivery/ Indefinite-Quantity (IDIQ) contract for the maturation, demonstration and proliferation of capability across platforms and domains, leveraging open systems design, modern software and algorithm development in order to enable *Joint All Domain Command and Control* (JADC2).**

The contract is part of a multiple award multi-level security effort to provide development and operation of systems as a unified force across all domains (air, land, sea, space, cyber, and electromagnetic spectrum) in an open architecture family of systems that enables capabilities via multiple integrated platforms.

Kymeta's next-generation solutions, including the ***Kymeta™ u8*** terminal and ***Kymeta Connect***™ connectivity services, offer seamless and uninterrupted mobile satellite-cellular and is designed to meet the needs of defense agencies, government, public safety, and commercial customers around the world.

Today, the u8 is the only commercially available flat panel antenna that is compatible with LEO and GEO satellite constellations. Kymeta u8 terminals, antennas, and ODUs are easy to set up and acquire service within minutes of installation. The u8 is also available in a transportable configuration called the u8 GO, which is ideal for rapid deployments.

"*Kymeta is pleased to participate in the Advanced Battle Management System (ABMS) competitive category for connectivity*," said ***Rob Weitendorf***, Vice President, Business Development, Kymeta. "*Our advanced technology is proven effective for rapid deployment, offers the highest levels of security and encryption, and is essential for mission critical operations. We are confident in our ability to provide connectivity solutions to U.S. Department of Defense organizations through JADC2.*"

BRAZILIAN MILITARY AWARDS COMTECH GOVERNMENT SOLUTIONS WITH $3.2 MILLION FOLLOW-ON CONTRACT

Comtech Telecommunications Corp. **(NASDAQ: CMTL) has announced that during the firm's fourth quarter of fiscal 2021, their *Government Solutions* segment was awarded a $3.2 million follow-on contract from the Brazilian military to supply additional satellite equipment and services for that nation's Air Traffic Control network.**

"*We are pleased that this customer continues to deploy our advanced satellite communication solutions to support their critical infrastructure*," said ***Fred Kornberg***, Chairman of the Board and Chief Executive Officer of Comtech Telecommunications Corp. "*We look forward to continuing to work with the Brazilian military on this and future opportunities.*"

COMTECH XICOM'S TWTAS RECEIVE CONTRACT FOR U.S. MILITARY COMMS SYSTEM

Comtech Telecommunications Corp. (NASDAQ: CMTL) has announced that their Santa Clara, California-based subsidiary, Comtech Xicom Technology, Inc., has been awarded a $2.0 million order for rugged, Ka-Band, high power, traveling wave tube amplifiers ("TWTAs") for a U.S. military communications system that provides a secure internet connection to U.S. soldiers without the need for fixed infrastructure.

"Comtech Xicom Technology's line of high-power amplifiers ("HPAs") are e*mployed in military communications applications around the globe. From transportable to airborne applications, Xicom leads the way for high-quality, state-of-the-art TWTAs and solid-state power amplifiers ("SSPAs"),*" said ***Fred Kornberg***, Chairman of the Board and Chief Executive Officer of Comtech Telecommunications Corp. "*We are happy to be selected to deliver reliable and high-performance Ka-Band amplifiers.*"

Comtech Xicom Technology, Inc. manufactures a wide variety of tube-based and solid-state power amplifiers for military and commercial satellite uplink applications. The product range encompasses power levels from 8 W to 3 kW, with frequency coverage in sub-bands within the 2 GHz to 52 GHz spectrum. Amplifiers are available for fixed and ground-based, shipboard and airborne mobile applications.

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MEETING CHALLENGES

For Expanded Capabilities Of Military Orbital Satellites

Author: Robert Stanton,
Director of Technology,
Omnetics Corporation

The defense space theater is rapidly evolving into a race for enhanced satellite capabilities in monitoring, analyzing and preparing Earth systems for potential support and direction from above.

Adding to complexity, defense systems are coupling services of multiple satellite orbits for more accuracy, constant visibility and better, precise position, point accuracy.

GEO satellites being used by the defense industry have the advantage of adding to multiple usage options when other satellite systems are active or in distress from contesting nations or other interruptive factors. GEO satellites travel parallel to the rotation of Earth and fly at the same speed, giving an appearance of being stationary above one point. They are, however, farther removed from Earth and offer a significant space reference point using far-star tracking for position management.

As GEO orbits are quite far above Earth, signal transmissions can be weaker and slower than the closer orbits of ***Medium Earth Orbit*** (*MEO*) satellites that are orbiting in the range of between 3,000 to 7,000 miles above Earth.

More rapid and immediate transmissions are available now from linked constellations of ***Low Earth Orbit*** (*LEO*) satellites orbiting as close as 500 to 1,000 miles overhead.

Based on needs for increased monitoring, high speed control and communications, our defense industry is using MEO and LEO constellations in a coordinated fashion, netting very rapid transmission speeds with minimum delay times in the tenths of seconds. As Earth proximity is a key to extending data speed, more digital information, military capabilities are greatly expanded.

Additional communication, direct control over autonomous vehicles and coordinated situational awareness is up to date. In addition, new equipment and defense systems are employed when immediately required.

More Data And Control

The amount of data being collected, processed, stored and transmitted is growing exponentially with advancements in remote munition control and autonomous devices. Newer defense satellites are deploying ***High Throughput Satellites*** (*HTS*) that handle more than 100 Gigabits/second. This is accomplished on high density chip systems that are programed to store and transmit data bits from selective cells that are separated from each other to avoid adjacent cell sequencing.

Older, cell radio transmission methods used cell storage systems and pulled data sequentially from across the array. Unfortunately, this method of pulling data from the adjacent points in the cell set causes co-channel interference noise because they are so close and burst effects transmitted to other cells, much like cross-talk in electrical circuit boards.

Advanced chip design matrix layouts for onboard computers now avoid this issue and handle significantly higher speed signal speeds to assist in battlefield data management. Additional, signal transmission speeds are being achieved by adding multiple messages on one transmission pulse or cycle.

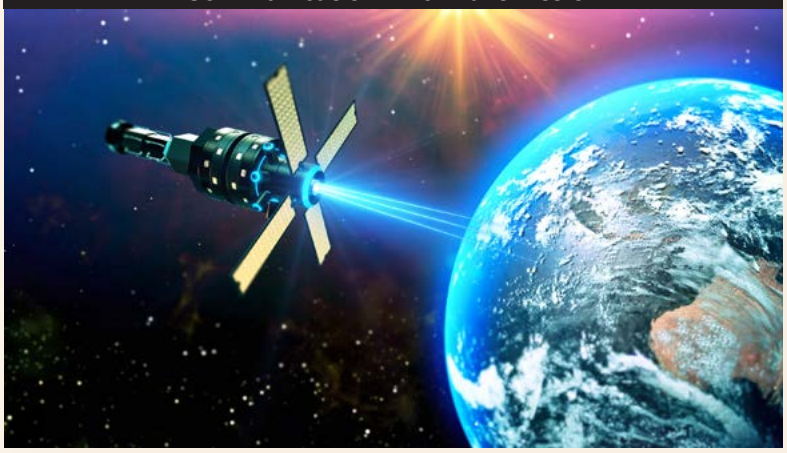
New signal modulation methods called "*PAM,*" or *Pulse Modulation Signaling*, employs the one signal burst as the carrier frequency, but it couples many signals on that signal. This is accomplished by starting the first signal at a voltage level of, say, 3 volts, that goes as high as 7 volts before returning to 3 volts. This is sometimes called ***non-return to zero*** (*NRZ*) signaling.

Immediately above that message another signal is set to start at 12 volts and swings up to 16 volts before returning to its base line of 12 volts. When managed well, the two signals run in parallel on the one primary carrier signal and do not couple across to one another.

A currently popular modulation process is called *PAM-4* as is carries 4 simultaneous signals, giving the user 4 times the data transmission as when only one signal is transmitted. Additional transmission methods include multiple phase-shifting of multiplexed signals that can run on a similar principle idea.

Designers are developing methods to assist with transmission methods for space related quantum computing in ranges that can approach terabytes per second data transfer.

Communication And Transmission



Laser beam communications via satellite.

To handle these levels of multiple signaling techniques, ***military satellite communication*** (*MILSATCOM*) systems are applying highly modulated, laser beam communications from satellite to satellite, as well as down to Earth. Laser transmission is actually an integrated, optical communication method which includes a transmitter to encode messages into optical signals, a laser beam that carries the signal to its destination and a receiver to collect and reproduce the message from the optical signal.

This is similar to the fiber-optic modems we use in our home for TV, with the signal modulated inside the beams of light from the laser. Advanced semiconductor lasers offer wavelengths thousands of times shorter than broadcast systems and operate in much narrower focus area.

Phased array positioning electronics directly control the laser beam focus to the exact position that the laser beam is targeted. By using a small amount of power and multiple target points in the general direction needed, a beam focusing nozzle is aimed electronically at one pre-determined point. This phased array process helps to eliminate the open-spray or circular image we are familiar with in standard weather radar patterns. (*Portable phased-array radar on the battlefield employ a similar algorithm for precision point munitions control on Earth.*)

Narrow beam focusing of laser transmission can be challenging, and demands excellent precision point aiming and accuracy. Additional studies are being made to potentially include laser beam point devices with new MEMs controlled, reflector mirrors that can add to hitting exact targets in key cases. The combination of using HTS data management at the chip level and the use of infrared light in laser transmission handles significantly faster data transmission than older radio waves with their high density wavelength patterns.

NASA has rapidly expanded their focus on using lasers in two ways. LEO orbits are close to Earth and Satellite to Satellite communication is faster because the distances are shorter. By using f***ree-space, optical communication***, (*FSOC*), new lasers transmitters exceed data transmission by 10 fold to rates of 5Gbit/sec to 10Gbit/sec. while achieving it with lower power and narrower focus than the older radio transmitting process.

In addition, a laser beam remains somewhat narrow in diameter and offers less noise and a more concentrated beam that is difficult for interception, except for the intended station. The stations on Earth receive more clean data faster compared to radio wave transmission, as well.

Surveillance Sensor Technology

Satellite hyperspectral image.

Military satellite network success starts with surveillance and the collection of data and then transferring it from satellite to satellite within the orbital constellation, as well as in providing useful information to Earth.

The surveillance imaging systems face multiple challenges within the various environments they experience as well as in seeing what is below on earth. Defense satellite imaging cameras will need to detect and report a wide range of data, beginning with topographical altitudes, land vs water and mass foliage growth.

More challenging tasks include detecting military activities hidden within forests, under camouflage and facilities painted to appear as part of the landscape. Multi-spectral imaging cameras have been employed and do a fair job of collecting information by focusing on separated sets of red, green and blue imaging sensors plus one infra-red sensor. The sensors can attenuate the illumination of each set when needed to add resolution and clarity to images seen by the camera.

The frequency of each sensor set is somewhat limited to a range of 400 Nano-meters out to approximately 700 Nano-meters in wave length. They do offer improved images over standard visual spectrum lens cameras when the sets are kept separate and image data is processed before combining the final image.

Multi-spectrum instruments can also be valuable for dark and or night vision systems with an additional set of infra-red sensors in combination with other application. Military satellites with hyperspectral imaging cameras provide optical data from a much wider electromagnetic spectrum than multi-spectral systems.

Electromagnetic signals are collected from ultra-violet, standard RGB visible range and on into the near infrared and/or the very short-wave infrared spectrum. As we know, spectrometry analysis systems such as this provide both color and light intensity or reflection that can indicate what materials the camera is observing.

When the military needs more exact information about devices, chemicals and even plating on metal devices, data can be collected by analyzing individual pixels while scanning over the entire surface area in view. Both overview scanning and or individual analysis methods are available with hyperspectral imaging systems. Using a combination of methods assist military surveillance systems the ability to see though camouflage netting and define various materials from metal to chemical storage in strategic arenas.

Positioning In Space

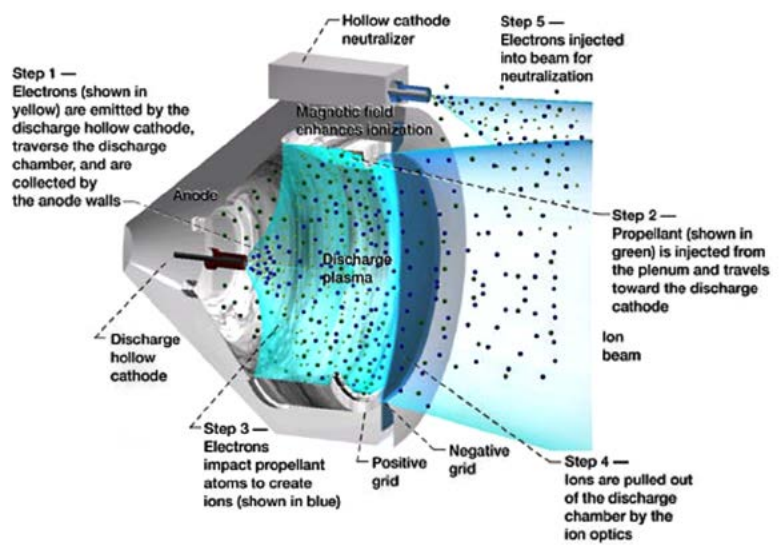
The BCT Star Tracker. Image is courtesy of the company.

Precise positioning of satellites is achievable with the use of a star tracking unit. A well-established list of star positions can be maintained in data bases onboard the satellite and, in some cases, depending on optical quality and resolution of the tracker, it can refer to the onboard data that defines individual stars in relation to prerecorded patterns of those stars above.

It is critical that both LEO and MEO satellite positions relate to Earth as well as their coordinative positions with their constellation. As satellite size and weight continues to be critical, a number of precision optical sensor and detection companies have offered excellent on board satellite based star trackers. Working in conjunction with gyroscopes and the beam position of other satellites they help sustain device attitude as well as relative position.

Previously, cubesat's had limited attitude position measuring equipment. BCT and JPL have developed a line of miniature star trackers while on projects such as ***XB3*** and ***RAVAN*** programs for the ***NLAS*** 3U cubesat.

Today's high resolution images are collected and measured in smaller instruments, such as the ***Blue Canyon Technologies*** tracker. This unit offers precision attitude position in a compact package weighing only about 500 grams and contains an on-board catalog of more than 23,000 stars. It can detect stars down to a 7.0 magnitude and helps set orbits at specific altitudes needed in a package designed for the small satellite industry. High reliable interconnects are used to send position



Ion thruster design, courtesy of NASA.

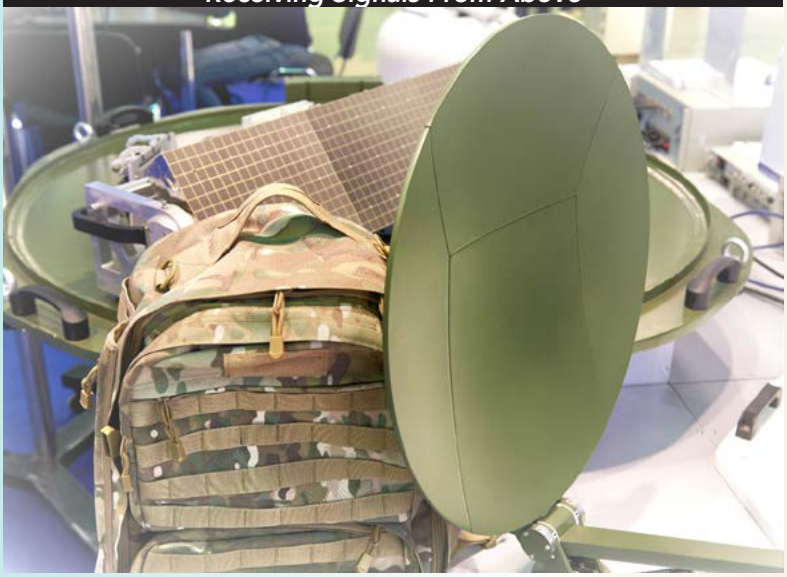
and navigation data to other components within the satellite and back home to the control center.

Satellite Propulsion

Ion propulsion thrusters have significantly evolved and are small enough to assist satellites in sustaining both attitude in relation to Earth and for moving satellites into or out of its place within the constellation.

NASA explains they are using solar energy to focus electrons onto plated metal walls inside a thruster cavity. The heated metal emits ion plasma particles off the walls and become a propellant mass. The mass of emitted ions escape out of the chamber through a beam forming nozzle. The ejected materials offer a light-weight push away from the satellite and act somewhat similar to a jet thruster. Note that smallsat thrusters are designed for minimal correctional attitude adjustments and slow movement within its area. Larger and more dynamic systems are needed for rapid movement and long range travel.

Receiving Signals From Above



Portable RF antenna.

Today's *MIOT*, (*Military Internet of Things*), must assist in control of a multi-domain battle situations by providing surveillance, communications, precision mapping and distance data, as well as munitions guidance.

Portable optics reflectometer.

Orbiting satellites armed with new sensor technologies and sensor data analysis will be sent down to individual warriors for constant monitoring and reporting of personal to functional information about the dismounted warrior. Digital data and instructions are modulated by optical modulation devices, similar to those used in fiber-optic transmitters, to carry large volumes of higher speed digital signal information and process that data onboard the satellite. The data are then sent directly to warriors below or forwarded onto other satellites within the defense constellation, as needed.

A critical element for coordinating our dismounted and on-ground defense teams is in receiving the signals from above. Highly portable and rugged antenna must fit well on-board the warrior as well as have the ability to survive extreme environmental exposure as well as the wear and tear of action on the battlefield.

Low weigh portable antenna receivers are being adapted to include inflatable and personal worn devices similar to optical reflectometers used in testing fiber signals. Current upgrades are evolving to support troop command and directions from satellites. Developers of the ***One System Remote Video Terminal*** (*OSRVT*) pack by Textron and the U.S. Army are in final design and are currently being tested on the ground.

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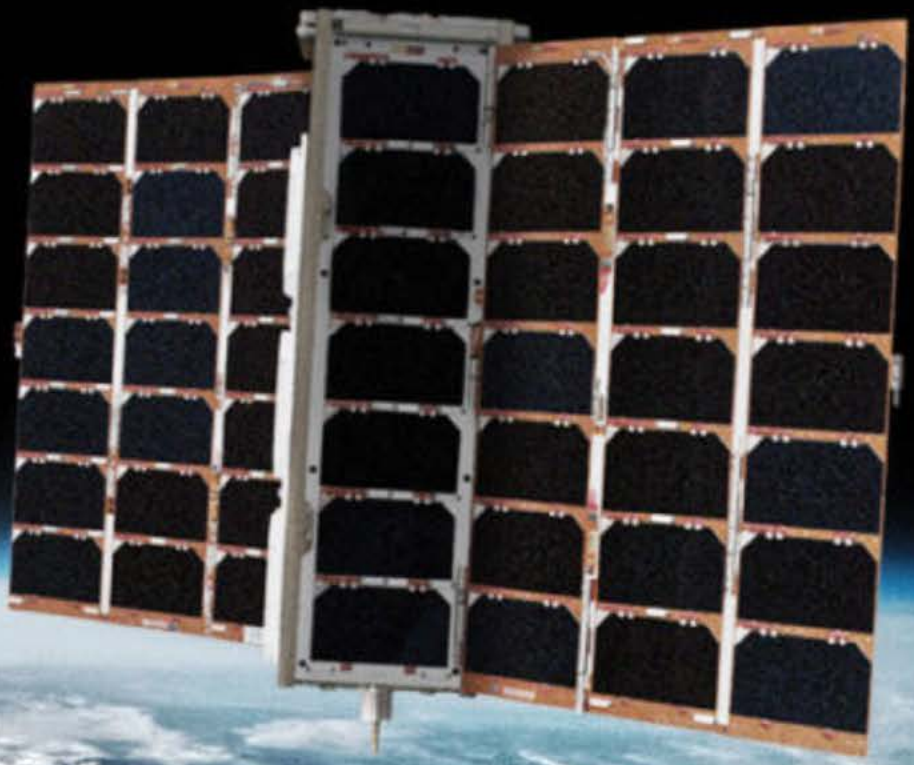
COMMAND CENTER: KEITH E. JOHNSON

Vice President and General Manager, Spire Federal

Keith E. Johnson has served as Spire's Vice President and General Manager, Federal, since August 2017. Prior to joining Spire, Mr. Johnson served as Vice President, Federal Sales at Thinklogical LLC, an information technology and services company and subsidiary of Belden Inc., from November 2012 to August 2017.

Mr. Johnson served as Vice President, Public Sector, at Vocollect, Inc., a computer software company and subsidiary of Honeywell International Inc., from January 2010 to December 2012 and in the same role at Liquid Machines Inc., a computer software company, from January 2006 to January 2010. Mr. Johnson holds a B.S. in Clinical Psychology from Towson University.



Artistic rendition of the Lemur-2 smallsat on-orbit. The image is courtesy of Spire.

Good day, Mr. Johnson... what is Spire?

KEITH E. JOHNSON

Spire provides Earth intelligence through a vast network of smallsats in order to help our clients and partners make the world a safer, cleaner, more prosperous, and more equitable place. Our constellation offers previously unattainable knowledge and insights about Earth from the ultimate vantage point — space.

Our data solutions currently offer customers insights relevant to areas inclusive of weather forecasting, maritime and aviation tracking, and other areas related to Earth Observation (EO) intelligence. This data enables organizations to act smarter, better, and faster.

Spire maintains its own proprietary, fully deployed constellation, providing global coverage, 24/7, regardless of weather conditions. As a software-defined business, we are regularly making updates to our satellites on-orbit, while also continuing to innovate our hardware, launching new satellites at a steady cadence with the latest technology capabilities.

Our space services essentially enables other innovators, commercial organizations and governments to rent our infrastructure and deploy their own applications and sensors. As we have successfully launched more than 110 ***Low Earth Multi-Use Receivers*** (*LEMUR*) across 28 campaigns on nine unique vehicles, we are positioned well to help other access the opportunities made available only from space.

We provide rapid deployment opportunities and subscription-based payment flexibility, with a fully-integrated space, ground and operations management system and a cloud-based API. These services are by nature very custom as we adapt the solution to meet each partner's' needs based on the problem they are solving for, the goals that they have, and their individual technology needs.

What is your role at Spire?

KEITH E. JOHNSON

I am the Vice President & General Manager of Spire Federal. My role is to build out Spire's business that is focused on the federal government.

Just as Spire works to collect data to solve problems on Earth, we recognize that the U.S. government is also looking at similar, significant issues and actively working to tackle them with the aim of improving the lives of U.S. citizens. We are both working to build a better world. My team and Spire support the federal government in a number of areas. Most broadly, we help agencies collect and analyze data from space. This data was traditionally collected from ground networks, but we now see it come mainly from ***Low Earth Orbit*** (*LEO*). We are helping collect, analyze, and securely transfer this data to federal agencies to help inform their actions.

It is inspiring work and I am looking forward to the coming years as we continue to build out our constellation's capabilities and develop more applications to help agencies better use data from space.

What issues is Spire looking to tackle? / What are Spire's upcoming priorities?

KEITH E. JOHNSON

From my team's perfective, we are focused on a few key issues in our industry. The first is data rights. We haven't seen clear guidance from the US government about data ownership and rights across multiple jurisdictions. Second, we work closely with government agencies on obtaining and maintaining necessary licenses to ensure our continued authority to operate in partnership with and on behalf of the US government. We are committed on doing this in a manner that upholds the highest level of security and safety while avoiding any interference with mission success. Finally, we are solidifying our position in the satellite community. We see the future as a hybrid architecture where businesses and agencies maintain and operate GEO satellites and are supported by the strong complementary capabilities of the CubeSats industry.

At Spire, we are focused on constantly advancing our technology, expanding our services, and increasing the applications of our data. We want to provide data that is helpful for humanity, notably as it pertains to climate change. An example of this is soil moisture data — soil moisture can provide life-saving information for wildfire prevention and forecasting in addition to being essential to farming and agriculture. Another example is sea ice. As we monitor climate change and its effects, sea ice levels give crucial insight into the state of the Earth and will impact shipping and transportation routes.

How can Spire support federal missions across the government?

KEITH E. JOHNSON

Spire can help support federal missions across all agencies, civil and military. Our federal team helps put competitive Earth and ocean data directly into the hands of government users with speed that allows them to make key decisions and rapidly respond to emergencies with granular data collected from even the most remote, guarded areas.

Our architecture is continuously hardened and updated which allows us to provide services such as AIS data for maritime awareness and ADS-B data for aviation—these are vital to helping secure these spaces and increase awareness and operational success.

We also provide radio occultations and data for weather forecasting to help support the advancement of the U.S. weather model. With a better model comes better prediction and better protection against natural disasters and extreme weather events.

Finally, various government agencies are looking to support missions with ***space-as-a-service***. With this model, these agencies can use their *GEO* satellites as its "*mainframe*" and supplement their satellites and data with industry capabilities, such as our cubesats.

At the end of the day, we can provide custom payloads to deliver these services and more and get our customers satellites into orbit in a fast and efficient manner.

Photo is courtesy of Spire.

Spire's smallsat test room. Image is courtesy of the company.

How does Spire support climate change work and initiatives?

KEITH E. JOHNSON

When we discuss weather and weather forecasting, we are talking about time — how far out you can predict and act — and accuracy. Both are crucial. We have seen instances where people weren't adequately warned in advance of storms and where storm strength and location were miscalculated. If we tell people to prepare for 12 inches of snow, and it ends up being 58 inches, that has a massive impact on the ability of citizens to take necessary precautions.

Spire's satellites and data collection capabilities have the ability to advance weather forecasting. We have global coverage and provide more than 10,000 radio occultations. A key to enhancing and improving weather forecasting is having global observations. Multiple-source observations can allow meteorologists to track dozens of variables from millions of points to give the model a more holistic picture of the globe to run equations for modeling.

We look forward to working closely with federal agencies to improve the U.S. weather model. Congress has allocated a significant budget to this initiative and we are hoping that agencies will actively use that money to pursue more significant data collection. With more data, especially radio occultations, the U.S. weather model and predicting capabilities can be improved exponentially. Ingesting data can save up to ten years of model building — a better model has the potential to ultimately save lives.

For climate change, it's a bit more of a long-term strategy. Spire supports climate change research and scientists studying its effects with crucial data such as soil moisture, sea ice levels, ocean wind, and more. We are also using smallsats to investigate the different types of gases in the Earth's atmosphere, any changes, and their role in our planet.

Our data is also helpful with green initiatives. For example, with the increase in renewable energy, we can provide data on weather and wind data to inform decision-making on the location of wind farms.

With the increase of satellites from private companies, what steps is Spire taking to ensure the data is secure and that space debris and congestion are handled?

KEITH E. JOHNSON

We take the security of our data very seriously and understand the sensitivities surrounding federal information. All data is encrypted in our constellation.

We are working toward CMMC certification and are looking at how that may affect any data availability. We have the flexibility to test and build satellites on U.S. soil. Additionally, we are looking at the possibility of building a manufacturing plant in the U.S.

With the possibility of a space-as-a-service environment, we are committed to working closely with agencies to match their security needs. We also recognize that for the *Department of Defense* there is a continuing conversation around GPS jamming and we are looking into how we can support that sector of defense.

Regarding space debris and congestion, Spire is committed to a safe space. We provide orbital debris mitigation plans, collision risk analyses and track our satellites. We work closely with partners and the U.S. government to ensure our satellites adhere to the ***FCC's** Orbital Debris Mitigation Rules* and are monitoring the ongoing development of new rules, as well.

We are hopeful that the U.S. government will work with industry to ensure that any rules related to this issue are clear and transparent and encourage safety without slowing progress or innovation. As an operator of the world's largest constellation of multi-purpose smallsats in LEO, Spire is invested in, and committed to, creating and participating in a space that is safe and beneficial to all.

What does the future of Spire Federal look like and how will going public affect Spire's Federal business?

KEITH E. JOHNSON

I am extremely excited about the future of Spire. Whether it's continuing to use soil moisture data to help farms, or sea ice information to understand shorelines or other issues, we're hoping to be a part of the growing efforts to improve life on Earth and help humankind.

Our company's move to go public this summer will be of great assistance. The additional funds will give the company the ability to invest and continue to grow our capabilities to support government missions.

What was your biggest accomplishment of 2020? What are you most proud of during your work with Spire?

KEITH E. JOHNSON

2020 was an exciting year for Spire, particularly for my team. We continued to grow our space services offering with great success.

One of the team's most exciting accomplishments of this past year was our work with the ***Australian Office of National Intelligence*** (*ONI*). We worked on their satellite, ***Djara***, as a part of their *National Intelligence Community Satellite* (*NICSAT*) program. From concept to launch that required six months of dedicated work, Djara became fully operational in nine months. This speed — from concept to launch to operational — is practically unheard of.

We worked hard to make that timeline and we extremely successful. Now, Djara is collecting and processing data on-orbit and leveraging Spire's cloud infrastructure to downlink and further process and analyze data.

I'm incredibly proud to work with the smart, confident, committed, and highly capable team at Spire.

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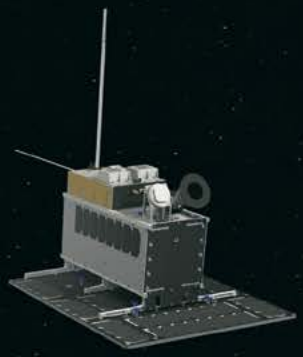

NorSat-3 Microsatellite
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