SATCOM for Net-Centric Warfare

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Artistic rendition of a GPS III satellite, courtesy of Lockheed Martin.

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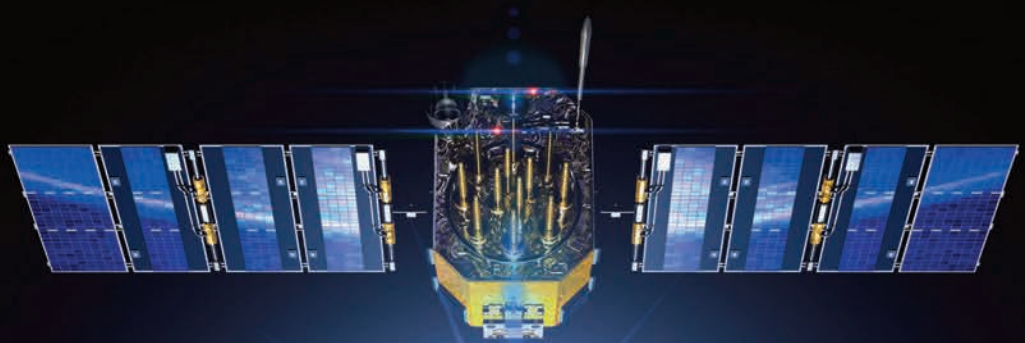

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Successful Launch for SMC + Partners' Fourth GPS III Satellite

The U.S. Space Force, Space and Missile Systems Center (SMC) and its mission partners successfully launched the fourth Global Positioning Systems (GPS) III satellite at 6:24 p.m. EST, November 5, 2020, from Space Launch Complex 40 at Cape Canaveral Air Force Station, Florida.

The Lockheed Martin-built satellite was carried to orbit aboard a Space Exploration Technologies Corporation (SpaceX) Falcon 9 launch vehicle.

"The launch of GPS III SV04 is a testament to SMC's ability to rapidly and safely deliver new capabilities on orbit," said Cordell DeLaPena, U.S. Air Force program executive officer for SMC's Space Production Corps.

"I'm proud of my team's 83rd successful National Security Space Launch and look forward to our future missions with SpaceX," said Col. Robert Bongiovi, SMC's Launch Enterprise director. "Ultimately, our ability to embrace innovation with our launch providers advances warfighter's capabilities while lowering costs to the U.S. Government and its taxpayers."

GPS III SV04 separated from its upper stage approximately 90 minutes after launch. Engineers and operators at Lockheed Martin's Waterton Facility will now begin on-orbit checkout and tests, which are estimated to complete in approximately one month. Operational use is expected to begin in a few months.

"The GPS III program continues to make strides in modernizing the GPS constellation for the U. S. Space Force while maintaining the gold standard for position, navigation and timing," said Col. Edward Byrne, Medium Earth Orbit Space Systems Division chief.

GPS III SV04 will join the current GPS constellation comprised of 31-operational spacecraft. GPS III, the newest generation of GPS satellites, brings new capabilities to users, including three times greater accuracy and up to eight times improved anti-jamming capabilities.

The U.S. Space Force's Space and Missile Systems Center is located at the Los Angeles Air Force Base in El Segundo, California. 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 situational awareness capabilities.

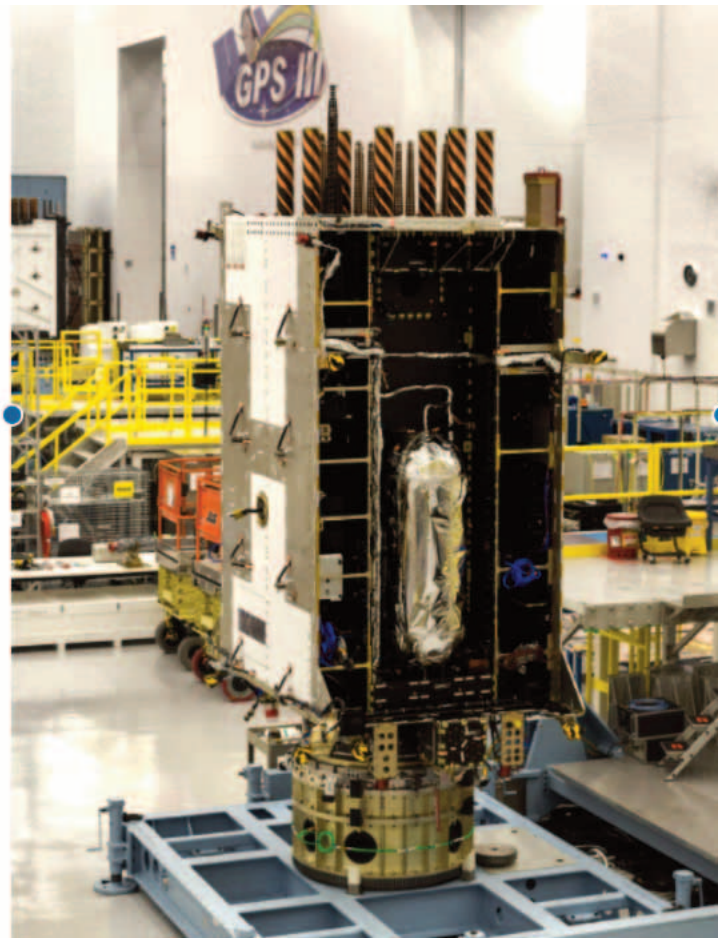
The fourth Lockheed Martin (NYSE: LMT)-built Global Positioning System III (GPS III) satellite is now headed to orbit under its own propulsion. Following a successful launch on November 5, GPS III Space Vehicle 04 (GPS III SV04) separated from its rocket and is now using onboard power to climb to its operational orbit, approximately 12,550 miles above the Earth.

About 89 minutes after a 6:24 p.m. EST liftoff from Cape Canaveral Air Force Station, Florida, U.S. Space Force (USSF) and Lockheed Martin engineers at the company's Denver Launch and Checkout Operations Center declared GPS III SV04 "separated" from its SpaceX Falcon 9 rocket and "flying" under their control.

In the coming days, GPS III SV04's onboard liquid apogee engine will continue to propel the satellite toward its operational orbit. Once it arrives, the engineers will send the satellite commands to deploy its solar arrays and antennas and prepare GPS III SV04 for handover to Space Operations Command.

GPS III SV04 is the latest next-generation GPS III satellite Lockheed Martin designed and built to help the U.S. Space Force modernize today's GPS satellite constellation with new technology and capabilities. GPS III satellites will provide significant capability improvements over previous GPS satellites, including:

- *Three times better accuracy*
- *Up to eight times improved anti-jamming capabilities*
- *A new L1C civil signal, which is compatible with international global navigation satellite systems, such as Europe's Galileo, to improve civilian user connectivity*



GPS III SV04 photo is courtesy of Lockheed Martin.

GPS III SV04 will also be the 23rd Military Code (M-Code) signal-enabled GPS space vehicle on orbit, continuing the Space Force's plan to fully field the more-secure, harder-to-jam and spoof GPS signal for military forces.

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

"With GPS III we are focused on rapidly fielding the best capabilities to the Space Force's Positioning, Navigation and Timing (PNT) Mission," said Tonya Ladwig, Lockheed Martin's Acting Vice President for Navigation Systems. "We are proud of our industry-government team on the launch of GPS III SV04. GPS III SV05 is already 'available for launch' and just waiting to be called up."

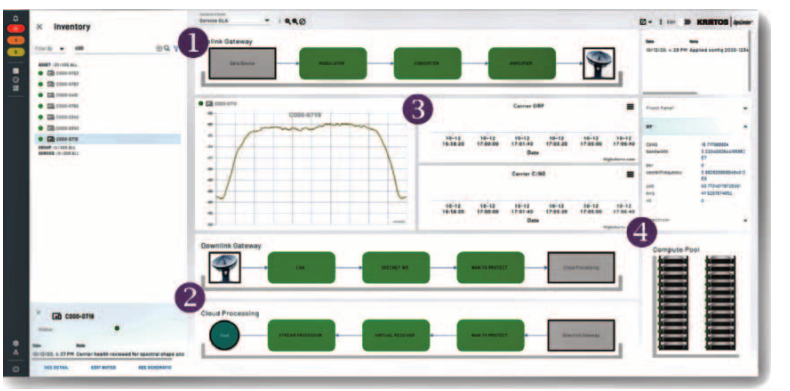
Kratos Debuts OpenSpace™ Platform To Support Software-Defined Ground Systems

***Kratos Defense** (Nasdaq: KTOS) has released **OpenSpace™**, a software platform and family of virtual products that enable satellite operators, Ground-as-a-Service (GSaaS) providers and others in the space services supply chain to create fully software-defined, dynamic ground systems.*

OpenSpace is a leap forward in ground network technologies that allows operators to apply advances in Software-Defined Networking (SDN) to the special needs of the space industry. SDN technology is already common in the broader communications and IT worlds, however adoption of SDN has been slower in the space industry, in large part because of the unique challenges of virtualizing Radio Frequency (RF) equipment and reliably digitizing the RF waves that are the staple of satellite operations.

Kratos has solved these challenges by virtualizing hardware components in its quantum™ line and by reliably digitizing RF signals for processing in digital environments. Now, with OpenSpace, Kratos moves beyond virtualization to add the orchestration, control and management capabilities that can create truly dynamic ground systems in which practically every element of the network potentially can become software-defined—almost all except the satellite and antenna.

By actively coordinating Virtual Network Functions (VNF) as service chains instead of purpose-built hardware components, operators can enhance the adaptability, resiliency, security and reliability of their ground systems. Ground functions that once took weeks to implement manually are now orchestrated as service chains with OpenSpace, making systems dramatically more responsive to real time changes in network resources, user demand and threats.



According to Kratos, OpenSpace disrupts the decades-long paradigm of ground networks based upon purpose-built, often proprietary hardware and stove-piped software applications in favor of standards-based, fully integrated, end-to-end service delivery running on COTS servers or in the cloud. OpenSpace's comprehensive SDN framework means operators can leap ahead in the transformation of their ground systems, employing accepted techniques from the broader communications industry.

The OpenSpace platform architecture incorporates four operating areas: OpenSpace VNFs are software applications that replace dedicated satellite hardware technology, such as receivers and recorders. Every OpenSpace VNF is built for cloud-native deployment on generic x86 compute resources without the need for Field Programmable Gate Arrays (FPGA) or Graphics Processing Units (GPU). OpenSpace VNFs can be purchased standalone or together as service chains.

The OpenSpace Controller is the brain center that coordinates the deployment of VNFs as service chains to support a specific Service Level Agreement (SLA) or mission. Using industry-standard interfaces such as MEF LSO, the OpenSpace Controller can orchestrate OpenSpace and third-party VNFs and interface directly with third-party service and resource orchestration frameworks, enabling truly dynamic network operation and vendor-independence.

OpenSpace OpsCenter™ is OpenSpace's unified manager which administers the service chain life cycle and bridges management functions across legacy analog components. Today, OpsCenter manages both physical and virtual network components and will soon add carrier management and ultimately satellite Command & Control (C2), all within a common API set, user interface and data model.

OpenSpace Digitizers reliably convert RF signals at any frequency band into a VITA49 Digital IF format that can be easily transported globally over a standard Ethernet/IP network. It preserves both frequency and timing characteristics, even over impaired Ethernet/IP network links when working with OpenSpace's VNF for WAN Transport Protection.

OpenSpace removes that bottleneck, bringing ground systems to par with their surrounding technologies and advancing the movement to disaggregate space systems from ground systems. Numerous, high-value advantages result, including: Virtual functions can run on generic, inexpensive computers or in the cloud instead of expensive, purpose-built equipment. Intelligence can be built into the network to implement new services quickly, shifting resources to where they are needed; a process that can take weeks in today's static ground systems.

Ground systems can potentially support not just satellites from multiple manufacturers, but multiple orbits simultaneously. The network achieves far greater levels of security, self-healing and resiliency to changing conditions such as hacking or interference. It becomes possible to bridge the data, transport and management aspects of satellite systems to provide a unified interface that describes service chains across network components, enables automation of those service chains, and delivers a common operating picture across all resources.

For more information about the OpenSpace platform and the products introduced in the OpenSpace family, ***visit this direct infolink…***

In addition to the release of the OpenSpace Controller, Kratos separately announced two new VNFs for EO and Sensing service chains, the OpenSpace WAN Transport Protector (OWTP) and the OpenSpace Stream Processor/Recorder (OSPR). Kratos debuted its first VNF, the OpenSpace Wideband Receiver, in August of this year.

According to Yves Pitsch, Principal Product Manager, Azure Networking at Microsoft of Microsoft's recently announced Azure Orbital Ground Station-as-a-Service offering, which employs OpenSpace products in its service architecture. "*An SDN-based architecture like OpenSpace's is critical to our ability to provide our customers with a platform that is complete, economical and easy to use. Virtualized operations provide us with the flexibility and scalability we need to optimally support many different customers, missions, satellites and other specialized needs without specialized hardware.*"

Yves Pitsch

OpenSpace™

WAN Transport Protector

Phil Carrai

"Going back to the very early days of space missions, satellites and their ground systems were designed from scratch to work together in tandem using custom hardware and software," explained ***Phil Carrai***, President of Kratos' Space, Training & Cybersecurity division. *"Over time, those ties have loosened as both satellite and network technologies have evolved—in fact, for decades Kratos has been a leader in developing standards-based signal processing and ground management products that work with multiple satellites in multiple mission frameworks—however the ground and the satellite have not been able to operate fully independently until now with OpenSpace."*

Greg Quiggle

Communications networks in other industries have increasingly adopted virtualization and, more recently, SDN as their new paradigm. Where virtualization converts functions that once were hardware into software, an SDN-based model like OpenSpace goes much further by adding a standards-based platform logic coordinating these virtual components. *"SDN technology makes communications and IT networks faster and more automated, resilient and flexible so that they can change and adapt rapidly to changes in network supply, demand and threats,"* commented ***Greg Quiggle***, VP of Product Management for Kratos Space. *"Ground systems must keep pace with these innovations. Otherwise, today's purpose-built, hardware-intensive ground systems will increasingly be the static bottleneck between two dynamic, software-defined endpoints."*

iDirect Government's Evolution® Platform Receives IA + Cybersecurity Enhancements

***iDirect Government** (iDirectGov) has enhanced their **Evolution®** platform with information assurance (IA) and cybersecurity, all as a part of a multi-layered approach to security.*

Two main technology advancements in Evolution 4.2.2.0 include SHIELD, a security service for remotes, and Communication Signal Interference Removal (CSIR™), a real-time streaming technology to mitigate interference. These enhancements are fully integrated across iDirectGov's 9-Series satellite modems.

To address vulnerabilities in satellite modems, SHIELD provides periodic IA security updates for the 9-Series modems. These remote-side packages are created using the same capability that the Defense Information Systems Agency's (DISA's) Assured Compliance Assessment Solution (ACAS) recognizes. When installed, SHIELD

addresses vulnerabilities based on the Common Vulnerabilities and Exposures (CVE) and Nessus ID database on the satellite modem and delivers IA posture across the SATCOM network.

CSIR excision technology effectively mitigates a wide range of interferers, from carrier waves to multiple strong interferers, without requiring any prior information on them. CSIR can locate fast-moving and intermittent interference and restore the quality of the original signal, without requiring additional hardware. This helps to combat adversaries who are increasing their implementation of signal intelligence (SIGNET) to attack military and government spectrum use by jamming transmissions intended for radio communications, radar and various operations.

SHIELD and CSIR add to the Evolution platform's award-winning, high standard of transmission security (TRANSEC) to create a multi-layered highly secure solution. Other enhancements as part of this approach include dual-mode and beam choice features to mitigate threats to a SATCOM network. Dual-mode enables the 9-Series modems to operate on both government-owned and commercial networks, giving the user both flexibility and ubiquitous coverage. Beam choice allows operators to manually select the ideal beam for their missions rather than using the automated process.

John Ratigan

"Our customers are becoming more proactive and are seeking ways to reinforce defenses before problems occur, and we are moving forward with our customers to secure our solutions with our specialized product enhancements," said ***John Ratigan***, President of iDirectGov. *"Safeguarding critical communications signals is important, and any satellite modem attempting to operate in a congested environment, especially where adversaries may be intentionally jamming signals, can benefit from CSIR.*

Ratigan continued, *"Whether attacks are intentional or unintentional, the CSIR interference mitigation is a core feature of the Evolution system to ensure holistic communication integrity and availability. Implementing a Defense-in-Depth approach allows defense,* homeland security, first responders and other government users to have reliable and secure communications to support their critical

missions. iDirectGov's approach to SATCOM cybersecurity provides the means to plan, detect, locate, remove, report and deploy mitigation to signal interference."

L3Harris Receives Manpack Radio Award From U.S. Special Operations Command

***U.S. Special Operations Command** (USSOCOM) has awarded **L3Harris Technologies** (NYSE:LHX) an initial $82 million, full-rate production order for the company's new Falcon IV® AN/PRC-167 multi-channel manpack radio that will provide Special Operations Forces (SOF) with advanced communications capabilities.*

The order is part of a $255 million IDIQ contract awarded by USSOCOM under the Next Generation Tactical Communications (NGTC) program to deliver multi-channel manpack radios. Prior to the award of the NGTC multi-channel manpack contract, USSOCOM also awarded the company an IDIQ contract for Falcon IV® AN/PRC-163 multi-channel handheld radios.

These multi-channel manpack and handheld radios are key elements of USSOCOM's next generation tactical communications. They provide complete DoD and coalition interoperability with the disruptive technology needed to enable mission success against current and future threats.

The AN/PRC-167 harnesses the power of multiple tactical devices converged into a single manpack radio. This compact, lightweight manpack delivers USSOCOM's tactical mission network and ensures interoperable connectivity with partner forces.

The AN/PRC-167 is engineered to meet multi-domain challenges of dismounted, vehicular, maritime, and airborne missions. It simultaneously runs a broad portfolio of line of sight, networking, SATCOM and resilient waveforms on each of the two 30-2600 MHz primary channels.

Multiple robust mobile ad hoc networking (MANET) waveforms empower Hyper Enabled Operators with information and data analytics at the tactical edge. The software-defined manpack supports fast, in-field software updates to add resilient waveforms and new capabilities.

The L3Harris Mission Module port allows plug-and-play add-on modules to function as a simultaneous third channel. These three channels can operate independently or be crossbanded to exchange voice and data between different radio networks. The initial mission module includes a Full Motion Video ISR receiver, and subsequent modules will add other emerging technologies.

"SOF are constantly pushing boundaries to execute their missions with greater stealth and speed," said Dana Mehnert, President, Communication Systems, L3Harris. "The AN/PRC-167 provides situational understanding between the tactical edge and command elements, allowing cognitive overmatch in any operational scenario."

Dana Mehnert

Viasat UK To Provide SATCOM For Royal Navy's New Type 31 Frigates

Viasat UK Ltd., a subsidiary of global communications company, Viasat Inc. (NASDAQ: VSAT), has been awarded a contract to provide Ultra High Frequency (UHF) satellite communications (SATCOM) for the new Type 31 frigates, to be delivered by Babcock Team 31, for the Royal Navy.

UHF SATCOM is a mission-critical capability that will provide the Type 31 frigates with secure integrated voice and data services for communications between Royal Navy maritime vessels and headquarters. It allows commanders to remain informed and aware of the fleet disposition.

It is also a vital component to enable maritime task group operations, extensively providing secure beyond line of sight (BLOS) communications between ships and mobile units such as sea boats, boarding teams and helicopters, which are all key elements of tactical combat and constabulary maritime operations.

The Type 31 frigate program is designed to deliver to the Royal Navy five flexible and affordable frigates that, alongside the BAE Systems-built Type 26 frigate, will replace the UK's current Type 23 frigates. The Viasat UHF SATCOM solution will provide reliable, dependable BLOS communications for the Royal Navy's Type 31 vessels, when introduced into service.

"*This UHF SATCOM capability will ensure the Royal Navy Type 31 frigates will have the robust, secure, world-wide UHF voice and data services it needs for modern warfare operations in the current information advantage environment,*" said ***Steve Beeching***, Managing Director, Government Systems, Viasat UK. "*We are very proud to be able to supply our world-class technology to the UK Ministry of Defence. The importance of the UHF SATCOM capability in enabling defence to co-ordinate limited assets, at its disposal, while effectively supporting Allies globally cannot be understated.*"

Spectra Group In AWE... 2020, That Is...

***Spectra Group** has recently taken part in the UK Army Warfighting Experiment 2020 (AWE20) demonstrating high-capacity over-the-horizon communications systems.*

The British Army has established AWE20 as a capability spotlight to explore emerging technologies and identify specific capabilities in the agile Command, Control and Communication (C3) space that are suitable for rapid exploitation. AWE20 aims to push the boundaries of technology and military capability, testing a range of systems by putting them in the hands of the user while giving invaluable military feedback to suppliers.

Previously known as URBan Experimentation (or URBEX), AWE20's purpose is to 'Identify how the Army can exploit developments in technology in the agile C3 arena.' At AWE20, Spectra Group, together with industry partners Comtech, have been demonstrating the advanced troposcatter mobile system known as COMET (Compact Over-the-horizon Mobile Expeditionary Terminal) that provides high capacity, low-latency data links for over-the-horizon communications, without the need to rely on satellites or multiple line-of-sight repeaters.

At AWE20 Spectra demonstrated how the new, innovative, low-RF signature modems can consistently deliver bandwidths far exceeding those possible using satellite communications systems. Sitting alongside Spectra Group's SlingShot satellite tactical communications system, COMET completes a mobile communications suite, enabling Spectra Group to deliver remote, beyond line of sight communications capability, both with and without satellites.

Simon Davies

Simon Davies, President of Spectra Group, said, "*It's an important and prestigious step for Spectra Group to take part in AWE20 with the COMET troposcatter system. Feedback has been very positive with users appreciating the ease of use, large bandwidth and overall ability to communicate over the horizon in a potentially satellite and GPS denied environment. Troposcatter and SlingShot offer different yet complimentary capabilities to our users. We're confident that all of our existing and future customers will see the benefits on offer in using both systems side-by-side, to meet every Beyond Line Of Sight communications scenario.*"

Roccor Acquired By Redwire

***Redwire** has acquired **Roccor**, a disruptive military and commercial hardware supplier in the rapidly growing smallsat market and a manufacturer of deployable booms, structures, antennas, thermal products, and solar arrays for the space industry — terms of the transaction were not disclosed.*

Founded in 2012, Roccor's satellite technologies, solutions, and products are helping to revolutionize spaceflight and are currently being used on missions with NASA, the Department of Defense as well as several commercial space companies. Based in Colorado, Roccor has a proven performance record with more than 75 successfully launched systems in orbit today with additional systems planned to launch next year.

Roccor marks the fourth acquisition by Redwire this year. Redwire was formed in June 2020 following the strategic acquisition of Deep Space Systems and Adcole Space by AE Industrial Partners, LP, a private equity firm specializing in aerospace, defense and government services, power generation, and the specialty industrial

markets. Redwire subsequently acquired Made In Space in June, a leader in on-orbit space manufacturing technology.

With the acquisition of Roccor, the Redwire technology portfolio will expand to include high performance and low-cost deployable structure systems designed for commercial and military satellites. Roccor's specialized products, including stand-alone booms, hinges, solar arrays, and antennas, will augment Redwire's current space infrastructure solutions to offer more innovative capabilities and deliver even greater performance at substantially lower costs for its customers.

"*AE Industrial set out to build Redwire because we recognized a need to bring together fast-growing yet established innovators with companies that possess extensive flight heritage,*" said ***Kirk Konert***, partner at AEI. "*Roccor brings added capabilities, an impressive customer list, and an incredible workforce that we are confident will achieve amazing results as part of Redwire.*"

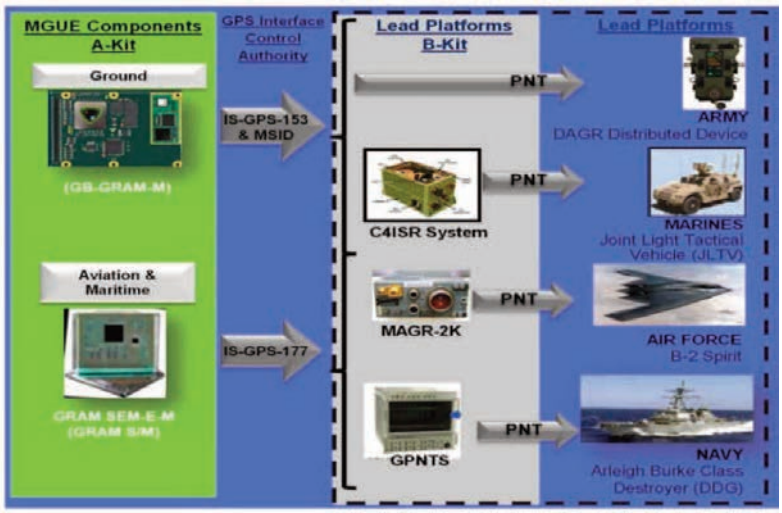
"*Roccor is exactly the type of company we are looking to add to the Redwire platform—a proven, growth company with a list of top-tier customers, that is also an industry disruptor,*" said ***Peter Cannito***, Chairman and CEO of Redwire. "*We are very excited to work closely with the talented Roccor team to build on their tremendous success and accelerate their advanced technologies.*"

"*Redwire is an exciting company at the forefront of space innovation and development and joining the platform will present Roccor with new opportunities that will lead to the next level of growth,*" said ***Chris Pearson***, who will continue to lead Roccor as President. "*The global satellite industry is growing rapidly, and the financial and operational support from Redwire and AE Industrial will allow us to keep pace with the demands of a constantly evolving industry.*"

U.S. Space Force Awards $552 Million Increment 2 Contracts to Rockwell Collins, L-3 and Raytheon

*The **United States Space Force's Space and Missile Systems Center** competitively awarded the Military Global Positioning System User Equipment (MGUE) Increment (Inc) 2 Miniature Serial Interface (MSI) with Next-Generation Application Specific Integrated Circuit (ASIC) to **Rockwell Collins, Inc.**, L3 Technologies and **Raytheon Technologies.** The three MSI contracts are valued at $552 million, and will be executed as Middle Tier Acquisition rapid prototyping efforts. The first delivery is scheduled for early fiscal year 2026.*

MGUE Inc 2 enables military GPS user equipment to receive allied Global Navigation Satellite System positioning, navigation, and timing (PNT) signals to increase both the resilience and capability of military PNT equipment, and deter attacks on GPS. These signals will supplement GPS-based PNT in accordance with DoD policies regarding usage of allied GNSS signals, ensuring identification and mitigation of cyber risks, and compatibility with existing PNT equipment.



Enhanced processing and security features associated with M-Code drove the decision to develop a smaller and more powerful receiver card for handheld and dismounted applications. The MSI with Next-Generation ASIC will enable Military-Code GPS receiver production, mitigating the obsolescence issue of current ASICs and providing significant security and performance improvements for GPS-enabled weapons systems. MGUE Inc 2 will be compatible with all existing and future spacecraft and ground systems.

The United States Space Force's Space and Missile Systems Center, located at Los Angeles Air Force Base in El Segundo, California, is the center offor acquiring and developing military space systems.

Space Operations Command Established By USSF Chief Of Space Operations, General John "Jay" Raymond

General John "Jay" Raymond

In an activation ceremony at Peterson Air Force Base, Colorado, on October 21, Chief of Space Operations, General John "Jay" Raymond, established Space Operations Command, the U.S. Space Force's first of three field commands.

Lt. Gen. Stephen Whiting

Lt. Gen. *Stephen Whiting*, who was promoted earlier in the day, assumed command of the new unit, which is mostly formed from the former Air Force units 14th Air Force and Air Force Space Command.

"As the primary force provider for United States Space Command, you are charged to lead space operations out of this pivot-point, to accelerate the transformation necessary to compete, deter and win a modern conflict, to prepare for war that either begins or extends into space," Raymond said. *"I'm convinced a war in space will be fought at high speeds and over great distances. We must be fast and agile, and we must focus on our primary mission, and that's to deter that conflict from happening."*

Raymond and Whiting both talked about the decades of heritage inherited by this new organization and its role in preparing warfighters for the space domain.

"Let's be clear: it's the decades of faithful, dedicated, and unparalleled space operations that you, and those who have come before you, have provided which are the foundation of all our new organizations – the new armed service and combatant command alike," Whiting said. *"Our charter is to focus exclusively on generating, presenting, and sustaining combat-ready space forces – and those forces will include intelligence, cyber, space operations,*

and combat support elements. We are structured explicitly for the function of providing space warfighting capability."

With the stand-up of SpOC, the Air Force unit named Space Operations Command at Vandenberg AFB, California, was re-designated as SpOC West, which retains its mission of conducting, integrating, and assessing global space operations in order to deliver combat-relevant space capabilities to combatant commanders, coalition partners, the joint force, and the nation.

"*The first step in the organizational changes you are about to witness in the re-designation and assumption of command, is to recognize the inactivation of what we know today as Space Operations Command, Vandenberg AFB, the former 14th Air Force, as it transitions to Space Operations Command West,*" said Col. ***Mark Sorapuru***, the narrator for the ceremony.

Maj. Gen. John Shaw

During the ceremony, Maj. Gen. ***John Shaw***, Commander of the Air Force's SpOC and Combined Forces Space Component Command, and Chief Master Sgt. ***John Bentivegna***, Command Chief of the Air Force's SpOC, furled and cased the former 14th Air Force command flag.

Chief Master Sgt. John Bentivegna

"*This is an appropriate time to acknowledge that what we are doing is significant. It's history in the making today,*" Raymond said. "*This ceremony is about you the Space Professionals who under the Air Force Space Command and 14th Air Force flags, built the world's best national security space enterprise.*"

The 14AF was established March 10, 1943, and conducted fighter and bomber operations over occupied Chinese territory in the China-Burma-India Theater during World War II. It is credited with destroying more than 2,300 enemy aircraft during the war. After standing down in 1960, it was reactivated as 14th Aerospace Force in 1968 to detect foreign missile launches and track objects in space. It moved to Vandenberg and joined then Air Force Space Command in 1993.

"*With the creation of the United States Space Force, the 14 AF was re-designated Space Operations Command,*" Sorapuru said. "*Now, its colors are furled, and the illustrious aviation lineage and honors of this organization are returned to the United States Air Force.*"

Following the furling of the 14AF flag, General Raymond and Chief Master Sgt. ***Roger A. Towberman***, Senior Enlisted Advisor, U.S. Space Force, took the stage to furl the Air Force Space Command flag as the last command team to lead that organization.

Chief Master Sgt. Roger A. Towberman

AFSPC was re-designated as USSF December 20, 2019, when the National Defense Authorization Act was signed into law, thereby creating the new service. AFSPC was established September 1, 1982, to serve as the operational command to oversee the Air Force's efforts in space.

"*Over the ensuing years, Air Force Space Command focused on consolidating and organizing space capabilities to improve operations,*" said Sorapuru. "*Its first major test came in 1990-1991, when the command provided space capabilities to the warfighter during Operation Desert Storm, in what many have called the First Space War.*"

AFSPC continued to focus on improving space support to the warfighter through the 90s through the creation of the USSF and being re-designated as USSF. Now it is being re-designated once again to meet the needs of the nation to deliver space capabilities to the joint force.

"*To the hundreds of thousands of men and women who have served in Air Force Space Command and to the officers who have commanded that prestigious organization … rest assured that the history and heritage of Air Force Space Command will live on in the Space Operations Command,*" Sorapuru said

After retiring the two Air Force units, the field command SpOC was officially activated, and Whiting stepped into his new positon as commander. "***Sir, I assume command of Space Operations Command***," Whiting said to Raymond. "*Even as we grapple with the extraordinary challenges brought by the establishment of our new Service, the United States Space Force, and our new Field Command, Space Operations Command, you can always find grounding in this three-part focus. No matter what changes we encounter, our attention will be laser-locked on our unit, our mission, and our calling.*"

The ceremony concluded with unveiling the SpOC emblem, and Bentivegna and lower echelon command teams rendering salutes to report for duty. The garrison and delta mission commands established in July now report to SpOC.

www.spoc.spaceforce.mil

Americas Space Conference Brings Together Six Nations to Discuss Research, Development Opportunities

In a historic virtual event, six nations of the Americas gathered to focus on coordination, cooperation and collaboration for space research and development opportunities.

The Americas Space Conference — co-hosted by U.S. Space Command, U.S. Southern Command and the U.S. Space Force — was a two-day event that aligned with the U.S. Department of Defense strategy of multi-national security cooperation and strategic partnership.

Space defense experts from the U.S., Brazil, Chile, Colombia and Peru participated in the conference, and though each nation has different strategies, there are natural overlaps, said U.S. Air Force Lt. Col. ***Galen Ojala***, USSOUTHCOM's Director of Space Forces at Air Forces Southern. "*These overlaps are opportunities to solve challenges together,*" Ojala said.

The participating nations coordinate efforts in regular bilateral agreements, but the conference was a way to identify challenges and opportunities in a multi-lateral forum, said U.S. Army Lt. Col. ***Peter Atkinson***, USSPACECOM's Chief of International Engagements. This was vital as officials work to manage the growing number of bilats where it can be a challenge to share information with common partners with common interests.

The most recent bilat was between the United States and the Republic of Chile during a series of virtual Space Engagement Talks from October 28 to 29.

"*Space is a fundamental domain for the security and development of our nations and a relevant variable for the multilateral collaboration among the Air Forces of the American Continent,*" said Chilean Air Force Maj. Gen. ***Francisco Torres***, Director of Operations.

U.S. Navy Rear Adm. ***Mike Bernacchi***, USSPACECOM Director of Strategy, Plans and Policy, called the conference and subsequent conversation an opportunity to "*grow and strengthen the great partnerships we have with each of you. Our space engagements are just the beginning of determining just how strong our future collaboration can be. By facilitating dialogue on the topics of space situational awareness, and cooperation and planning, partnerships with the commercial and civil space industry, these and future talks strengthen all our respective space programs and support the safe and peaceful use of space worldwide.*"

Representatives from participating nations virtually attended the Americas Space Conference from their respective countries Nov. 4-5, 2020. In this historic event, five nations of the Americas gathered to focus on coordination, cooperation and collaboration for space research and development opportunities. The conference, co-hosted by U.S. Space Command, U.S. Southern Command and the U.S. Space Force, included space defense experts from the U.S., Brazil, Chile, Colombia and Peru.

Partnerships in Latin America are extremely important, he went on the say, and "*I hope we can continue to deepen these relationships over time.*"

In recognizing the extreme importance of space as a new, contested domain "*where there are no sidelines*," this is one of the most transformational periods in the U.S. military's history, Bernacchi said. The U.S. relies on allies and partners in daily operations, planning, and strategy development to achieve common objectives. In short, the United States cannot go at it alone in space.

"*Space debris, of any result, does not stay in one place. It passes through the space traffic of all nations*," Bernacchi said. "*The only way to truly counter that is to dissuade, deter and establish norms of responsible behavior as we have for the sea, air and land domains.*"

Cooperation and coordination are defining attributes of space security and shared success in the space domain. The presentations on research and development during this conference were yet another example of where participants could partner, said U.S. Space Force Lt. Gen. ***William Liquori***, Deputy Chief of Space Operations for Strategy, Plans, Programs, Requirements and Analysis. During one of the sessions, Liquori emphasized the participating nations' shared interest in space moving forward.

"*The best part of this conference is being able to listen to your thoughts today and to recognize the path forward on how we can continue to work together as we venture into this new frontier,*" he said. "*As sovereign nations, we all have our own goals, our own objectives. But we do have shared interest in the ensuring access to, and peaceful use of the space domain.*"

More people throughout the world are understanding the importance of space to their everyday lives — including communication, navigation and weather forecasting — and it would be devastating for many people to lose these capabilities, said U.S. Space Force Lt. Col. ***Bobby Schmitt***, USSOUTHCOM's Space Integrated Planning Element Chief.

Peruvian Air Force Maj. Gen. ***Javier Martín Tuesta Márquez***, Head of the Space Agency of Peru, highlighted common interests from the participants with topics such as Space Situational Awareness (SSA), space weather and the use of satellite images to attend multiple needs, especially those related to humanitarian aid in case of disasters.

"*The Americas have seen a surge of space activity,*" Ojala said. "*Various civil and defense ministries actively operate and pursue additional capabilities across industry and academia for the good of their people and regional security. On a single overflight of Earth, their satellites support urban planning, crop estimates during COVID, law enforcement, environmental monitoring and territorial security.*"

The Americas Space Conference was originally scheduled to take place earlier this year in Chile and was again rescheduled for the ***36th Space Symposium*** in Colorado Springs, Colorado. Constraints set forth by the COVID-19 environment led officials to coordinate a virtual event to ensure these vital talks could take place.

Americas Space Conference revolved around the tireless search for the development of space capabilities and the consolidation of alliances in Latin America, Colombian Air Force Brig. Gen. ***Eliot Gerardo Benavides González***, Commander of Human Resources Command, said.

These are extremely important "*so that the five countries involved significantly improve access and exploitation of the space domain for the growth and well-being of our peoples*," he added. "*With a strong commitment to research, innovation, development in nanosatellites, artificial intelligence, propulsion and multiple areas of research across space.*"

Discussion during the first Americas Space Conference was guided by Dr. ***Thomas Cooley***, U.S. Air Force Research Laboratory's Space Vehicles Directorate Chief Scientist. Cooley is a flag officer-level technical civilian.

Officials expect that as the conference and regional space interest grows, participant numbers will increase. Representatives from Canada observed the conference to get a better understanding of the Latin American participants' space goals and areas where interests overlap, Schmitt said, opening the door to more space integration between the United States, Latin America and Canada in the future.

"*This event was extremely useful to equalize the diverse views of the Air Forces of the allied countries on important topics to be developed*," Brazilian Air Force Maj. Gen. ***José Vagner Vital***, Executive Vice President of Brazil's Space Systems Commission.

"*Common interests were identified and opportunities for joint actions were highlighted. Without a doubt, this event brought the prospect of a promising future for multilateral activities in outer space for the countries of the American continent.*"

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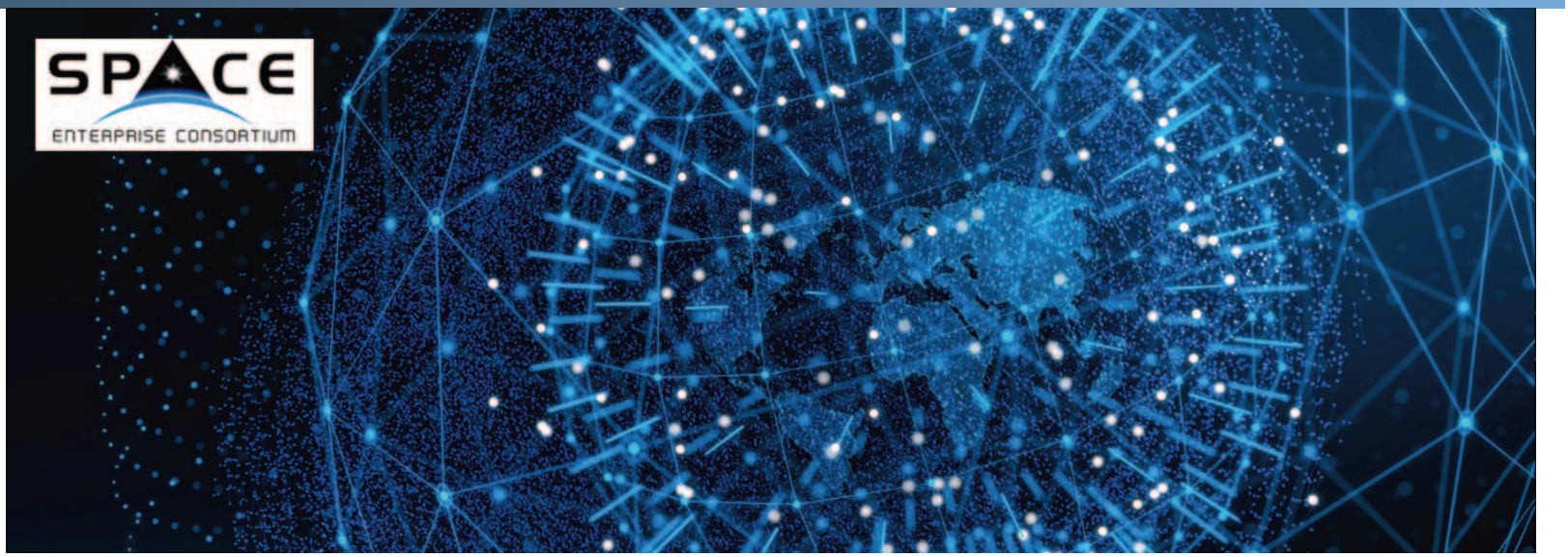
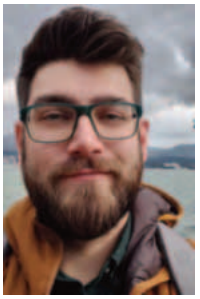


SMC'S SPEC — PARTNERSHIPS TO INNOVATE AT THE SPEED OF RELEVANCE

Developing the newest and most innovative technologies for space operations requires a team approach — plus, recruiting the best team members means making certain that the barriers to entry are minimized to work with the *U.S. Space Force* (USSF).

The ***Space and Missile Systems Center*** (SMC)'s ***Innovation and Prototyping Directorate***, part of the ***Space Development Corps***, has been encouraged by the success of the organization's ***Space Enterprise Consortium*** (SpEC) in accelerating prototype development and increasing collaboration between the U.S. government and industry partners. The directorate is particularly proud of the Consortium's growth, with membership increasing 55 percent year over year since its initiation in 2017. This growth reflects industry and academia's interest in developing the next generation of war-winning technologies and maturing future architectural concepts.

The U.S. Department of Defense (DoD) is benefiting from the diverse expertise of the 433 members of the Consortium, more than 80 percent of which are non-traditional vendors that have not recently performed work for the DoD. Connecting these new perspectives with the deep knowledge of traditional defense contractors helps ensure that the space systems SMC is developing and delivering will continue to outpace the threat of peer competitors.


Robert Kunc

Mimyr, a Torrance, California-based company founded in 2017 that provides professional engineering solutions in the fields of satellites, networks and autonomous systems. ***Robert Kunc***, Co-Founder and CEO, said the company had success with some ***Small Business Innovation Research*** (SBIR) awards, but was interested in competing for ***Other Transaction Authority*** (OTA) programs, which focus on more mature technology.

"*When you're a cog in a huge defense program, acquisition lifetimes are really long and programs can get cancelled,*" Kunc said. "*On the other hand, SBIR is an amazing, no-risk investment by the government into new technology. But the 'IR' in SBIR stands for innovation research and it's hard to take research from that into mature programs, like CASINO (Commercially Augmented Space Inter Networked Operations, dealing with Low Earth Orbit (LEO) satellite constellations.) We wanted to make something deployed and useful – the stakes are much higher and we wanted that challenge.*"

Kunc said Mimyr had heard horror stories about the complex and sometimes convoluted acquisition process for military programs and thought it would be difficult to compete against larger, more established prime defense contractors. But the SpEC process shielded Mimyr from clauses and controls that normally would have stopped a small company from applying, and supported Mimyr with the tools and trust to prove itself.

"*I'm sitting next to a guy who's literally the top expert in space encryption, and he's asking my opinion,*" Kunc said. "*(SpEC's attitude is) 'We awarded the contract, that's the end of the reviews, let's get the job done fast.' That's not common in defense acquisition.*"

Mimyr not only successfully competed against several larger companies on an equal footing, the company was able to develop a successful prototype to support CASINO operations, he added.

"*Technology changes so rapidly — compare the processing power on a laptop today with what was used on the space shuttle,*" Kunc said. "*The commercial world far out-paces multi-year-(defense industry) acquisition cycles. In order to take advantage of the cutting edge technology commercial industry is using, you need to start relaxing the rules. The commercial world needs to be innovative, it needs to be fast and if you have a difficult process to bring these innovations to the military, you're going to go out of business.*"

Lt. Gen. John F. Thompson

At a SpEC meeting last month, Lt. Gen. ***John F. Thompson***, Commander of SMC and USAF Program Executive Officer for Space, cited the book, "***How We Got to Now***," by *Steven Johnson*, which covers the history of innovation and posits that "*ideas are fundamentally networks of other ideas.*"

"*This is one of the things I'm most excited about: seeing the growth of SpEC over the last few years,*" Thompson said. "*We're not just building a robust and resilient base of great companies and organizations, but all of us, together, are building up a network of ideas – ideas that the U.S. Space Force will need to maintain our leadership in space and take on the challenges of operating in cislunar space and beyond in the decades ahead.*"

Government teams across the DoD have recognized the power of this acquisition tool to access niche prototyping capabilities, resulting in more than 80 awards made on average 40 percent faster than traditional acquisitions, SMC officials said.

"*Leveraging a diverse consortium coupled with the flexibility of Other Transaction Authority is a relatively recent advancement in SMC practices,*" said SMC's Col. ***Heather B. Bogstie***, Senior Materiel Leader, Rapid Development Division.

"SpEC has been an overwhelming success for the government programs that have utilized it to accelerate their prototyping, and for the Consortium members to gain a better understanding on the USSF's architectural direction."

- Col. Tim Sejba
SMC Program Executive Officer for Space Development

"The SpEC process shielded Mimyr from clauses and controls that normally would have stopped a small company from applying [for the contract], and supported Mimyr with the tools and trust to prove itself."

- Robert Kunc
co-founder and CEO, Mimyr

"Being part of SpEC allows us to collaborate closely with our customers and non-traditional teammates to deliver the innovation our warfighters need on a timeline that meets the evolving mission threats. We've enjoyed success on multiple SpEC programs and look forward to more opportunities in the future."

- Arnie Streland
Corporate Lead Executive – Los Angeles
Northrop Grumman Corporation

"All of us, together, are building up a network of ideas."

- Lt. Gen. John F Thompson
SMC Commander and
USAF Program Executive Officer for Space

"Accessing the VC community is a priority, and as the Consortium continues to grow and evolve, our management strategy reflects that."

- Maj. Adam Burnetta
SMC's SpEC Program Manager

"As a small business, SpEC is a great resource. It combines the opportunity to build relationships with the Government, Industry Partners while pursuing specific opportunities. The SpEC opportunities are very diverse with small studies and prototypes where small businesses can compete as well as large programs that provide teaming opportunities."

- Carol Zanmiller
CEO, Cosmic Advanced Engineered Solutions, Inc.

As government demand for prototyping under SpEC has increased, so has its ceiling, growing from $100 million for the initial award in November of 2017 to $500 million and later $1.41 billion in April of 2018 and January of 2020, respectively.

The next iteration of the consortium management agreement, dubbed ***SpEC Reloaded***, which is projected for award in December of 2020, will bring a new $12 billion ceiling. One of the provisions of the SpEC Reloaded solicitation was to address how potential proposers would address facilitating commercial investment in members of the consortium, with the goal of driving increased access to venture capital firms for member companies and potentially increasing the DoD's use of venture capitalist-funded innovation.

"*Accessing the VC community is a priority for our Directorate, and as the Consortium continues to grow and evolve, our management strategy reflects that,*" said Maj. ***Adam Burnetta***, SMC's SpEC Program Manager.

"*There's no question that SpEC has been an overwhelming success for the government programs that have utilized it to accelerate their prototyping, and for the Consortium members to gain a better understanding on the USSF's architectural direction,*" said Col. ***Tim Sejba***, Program Executive Officer for Space Development at SMC. "*We're looking forward to broadening our access to non-traditional vendors under SpEC Reloaded, whether from the brilliant minds in our academic institutions or from the disruptive concepts that can come out of the high growth potential VC-funded community.*"

Contact SMC at ***SMC@spaceforce.mil***

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Baking Cyber into the Acquisitions Community DNA

Shortly after the United States' cyber campaign plan was stood up in 2015, the Cyber Resiliency Office for Weapons Systems, or CROWS, was created to advance the Air Force's enterprise-wide holistic efforts to tackle cyber vulnerabilities.

The cyber campaign plan assesses the landscape across the Air and Space Force acquisition, operations and infrastructure communities, focusing on identifying and mitigating cyber threats and recommending how our acquisition and operational communities operate resiliently in cyber contested environments.

"*CROWS facilitates methodologies that assist partners to build more resilient weapons systems*," said CROWS director, ***Joseph Bradley***. "*One of the foundational challenges to changing the Air Force's approach to cyber threats is cultural adoption — how best to embed an understanding of cyber into the culture of every airman.*"

Bradley spoke at the Space and Missile Systems Center (SMC)'s Virtual Cyber Expo on October 13, 2020.

The advantage of a holistic approach to cyber resiliency is that it allows participants to develop enterprise-level solutions to mitigate critical vulnerabilities in conjunction with program executive officers to ensure broad application across multiple weapons systems. Cyber resiliency impacts all Air and Space missions. New or emerging threats constantly require new approaches to improve cyber mission assurance.

CROWS enables SMC and the acquisition community to assess and protect the fielded fleet against cyber vulnerabilities and to bake cyber resiliency into new weapons systems. This is done through delivering tools, training programs, cyber intelligence and guidance to institutionalized cyber resiliency requirements in systems engineering, testing and contracting activities across the entire acquisition life cycle.

"*CROWS deploys consistent yet scalable methodologies that nestle into the acquisition timeline and assist program officers in understanding their cyber posture," Bradley said.*

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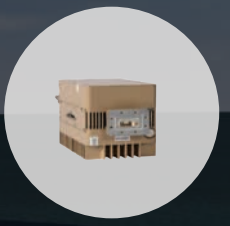

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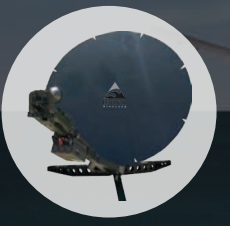

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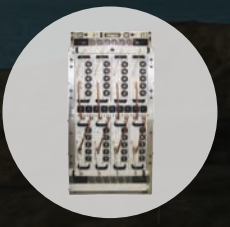

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"This in turn allows partner organizations to understand their risk — an important step in collaborating to devise and prioritize mitigation strategies."

NDAA 1647, a Congressional mandate in the Fiscal Year 16 National Defense Authorization Act, called for the evaluation of cyber vulnerabilities of weapon systems, part of which included the identification and mitigation of cyber vulnerabilities of major weapons systems. The information was collected by the DoD for submission to congressional committees, which also included a mandate to develop strategies for mitigating risks for cyber vulnerabilities identified during these evaluations.

To that end, SMC program offices have collaborated with CROWS' Mission Risk Analysis Team (MRAT) for SMC space systems on the NDAA 1647 list. Additional acquisition support has included funding for SMC's Defensive Cyber Operations (DCO) capability and engaging on a MRAT-sponsored satellite code signing effort through MIT-Lincoln Labs that was recently sent to Aerospace Corporation for further development.

In 2018, CROWS and SMC partnered in the development of a space cyber test range which provides space weapons systems the capability to increase system resiliency and survivability by identifying and assessing vulnerabilities, testing mitigation options, verifying patches and providing cybersecurity expertise for ensuring critical functions successfully operate at mission completion.

That year also included the standup of a cyber-risk management cell at ***Pacific Northwest National Laboratories*** in Richland, Washington, primarily for space acquisition supply chain analysis, and component testing.

What's next in the cyber recipe? Space enterprise critical component supply chain security. DoD policy requires program officers to develop program protection plans that include assessment and management of risks to supply chains of critical program components, Bradley said.

A new space enterprise critical component information cell and hardware/software examination capability will deliver fast, accurate and space-relevant assessments of the trustworthiness of vendors and their products so that acquisition professionals can meet the requirement for supply chain security of critical components.

The space enterprise critical component information cell consists of analysts and engineers from SMC, Pacific Northwest National Laboratories, and the Air Force Office of Special Investigations. Given vendor or critical component lists from space programs, these experts rapidly examine or source all publicly available information to report foreign influence on vendors, financial stability, past performance, product reputation and other indicators of vendor trustworthiness.

In Fiscal Year 21, SMC is partnering with CROWS on a shared-cost effort on the Space Vehicle Cyber Defense Payload, which develops the second of two low-size, weight and power on-orbit cyber defensive payload prototypes that mitigates the increased adverse persistent cyber threats and risks to blue legacy and future space vehicle systems.

Collaboration is also exemplified in the stand-up this year of Space ISAC, a global-focused intelligence sharing group comprised of representatives from ***U.S. Space Force***, the ***Department of Homeland Security***, and ***NASA*** to facilitate teamwork across the global space industry to enhance our nation's ability to prepare for and respond to vulnerabilities, incidents, and threats. Working groups in the cyber and the space environment share information and help with identifying and working through the gaps in space legacy systems.

While space and air are different domains and mediums, the technology that underwrites them is shared across both. And as such, air and space can and will leverage efforts and best practices.

Collaboration for Resilience in Space, Cyber, and Acquisitions

The majority of currently fielded weapons systems were designed in a pre-cyber contested landscape. Foundational challenges have been identified, but awareness to actual system vulnerabilities is low due to the limitations of cyber security testing.

The question then becomes: what is the Department of the Air Force doing to make our nation's weapons systems more resilient to outside attacks. The answer, thankfully, is they are doing quite a lot.

Resiliency efforts were highlighted during a panel discussion at ***Space and Missile Systems Center (SMC)'s Virtual Cyber Expo*** *in October. The discussion was moderated by* ***Ty Berthiaume****, Deputy CIO for SMC's* ***Enterprise Cyber Ops*** *and featured* ***Ron Carpinella*** *of* ***Ionic Security****; (Ret) Maj. Gen.* ***Sandy Finan****,* ***Pacific Northwest National Laboratory*** *and* ***Erin Miller****,* ***Space Information Sharing Analysis Center*** *(ISAC).*

The specific initiatives, processes and methodologies currently in place to identify and mitigate vulnerabilities are strong, panelists said. SMC demonstrated this strength at its virtual cyber expo centered on cyber resiliency — bringing together government, military, industry and academic experts for discussions about some of the most important aspects of cybersecurity as a warfighting domain.

When asked, what will be required to maximize the space domain with U.S. allies and industry partners?, panelists shared the need for faster advancement where everyone takes a piece of the mission and progress is parallel.

This improves performance as it allows everyone involved to focus on fewer things. That sharing piece is increasing productivity and is a key aspect to achieving future success.

Other discussion points included the need to trust others in the space domain and the importance of sharing data and different parts of space missions.

With space being the ultimate place for globalization, panelists agreed the greatest barrier to collaboration is establishing trust.

This is an operational shift; however, collaboration with international partners, industry partners, and other government agencies is the key to success. We all have to trust our future in space with others.

Warfighters, Decision Makers

At its simplest, the Defense Department's new data strategy, released in September of 2020, aims to make it easier for users to get access to the data they need to do their job.

U.S. Air Force airmen monitor battlespace movements at a simulated austere base during the Advanced Battle Management System exercise at Nellis Air Force Base, Nev., Sept. 3, 2020. Photo is by Air Force Tech. Sgt. Cory D. Payne

At the center of that, however, are the warfighters and decision makers who are most reliant on critical, accurate and timely data to carry out the department's mission, said the department's Chief Data Officer.

"This strategy is for warfighters and decision makers," said David Spirk, who spoke at the National Defense Industrial Association. "It's 100 percent focused on improving the speed and execution of decisions — to support informed decision making, to improve situational awareness and knowledge at every level, to improve our ability to anticipate events and resource needs before they were known."

To ensure the fastest, smoothest distribution of data to warfighters, decision makers, and even artificial intelligence systems, the DoD data strategy lays out a plan to, among other things, standardize how data is collected, categorized, tagged and distributed.

The strategy sets goals for the department to build a data environment that makes it easy for would-be users of data to not only find what data they need, but to also get access to it — wherever that is. That data must also be adequately described in language that is standardized across the department, so that would-be users can easily identify its relevance to their portion of the mission.

Also important within the strategy is that data be trustworthy. The strategy calls for development of standards to ensure that when users get ahold of data, for instance, it's always accompanied by additional, standardized information that makes it clear where that data came from.

New Spectrum Strategy Reveals DoD's Plan to Master the Airwaves

Short of face-to-face conversation, wired internet or telephone land lines — a mystery to many young Americans — nearly every form of communication the Defense Department uses today, especially on the battlefield, is wireless. Some U.S. adversaries are working very hard to cut off that form of communication.

The Defense Department released the "2020 Department of Defense Electromagnetic Spectrum Superiority Strategy." This document lays out how the military will guarantee its continued and unfettered access to the airwaves, or spectrum, which facilitates GPS, radio, satellite and cell phone communications. This document also reveals how the military plans to master that spectrum while on the battlefield.

"*The rise of mobile systems and digital technology across the globe has placed enormous strain on the available spectrum for DOD's command, control and communication needs,*" said ***Dana Deasy***, the department's CIO. "*This strategy will help set the conditions needed to ensure our warfighters have freedom of action within the electromagnetic spectrum to successfully conduct operations and training in congested, contested and constrained multi-domain environments across the globe.*"

The electromagnetic spectrum is the range of radiation frequencies that are used to transmit information wirelessly. While frequencies above 300 GHz make up infrared light, visible light, ultraviolet light, and x-rays, frequencies at 300 GHz and below are used to transmit information for cell phones, television, radio, satellite communications, GPS, hand-held two-way radios and even key fobs that lock and unlock cars.

A signal support system specialist prepares the radio system used to allow soldiers and airmen to keep in constant communications with one another during a mission. Graphic illustration by Regina Ali, DoD

Navy Petty Officer 3rd Class Daniel Torotorres, assigned to the guided missile destroyer USS Ralph Johnson, conducts maintenance on a data router in the Persian Gulf. Photo By: Navy Petty Officer 3rd Class Anthony Collier

The strategy demands a lot of changes from those across the department who collect, generate and maintain data, so that users in other areas can always have what they need, when they need it. Spirk said getting those people on board will be critical to the success of the data strategy.

One way to do that, he said, is creation of chief data officer positions, where appropriate, to ensure the data strategy is being implemented and, also, to build relationships and trust between agencies so that data can move to where it needs to be more efficiently than it may be doing now.

Spirk said the department will know it has been successful in implementing its data strategy by the responses of the warfighters.

"The measure of our success is going to be a recognizably faster warfighting operation tempo," he said. "This will be achieved by treating data as a weapon system, effective partnerships and a collective focus. And when I say weapon system, I mean we need to think of the data ecosystem as the weapon system that fires the data and ensures it's available to our warfighters at the time and place they need it before they realize that they did.

A soldier monitors air and ground position information on the Windows and android tactical assault kits to get a common operating picture that enhances situational awareness and data sharing at Yuma Proving Ground, Ariz., Sept. 16, 2020. Photo is byJustine Ruggio, U.S. Army.

Those who want to transmit information over those communication frequencies typically apply to the federal government for a license. This ensures that only one entity is attempting to use a frequency at a time.

There are hundreds of locations on the electromagnetic spectrum blocked out by the U.S. federal government — and by governments globally — for specific applications by specific users in every part of the world.

The Defense Department is, perhaps, the biggest user of spectrum in the United States, said ***Frederick D. Moorefield***, the Deputy CIO for Command, Control and Communications.

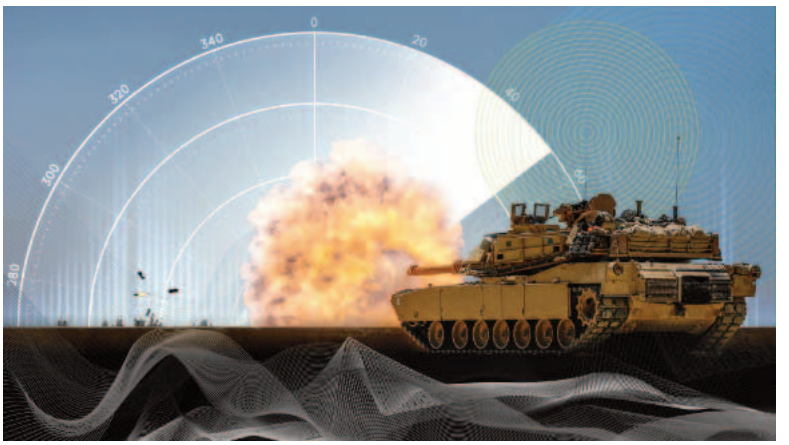
"*DOD uses spectrum for almost everything wireless, everything from tactical radios that the soldier uses in the field, or in operations, to satellite communications, to radar that we use to track objects and devices," he said. "We use it for everything wireless.*"

"*The department's evolution in the EMS is necessary for the U.S. military's ability to effectively sense, command, control, communicate,* Undersecretary of Defense for Acquisition and Sustainment

For a long time, Moorefield said, DoD was uncontested in its use of the spectrum. That means either stateside or abroad, wherever the U.S. military went, it was able to use whatever portion of the spectrum it wanted to facilitate its own communications. Other nations weren't technologically capable of using spectrum. But that is no longer the case.

Now, due to the low-cost of entry into spectrum use and ubiquity of wireless communications equipment, any adversary, not just peer and near-peer competitors, has as much access to the spectrum as the Defense Department. That means that in any conflict, any adversary may be using spectrum crucial to the department and preventing the military from being able to use it. Adversaries may also use jamming techniques to actively block DoD from using portions of the spectrum.

"*Technologies evolved and our peer competitors have improved and watched us over the years and have gotten smart,*" Moorefield said. "*We're getting jammed on everything from GPS to our [unmanned aircraft systems.] That's why we have our counter-UAS program out there. Everything's getting interfered with. That is a contested environment. Everything's getting jammed.*"



An illustration with an M1 Abrams tank firing. Graphic illustration by Regina Ali, DoD.

It's not just on the battlefield where the U.S. can be jammed either, Moorefield said. Jamming is happening while doing training overseas and in other places as well.

"*Just during our training and exercises, we're getting jammed," he said. "Stuff is going on — GPS is getting denied and jammed all the time in different countries. Our UASs are getting jammed and spoofed.*"

Even stateside, Moorefield said, the department finds itself in competition in the electromagnetic spectrum with industries and communities around military bases.

Moorefield noted, "*At some of our bases we used to be able to go out and do training and testing and exercises — just go out and do whatever we wanted to do. But now, the surrounding neighborhoods and the surrounding communities are just getting more and more crowded using wireless. So that access that we used to use, and freedom that we used to have using the spectrum on those bases is diminishing as the communities are growing.*"

The department's electromagnetic spectrum superiority strategy is driven by three "C's," Moorefield said: a contested environment, spectrum congestion and spectrum constraint.

A contested environment, he said, means adversaries have gotten smarter in how they jam the spectrum. Even if an adversary isn't using a portion of the spectrum, he said, they can prevent the U.S. from using it through jamming.

"*We have to figure out how to be smarter than them and develop capabilities to allow us to be able to get access to the spectrum whenever we need it, and however we need it and to also be able to deny the enemy the same access,*" Moorefield said. "*We call that 'freedom of maneuver' within the electromagnetic spectrum.*"

The congested environment, he said, means there's simply more people wanting to use spectrum. That might mean stateside or abroad, in actual warfare or in training, the department will find that there's just a lot more users now of the electromagnetic spectrum than there have been.

"*The spectrum space is getting more and more crowded,*" Moorefield said. "*That includes 5G, the next G coming, SATCOM, tactical radios, commercial and federal — everybody's using spectrum more and more. So, we have a congestion problem, everything is crowded.*"

Finally, he said, there is constraint. Whereas the department in the past had more freedom to move about the spectrum when it needed to, domestic and international regulations have decreased the amount of spectrum available for military access.

"*We don't have that big access and use that we used to have. DoD used to use a spectrum any way they wanted to. Those days are over,*" he said. "*That constraint is limiting us in our ability to train as we fight.*"

To ensure that in the future the U.S. military has the ability to operate in the electromagnetic spectrum, the department has developed the "***2020 Department of Defense Electromagnetic Spectrum Superiority Strategy***."

"*Superiority means being able to access the spectrum, use any frequency you want to, be able to maneuver ... and deny the enemy access to the spectrum at the same time,*" said Moorefield.

The strategy includes five goals to help the department attain that superiority:

1 Develop superior EMS capabilities.
2 Evolve to an agile, fully integrated EMS architecture.
3 Pursue total force EMS readiness.
4 Secure enduring partnerships for EMS advantage.
5 Establish effective EMS governance.

For the U.S. military to attain that superiority, there will need to be modernization and reform, new policies put in place, and new gear — all of that is spelled out in the strategy.

"*The department's evolution in the EMS is necessary for the U.S. military's ability to effectively sense, command, control, communicate, test, train, protect and project force,*" said ***Ellen Lord***, the Undersecretary of Defense for Acquisition and Sustainment.

"*Modernizing to maintain competitive advantage over near-peer adversaries will enable DOD to assert EMS superiority and mitigate risks to U.S. national and economic security One part of reform,*" said Moorefield, "*is a change in the way spectrum is managed. Today, spectrum is managed by static frequency assignments and licenses. We have to get dynamic, flexible and cognitive to be dynamic enough to be able to move around at different frequency bands.*"

Also involved, and part of the strategy, is development of spectrum sharing capability. That means acknowledging that there are other users of a segment of spectrum the DoD wants access to, that there are benefits to U.S. commerce if the private sector or even other federal agencies have access to that spectrum and then developing a system whereby more than one entity can take turns using that part of the spectrum when needed. That's not happened in the past, but it's happening now, Moorefield said.

Implementing the EMS Superiority Strategy enables us to take that bold action so we are able to dominate the spectrum in all domains and, if challenged, win against our enemies." Air Force Gen. ***John E. Hyten***, Vice Chairman of the Joint Chiefs of Staff

EMS superiority will also involve new kinds of technology that are able to determine on their own what frequency they ought to be on at any time, Moorefield said. That technology will be able to assess the environment to see what else is using spectrum, and what part of it, and then find the best available portion of the spectrum to use to accomplish the communications it needs to accomplish -- all without the assistance of users.

"*We're trying to get to autonomous kinds of operations, meaning*

machine-to-machine," he said. "*You've got the machines talking to each other. You won't have to have segregated allocations. You'll have the machine built to be able to tune across a variety of different frequency bands. It'll listen within the environment. And it'll be talking to another machine and say I'm using this frequency; you move to another frequency.*"

Policy changes are needed, as well. The department's acquisition elements must be allowed to obtain the right kind of equipment to attain spectrum superiority, he said.

"*We have to be able to reform acquisition [policies] so that they know that they can build capability to do that — to be able to be dynamic*," he said. "*Today we can't do that. The regulations don't support it. We have to reform the regulations to allow dynamic spectrum operations. We have to inform acquisition so they can now acquire those kinds of capabilities. We need to inform research and engineering so they can do the research and development, so that acquisition can purchase it.*"

There's a lot of equipment in the department's inventory today that was designed to operate in the EMS. But that equipment was built to operate in clearly-defined areas of the spectrum. Eventually, all that gear will need to be replaced with new gear that can operate more freely in the spectrum, and share spectrum with other pieces of gear.

"*That's going to take several years to make the transition*, " Moorefield said. "*But along the way, new gear will be cognizant of the older equipment on the battlefield, and will be able to work alongside it. We've got old stuff out there, we've got medium stuff and we've got new stuff. As you do your tech refresh, and you implement the policies into the acquisition reform, to be able to build dynamic spectrum stuff, that new capability will be able to cohabitate around the old stuff because it now has that dynamic flexible operation. So it's not sitting on a single frequency. I don't care what your old stuff is doing, I'm going to operate around you. And when that old thing expires, then they're going to tech refresh and become dynamic. Over time, we'll get there. But it's going to take us time to do that.*"

Another big part of the superiority strategy is the blending of the electromagnetic warfare and electromagnetic spectrum management communities into one "*electromagnetic spectrum operations*" or EMSO community, Moorefield said. "*In the past, the electronic warfare community kind of did their own thing*," he said. "*They're out there doing jamming, electronic attack and the protect mission without any regard to the other communication equipment in the battlefield.*"

The result of that, he said, sometimes created spectrum "*fratricide*" on the battlefield, where blue force use of the spectrum to damage enemy forces also hurt other blue force operators.

"*The guys on the ground were getting blasted — they couldn't even talk on their radios anymore because you got a big platform flying through and he's just blasting out, jamming the entire battlefield*," Moorefield said.

The merging of the existing electronic warfare and EMSM communities into an EMSO community, he said, can fix this.

"*This now blends this all together and forces us as a department to be able to orchestrate this battlefield*," he said. "*Now you have EW, you got all your other comms — whether it's tactical radios, radars, EW, all being orchestrated in the environment. Our goal is to develop a common operating spectrum picture so that the commander can see what those operations look like and he can command and control those operations, based on that spectrum picture.*"

The strategy doesn't lay out a timeline for how the Defense Department will get mastery of the EMS. Instead, Moorefield said, the strategy sets a "*broad vision of where we go and how we get there*. What's clearer, he said, is the consequences of not achieving spectrum superiority.

"*If we don't figure out how to dominate the spectrum space we're going to be at the mercy of our peer competitors*," he said.

General Hyten added that the 2020 Department of Defense Electromagnetic Spectrum Superiority Strategy is what the Defense Department needs to ensure U.S. warfighters continue to have freedom of action wherever they are asked to fight.

"*The department is dedicated to a unified, holistic electromagnetic spectrum operations approach which ensures our freedom of action in the EMS at the time and place of our choosing*," Hyten said. "*We cannot expect military success in any domain if we fail to take bold action to ensure that the United States and its allies have freedom to act in the spectrum. Implementing the EMS Superiority Strategy enables us to take that bold action so we are able to dominate the spectrum in all domains and, if challenged, win against our enemies.*"

DoD feature articles authored by C. Todd Lopez, DoD News

An illustration showing two MH-60S Seahawk helicopters conducting a vertical replenishment-at-sea with the aircraft carrier USS Nimitz. Graphic illustration by Regina Ali, DoD

THE FOUNDATION OF ARCTIC CONNECTIVITY

By Scott Scheimreif, Executive Vice President, Government Programs, Iridium

To most, the Arctic is considered a mysterious and uncharted territory. Known for its frigid temperatures, harsh topography and remote location, it is not a top travel destination. However, for many industries and organizations, such as oil and gas (O&G), mining, merchant fishing, scientific research and global militaries, it is frequently visited and a place where critical work and discovery are accomplished.

As the polar regions become increasingly more traveled and competitive from a geopolitical standpoint, the satellite industry must ensure that resilient and reliable connectivity is always available.

Today, the backbone of weather-resilient Arctic satellite connectivity is supplied over L-band spectrum via Iridium's Low Earth Orbit (LEO) satellite constellation. It may seem a surprise with so much attention given to new LEO constellations, but Iridium remains the only mobile satellite communications provider capable of delivering reliable SATCOM to both poles.

The Iridium network is comprised of 66, crosslinked, LEO satellites that create a web of L-band connectivity around the entire planet. Due to its unique meshed network architecture, the satellites are constantly orbiting the Earth at 17,000 miles per hour (27,350 kph), converging at the North and South Poles, creating high visibility for *Iridium Connected*® devices in the Arctic and Antarctic regions.

In comparison to other commercial satellite networks, Iridium's L-band offers low latency, with no need for local ground infrastructure plus weather resilient connectivity over small, low-power, highly secure, mobile terminals — all key characteristics for anyone operating in these areas of the world.

A geography of extremely high interest for global militaries and governments, the Arctic is of paramount importance to the U.S. maintaining a strong Arctic presence, further highlighting the critical importance of reliable communications capabilities. As such, it is a strategic location for various military exercises and communications demonstrations.

For instance, the United States Coast Guard (USCG) recently executed a demonstration that featured multinational collaboration, thereby further validating the efficacy of the company's Iridium Connected, L-band resources. In partnership with French and Royal Danish naval assets, the U.S. Coast Guard Cutter Campbell demonstrated ship control and interoperability while navigating some of the world's harshest waters that are well known for fostering the most active icebergs off Greenland's western coast.

Covering 10,000 nautical miles, this exercise was just one example of the work being done in the Arctic and the importance of L-band SATCOM. With plans to support future demonstrations and exercises, Iridium will continue to play a key role in leading Arctic connectivity.

Iridium's strong reputation in the Arctic is evident through the company's unique presence in the region as well as the firm's longstanding relationship with the United States Government.

For nearly 20 years, Iridium has been the trusted mobile SATCOM provider for the United States Department of Defense (DoD), particularly through its multi-year, fixed-price *Enhanced Mobile Satellite Services* (EMSS) contract. In September of 2019, the DoD awarded Iridium the contract, now executed under the U.S. Space Force (USSF), for an additional seven years, to continue providing unlimited global usage for an unlimited number of subscribers on its narrowband service.

The DoD and its select departments, including the U.S. Northern Command, rely on the Iridium® network for critical communications needs across multiple functions, such as disaster relief, emergency preparedness, homeland security and command-and-control communications around the world — especially in the Arctic.

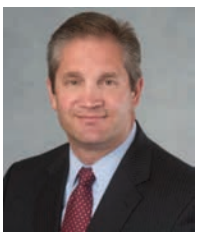
Iridium Connected sensors and tracking devices are deployed across the region, helping scientific organizations monitor environmental research projects and global militaries keep track of valuable assets. Additionally, military vehicles, vessels and aircraft are equipped with Iridium satellite phones and ***Iridium Certus***™ broadband terminals, supplying reliable two-way communications and Internet access to deployed personnel. From the perspective of a SATCOM provider, the industry has entered a new era, one that encourages innovation and collaboration.

With the large number of new space entrants proposing mega-constellations and launching thousands of smallsats to space, there is tremendous opportunity for partnership and multi-band solutions in the future. As the Arctic becomes more accessible, activity will continue to increase.

The need for weather resilient SATCOM that is easily deployed, mobile and highly portable will become even more crucial than it is today.

However, even with a constantly changing landscape, one element remains the same — L-band SATCOM is the foundation for any robust Arctic communications infrastructure — Iridium has the experience and proven success to continue leading connectivity efforts in this highly sought after and increasingly important corner of the world.

www.iridium.com



The author, Scott Scheimreif, is the Executive Vice President, Government Programs at Iridium Communications Inc., the only satellite communications company that offers truly global voice and data coverage. Scott brings more than 20 years of experience in the satellite communications industry as well as over 25 years working closely with the U.S. government and particularly the Department of Defense in the telecom industry. He is responsible for program development and growth of Iridium's support to the U.S. Department of Defense (DoD)

Photo left: Thales MissionLINK terminal
Photo right: Thales VesseLINK terminal.

Three images were collected in rapid succession over Port Elizabeth, South Africa, on August 10, 2020, at 11:31 a.m. local time. By analyzing these images, BlackSky is able to extract critical economic and financial indicators to offer a near-real-time view of commercial activity in Port Elizabeth.

In particular, with the assistance of Spectra AI, BlackSky can count the number of container stacks in the container yard, identify the container and bulk carrier ships currently berthed, count the number of vehicles awaiting export in the car terminal, track ground vehicle movements, and even determine which cargo holds are actively being loaded. With the ever-increasing revisit rates offered by the BlackSky Global constellation and the advanced automation capabilities enabled by Spectra AI, economic activity is revealed at a velocity previously thought impossible.

FIRST-TO-KNOW INSIGHTS FUEL GEOSPATIAL OPPORTUNITIES

By Brian O'Toole, Chief Executive Officer, BlackSky

Much in the same way that global positioning once shook the world, BlackSky is providing a new perspective on geospatial intelligence, expanding it out of the defense and intelligence domain and putting it in commercial hands.

BlackSky is making good on its promise to deliver first-to-know global observations on emerging events and anomalies using deep activity monitoring and predictive analytics.

This near real-time intelligence — once the sole province of top defense and intelligence organizations — is now affordable and accessible for commercial use. And that opens up entirely new avenues of opportunity for the use of space-based intelligence.

More than a satellite company, BlackSky is truly a global monitoring company.

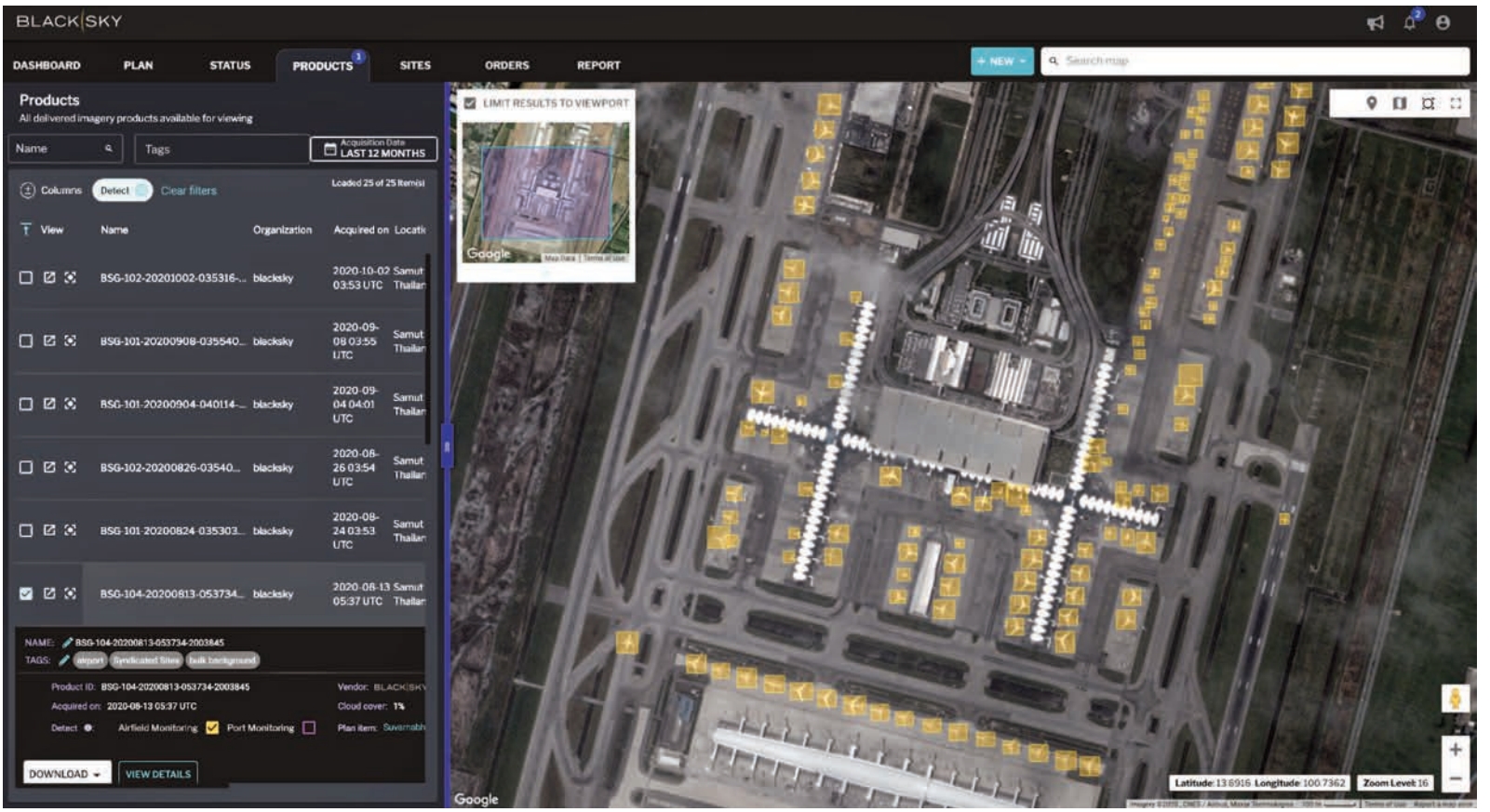
By combining geospatial information with a variety of sources, sensor data and IoT feeds as well as leveraging artificial intelligence (AI) and machine learning (ML) techniques, BlackSky's *Spectra* AI platform provides an unprecedented level of data depth and analysis for customers at almost instantaneous speeds.

Global Monitoring Highlights BlackSky's Innovation Curve

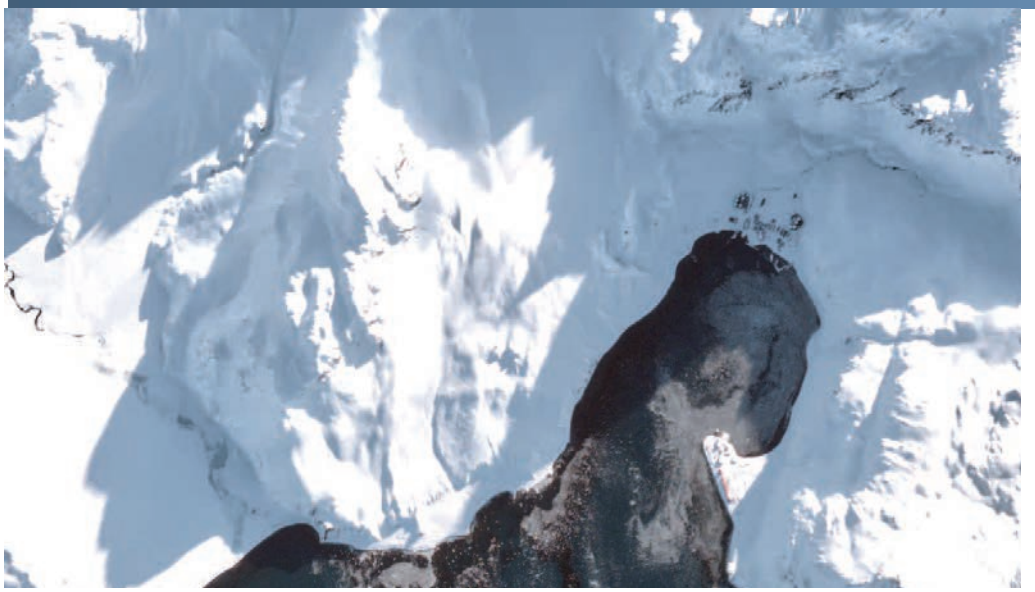
BlackSky's platform has found favor as a valuable tool for intelligence, surveillance and reconnaissance (ISR) related missions and for tracking major global events. This has led to several significant contracts this year.

As part of a multi-year contract with the ***Defense Innovation Unit*** (DIU), BlackSky will be providing the U.S. Army Tactical GEOINT (TacGEO) prototype program (***see the sidebar***) with its high-revisit, low-latency constellation architecture.

Screenshots from BlackSky's Spectra AI platform are courtesy of the company.



"This image shows the impact of COVID-19 on air travel on Bangkok's Suvarnabhumi Airport.
Many parked aircraft are visible in this image as well as the new satellite terminal, whose opening has been delayed by the pandemic.



A single ship (in yellow, bottom) approaches Grytviken in South Georgia and the South Sandwich Islands at 5:25 p.m. local time on August 10, 2020, as captured by BlackSky-8. An image at this time of the day is achievable due to the specific inclined orbit of the BlackSky satellites. All ships entering Grytviken are required to pass a thorough COVID-19 screening process before entry is permitted.

The ***Department of Defense*** (DoD) is leveraging BlackSky's low-cost, high-revisit, small imaging satellites to develop critical concept of operations (CONOPS) including tactics, techniques, and procedures, and to inform future operational systems.

BlackSky was also awarded a contract leveraging its AI platform to monitor the efficacy of global COVID-19 mitigation efforts. Specifically, BlackSky's Spectra AI has been enlisted to monitor overseas U.S. military bases and help secure critical supply chain nodes. The company's global monitoring capabilities will track the outbreak and spread of COVID-19 to ensure the protection of deployed personnel.

Industry Leading User Experience

BlackSky has overcome enormous barriers, in place for decades, to increase the company's capabilities for rapidly iterating, evolving and innovating smallsats in Low Earth Orbit (LEO). Today, with Spectra AI, customers can easily task a satellite from any internet-connected device to affordably obtain images and timely insights.

The next phase of growth will be determined by user experience with access to data and imagery.

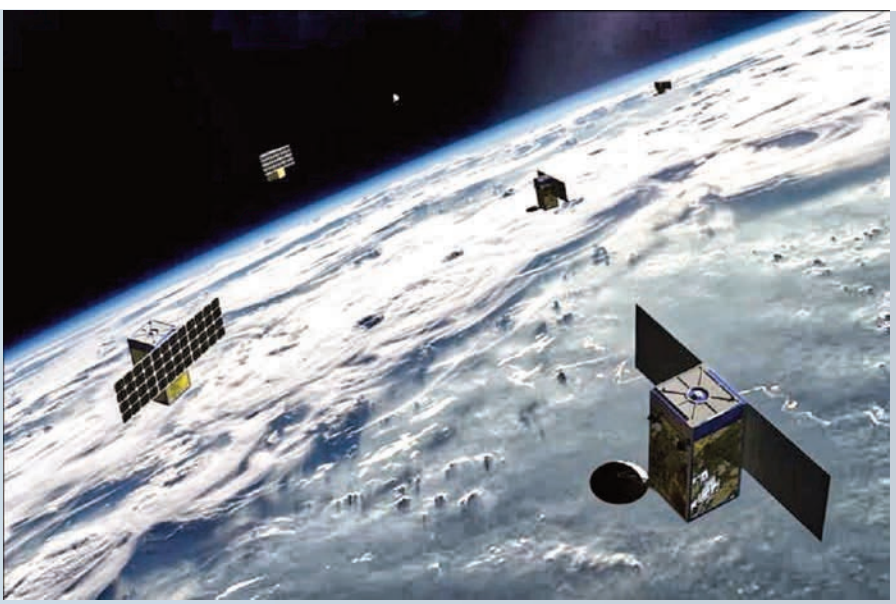
BlackSky is also seeing interest from a number of companies such as risk management and investment research firms, strategic intelligence and consulting companies, security service businesses, non-profit think tanks, geospatial analytics companies, internationally sustainable development agencies, public transportation organizations and airlines.

Like that historic GPS moment in global technology, BlackSky's Spectra AI is creating new expectations today and has the potential to change the future. ***https://www.blacksky.com***

Author Brian O'Toole is the Chief Executive Officer of BlackSky.

BlackSky has initiated the next phase of expansion of its high-revisit commercial satellite constellation with the unveiling of its next generation, Gen-3, satellite architecture.

In addition, the company also announced it has conducted the preliminary design review of its Gen-3 satellite design for the U.S. Army Tactical GEOINT (TacGEO) prototype program as part of a multi-year contract with the Defense Innovation Unit (DIU).

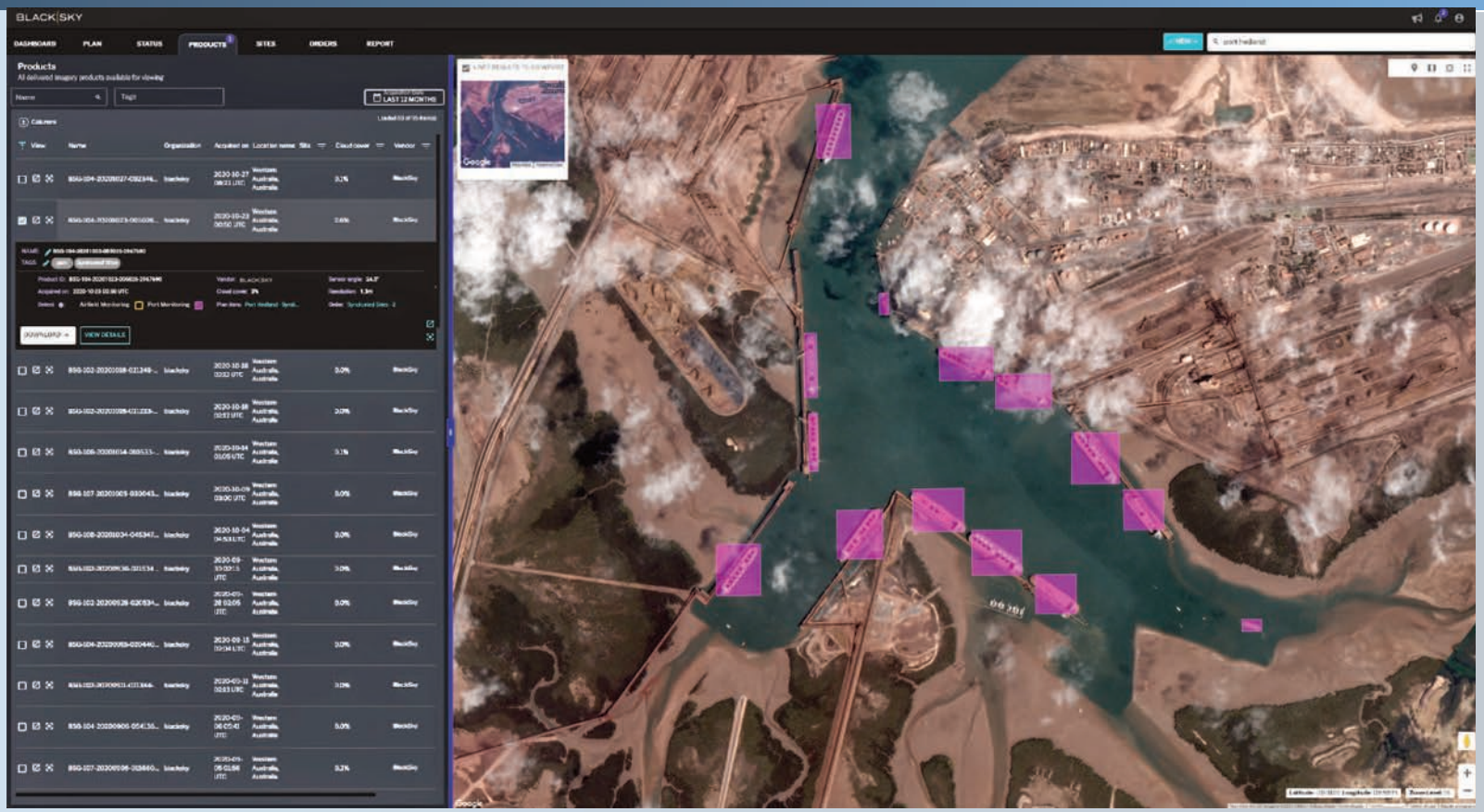


BlackSky smallsats constellation on-orbit. Image is courtesy of the company.

The commercial constellation expansion features Gen-3 satellites capable of producing images with 50 cm resolution and the hosting of multiple sensors that include short-wave infrared (SWIR).

The improved resolution and enhanced spectral diversity of the Gen-3 satellites will extend BlackSky's ability to provide real-time insights to the firm's customers via a broad set of conditions, including nighttime, low light and challenging weather.

The TacGEO program is designed to support the DoD's needs for responsive, space-based intelligence, surveillance, and reconnaissance (ISR) for tactical applications. The TacGEO program is a science and technology program to demonstrate the tactical utility of a single satellite of Gen-3's capabilities.



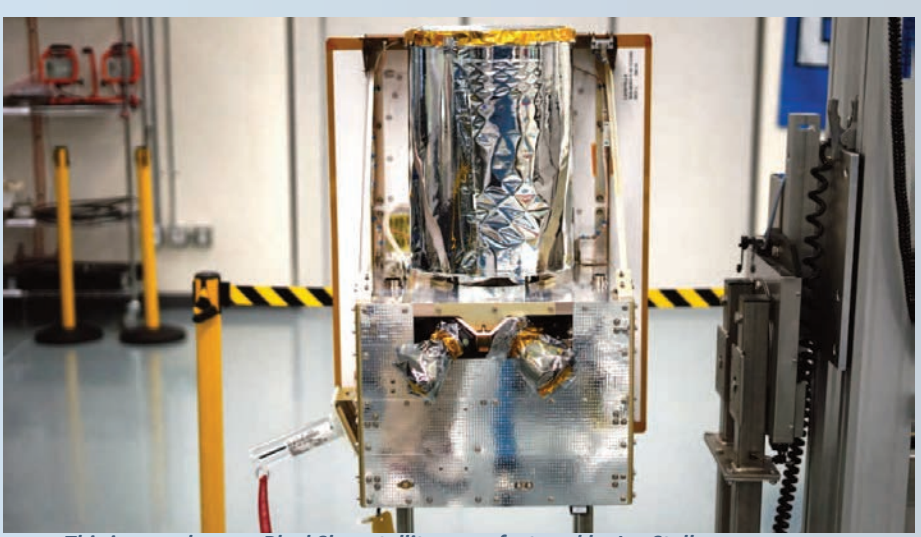
BlackSky routinely monitors Port Hedland, the highest tonnage port in Australia, for changes in activity expected to influence regional iron ore prices.

BlackSky's Gen-3 satellites will enable rapid distribution of highly responsive insights to warfighters to support concurrent war games, exercises, and combat training center events and help measure technology readiness.

The TacGEO project leverages BlackSky's high-revisit, low-latency constellation architecture to address a growing need for responsive intelligence, surveillance and reconnaissance for the tactical ISR missions.

BlackSky accelerates the DoD's ability to leverage low-cost, high-performance, small imaging satellites to develop critical concept of operations (CONOPS) including tactics, techniques and procedures, and to inform future operational systems. The contract was awarded to BlackSky in January 2020 after a competitive bid process. The TacGEO satellite program is now well into the design and development phase and is on track to launch and demonstrate operational capabilities in 2022.

"BlackSky is committed to ensuring the success of our customers' missions. Our strategy of combining rapid evolution and deployment of space-based remote sensing capabilities with an industry leading AI-driven analytics and delivery platform will ensure that our customers are always the first to know," said Brian O'Toole, CEO of BlackSky. "We are very proud to have reached this performance milestone. It demonstrates our ability to leverage a next generation space and analytics architecture to deliver new insights at a pace and economics unprecedented in the industry."



This image shows a BlackSky satellite manufactured by LeoStella. Image is courtesy of LeoStella

The Gen-3 design is an evolution of the Gen-2 system that is currently in production with BlackSky's satellite partner, ***LeoStella***. BlackSky's rapid innovation approach and vertically integrated architecture enables it to produce new generations of satellites, while continuing full-scale production and operations of its current satellites.

This agile development and production strategy will enable BlackSky to complete design and manufacturing of its Gen-3 satellites in less than 24 months.

THE FRAGMENTED APERTURE ADVANTAGE

By Anne Wainscott-Sargent for NXTCOMM

The defense community increasingly recognizes the high potential of non-geostationary satellite (NGSO) constellations for meeting the military's insatiable need for low-latency, high bandwidth satellite communications (SATCOM) connectivity.

While many national space assets have traditionally resided in geosynchronous orbit (GEO), unprecedented shifts in warfighter operating environment are driving instantaneous reach and critical capacity requirements for mobile forces and SATCOM connectivity — fueled by the U.S. Space Force's (USSF) new warfighting architecture. The capacity, agility, and interoperability can only be unlocked by *electronically steered antennas* (ESAs) that operate over Low Earth Orbit (LEO) constellations.


Carl Novello

"LEO networks offer the potential for higher bandwidth at lower latency and are inherently more global than a GEO satellite," said Carl Novello, CTO of NXT Communications (NXTCOMM).

Enabling Terminal Agility

LEOs require a new antenna solution: one that can track two satellites simultaneously. In fact, the "*Fighting Satcom*" vision embraced by the USSF clearly calls for terminal and modem agility, where terminals operate on a variety of waveforms over varying frequencies, with quick or ideally, simultaneous transition to a new frequency. Only an *Electronically Scanned Array* (ESA) terminal can deliver on the USSF's technical challenges.

"*These challenges are driving industry to provide equipment with network resiliency, which will reduce cost while increasing operational ubiquity, all of which serves to multiply capabilities across all domains*," Novello added.

It's almost impossible to predict how such a fundamental change will drive downstream benefits, in much the same way that the benefits of GPS played three decades ago.

In October, NXTCOMM announced their intent to serve the military market's next-generation antenna needs. ***NXTCOMM Defense*** builds on the company's fruitful R&D relationship with the ***Georgia Tech Research Institute*** (GTRI) that enabled the company to unveil its fragmented aperture technology that supports a wide range of products for the military and commercial markets.

The NXTCOMM approach to the ESA challenge focuses on the often-overlooked part of the antenna that faces the satellite, whereas competing solutions focus on the back of the antenna where the beam forming occurs. Not that NXTCOMM doesn't take advantage of those improvements in beamforming chip development — they do that, as well — and then use a super-computing fueled, genetic algorithm to squeeze out every last dB from the design.

Targeting The COTM Needs of Special Ops Soldiers

Stephen Newell

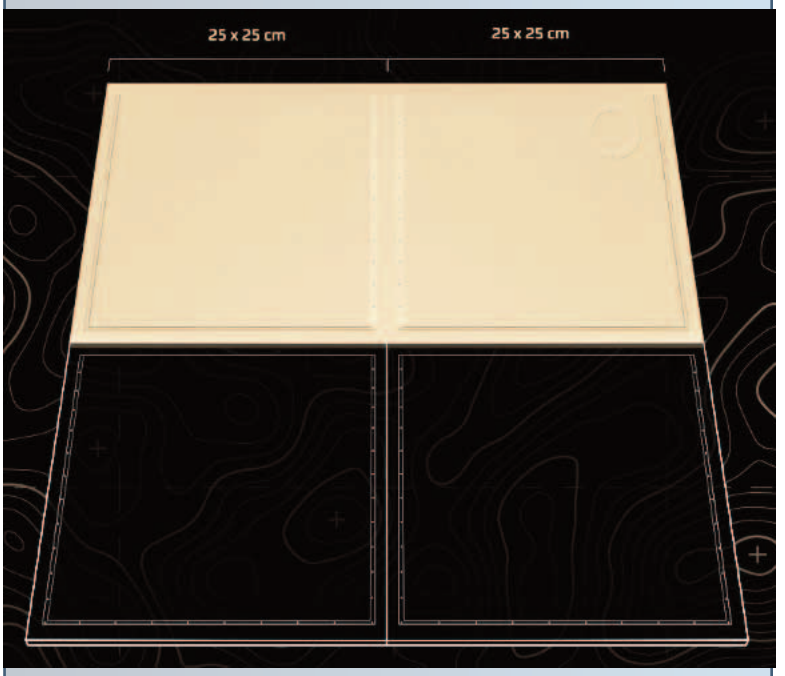
"*The greatest need for a nimble ground infrastructure come from 'Special Forces': they require not only portability and low-profile stealth, but also broadband capacity and high-level operational performance,*" explained ***Stephen Newell***, NXTCOMM's recently appointed Chief Commercial Officer (CCO). "*NXTCOMM will deliver rugged, reliable, powerhouse connectivity to military users, particularly the special operators in theater who need flexible solutions that give them the versatility to go from platform to platform – whether it be a vehicle mounted or manpack solution.*"

Newell said both commercial and military users' insatiable demand for broadband will only intensify in the future, pushing adoption for new connectivity solutions. He pointed out that, over the last five years, $14 billion was spent for one terabyte of data per second of global satellite capacity; however, over the next five years, another $14 billion will be spent to obtain 33 terabytes of data per second.

"*When the sky is filled with LEOs delivering orders-of-magnitude more capacity, the shift from traditional parabolic dishes to ESA will be a wholesale transformation, the way dial-up was relegated to the dust bin the second DSL or cable showed up at your door,*" predicted Newell. *Electronically steered arrays are now a must-have for today's military to tap into the next-generation constellations. They need an agile manufacturer that can support both current and future systems and requirements.*"

"*Our antenna design acts like a LEGO brick, where users only need to add more LEGO blocks to scale the technology to fit an application.*" — *Carl Novello*, CTO, NXTCOMM

Introducing the First Fully Wideband Ku-band ESA — Ka-band Version Next



NXTCOMM's Ku-band product is inherently wideband, allowing defense users to capture the full bandwidth of this spectrum in a single antenna, including both instantaneous and dynamic bandwidth.

The company plans to roll out a Ka-band version of its antenna next year. The company began over-the-air tests for its Ku-band subarray this year and will continue with a full prototype antenna in Q1 2021 before starting initial production of the product next year.

Future-Proofing Ground Infrastructure

NXTCOMM intends to be that partner. Novello points out that the form factor, power consumption and ruggedization challenges facing antenna makers serving the military market are no different today than they were yesterday. "*The new big challenge to solve is future proofing,*" he stated.

What makes NXTCOMM's approach different than other flat panel or ESA efforts? NXTCOMM has designed their antenna product line to be flexible —- with the ability to go from platform to platform — whether it be a vehicle mounted or manpack solution. Because the antennas use an advanced, silicon-based chipset and a unique combining network, NXTCOMM can manufacture their arrays on a single, printed, circuit board.

The base antenna measures about an inch thick, is completely electronically controlled, and, as it has no moving parts, it has a high reliability and works with LEO, MEO and GEO satellite constellations.

Initially targeted at special forces most in need of portability, low-profile stealth, broadband capacity and high-level operational performance, NXTCOMM's antennas are modular and can be conformal. That means they can scale up or down, based on the application.

For example, an antenna could fit on the roof of a Humvee and deliver secure network for warfighters no matter where they are located. Or, the ESA could unfold quickly from a backpack for a special ops team engaged in ground opd.

NXTCOMM points to several benefits for military users that are inherent in its antenna technology:

- ***Inherently wideband - instantaneous band equals dynamic bandwidth***
- ***Greater efficiency – leading to a decrease in parasitic losses***
- ***Reduced power consumption, lower heat dissipation and increasing reliability***
- ***Modular architecture and highly integrated silicon-based chip sets with no moving parts, increase reliability, ease of manufacture and reduced cost.***
- ***Lower weight and low-profile, portable and easily deployed***

The transition to NGSO is a fundamental change that the military will deem as a strategic advantage in the same way that telegraph, telephone, radio, radar, lasers and GPS all brought about fundamental changes in the way the military conducts their operations — NXTCOMM looks forward to serving those needs through the firm's technology innovations and dedication to the wawrfighters missions.

www.nxtcomm.com

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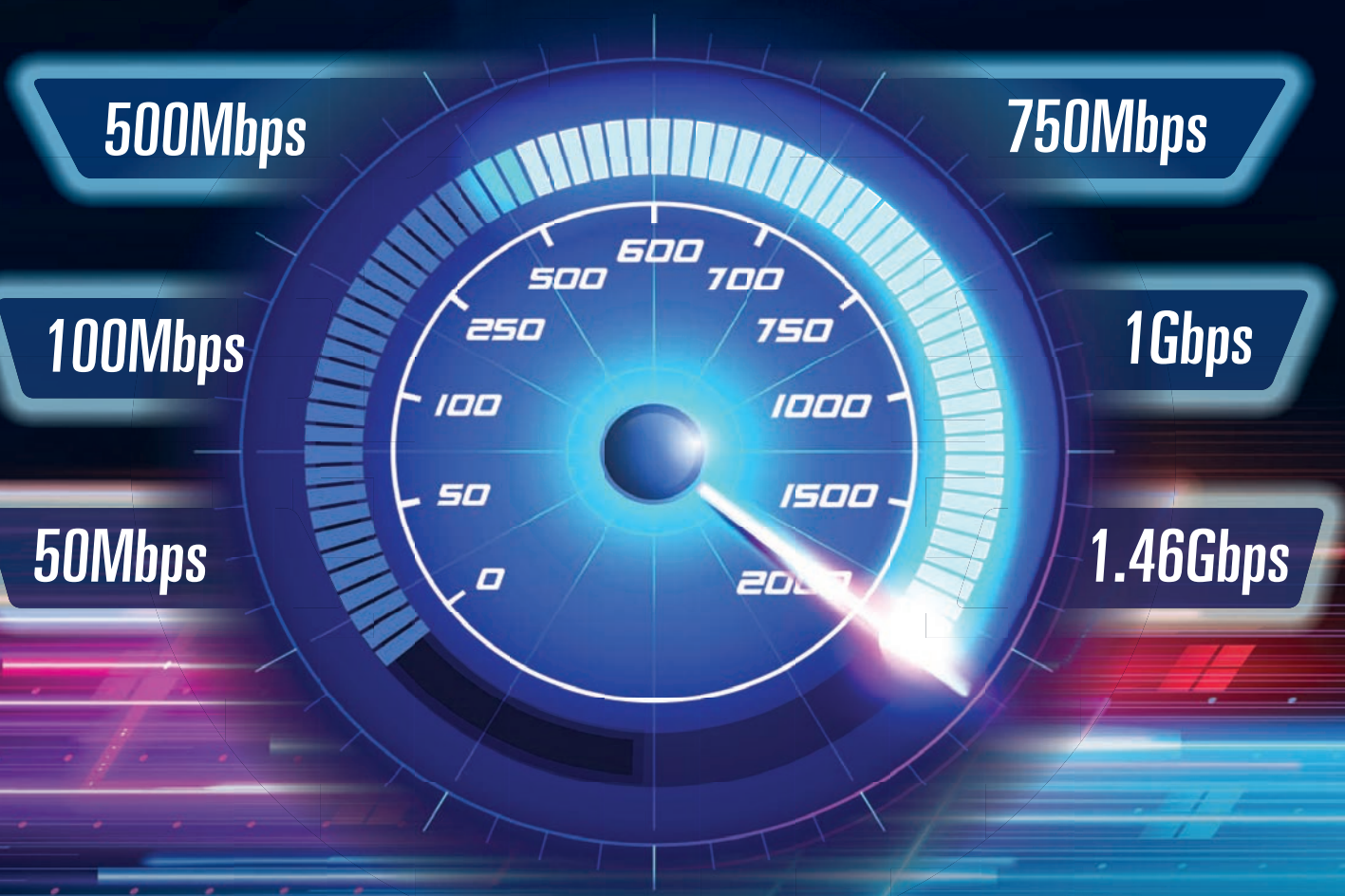

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With its own waters largely depleted, China's fleet of fishing vessels has journeyed abroad over the past several years to exploit more plentiful marine life. Although China maintains that its fleet abides by international laws and regulations, claims of indiscriminate fishing, resource depletion, and aggression against other vessels and authorities have followed the fleet.

Most recently, the Chinese fleet was spotted outside the exclusive economic zone (EEZ) surrounding the Galápagos Islands. HawkEye 360 quickly initiated monitoring to improve situational awareness of fleet activity. The company's results reveal Chinese vessels attempting to hide by deactivating *Automatic Identification System* (AIS) tracking hundreds of times. Hawkeye 360 also discovered evidence of illegal fishing, with multiple instances of dark vessels operating within the Galápagos EEZ.

Background

In late July 2020, the Ecuadorean Navy ***discovered*** a fleet of roughly 260 Chinese fishing vessels just outside the EEZ surrounding the Galápagos Islands.

Although the Chinese fleet was in international waters, global concern around the incident grew. Deemed a "*living museum and showcase for evolution*" by ***UNESCO***, the Galápagos Islands are home

to a diverse range of geological features, wildlife and marine life, including several rare and endangered species. Chinese fishing vessels have been identified in the seas near the Galápagos over the ***past several years*** as they search for new fishing areas and, in 2017, the Ecuadorean Navy captured a Chinese fishing vessel within the Galápagos marine reserve carrying 300 tons of marine wildlife — including endangered species.

This is not the first time China's fishing fleet has raised international tensions. With its own waters fairly depleted, China's "*dark fleet*" has surfaced further and further abroad to fill its nets. Reported incidents with China's fishing fleet are often accompanied by claims of indiscriminate fishing and aggression that have prompted ***some critics*** to call it "*more than just a commercial concern; it acts as a projection of geopolitical power on the world's oceans.*"

Monitoring is essential for a country to properly police its EEZ and prevent encroachment by foreign entities. However, the vast ocean expanses make it incredibly difficult to find vessels that may be participating in illegal fishing — especially when a fleet of vessels turn off their AIS, as has been reported about the Chinese fishing fleet.

The EEZ for the Galápagos Archipelago encompasses 700,000 square kilometers. This area is larger than the state of Texas or greater than Spain and Portugal, combined. Effectively patrolling this massive region using traditional coast guard or airplane-based observation is nearly impossible, making it easy for a fishing vessel to "go dark" and cross over EEZ boundaries in pursuit of richer catches.

Revealing New Insights

HawkEye 360 delivers a unique method to gain maritime awareness through radio frequency (RF) geospatial intelligence. HawkEye 360 monitored the Galápagos Islands over the summer of 2020 to supply a fresh set of eyes on the Chinese fishing fleet behavior. The company routinely collected and analyzed a variety of maritime RF signals, such as X-band marine navigation radar, to increase visibility beyond just AIS.

The Chinese fleet first approached the Galápagos around the start of July and remained in the region for two months before leaving the end of August. The composite data image below displays all AIS vessel traces, showing the intensity of RF activity as the fleet swarmed along the southern edge of the EEZ boundary (***see Figure 1 on the next page***).

The bulk of the fleet appeared careful to not cross the EEZ boundary, instead deciding to come as close to the line as possible without violating international law. Although it's technically not illegal to fish in this manner, such intensive and large-scale fishing by the fleet pushes the bounds of proper behavior, stripping adjacent waters of many types of marine life.

It's even more important to consider what can't be seen. This is especially true when searching for vessels that may not be transmitting AIS signals. HawkEye 360's ***SEAker® analytics*** identified gaps in the AIS records where vessels seemed to disappear for eight or more hours. The next graphic displays all of these disappearances, grouped into half-month periods through July and August (***see Figure 2 on the next page***).

As the Chinese fleet entered the region, the preponderance of dark tracks rapidly increased, with Chinese-flagged vessels representing 87 percent of all gaps by the end of July. Likewise, when examined by vessel type, fishing vessels composed 90 percent of all gaps.

Chinese fishing vessels move sporadically, remaining in the same vicinity for as long half a day, then rapidly traveling 50 km to a new position within a few hours, making it very difficult to track without consistent AIS records.

To piece together what happens during tracking gaps, HawkEye 360's satellites located vessels by looking for other common marine vessel signals. HawkEye 360's ***RFGeo™ product*** identifies and geolocates a wide variety of RF emissions, both at sea and land, providing a new dimension of knowledge.

During a six-week period from mid-July to the end of August, we compared our geolocations against AIS data to filter out vessels that were routinely reporting their locations. The remaining hundreds of geolocations indicated previously unknown vessel positions. (***See Figure 3*** two pages ahead).

Of greatest concern, HawkEye 360 discovered multiple instances of RF activity within the EEZ immediately adjacent to the heart of the Chinese fishing fleet. None of these locations correlated with AIS records for the entire day when they were detected.

Although this could be other types of vessels engaged in legitimate activity, these signals may be evidence of dark Chinese vessels crossing into the EEZ to conduct illegal fishing. This is where RF geospatial intelligence serves value in pinpointing suspicious behaviors for authorities to conduct further investigation.

HawkEye 360 leveraged its insights to collaborate with partner ***Airbus Defence and Space Intelligence*** in a joint RF and synthetic aperture radar (SAR) co-collection to perform a Multi-INT analysis. On August 1, HawkEye 360 collected RF signal data multiple times throughout the day. Airbus tasked their ***TerraSAR-X*** satellite to capture a large scale ScanSAR radar image. Radar imaging has the benefit of seeing through poor weather conditions (***see Figure 4 two pages ahead***).

Airbus' satellite-based vessel detection chain extracted 58 vessels locations from the SAR image and provided estimated size and heading for each vessel. Comparing these locations against +/- 60 minutes of AIS data matched 16 vessels to AIS tracking, reinforcing the many gaps in the AIS record.

Item A in *Figure 4* displays a large cargo vessel that has a strong AIS record and appears to be passing through the EEZ legally. In contrast, Airbus located another vessel within the EEZ that HawkEye 360 could not associate with any AIS, raising suspicion of that vessel's activity.

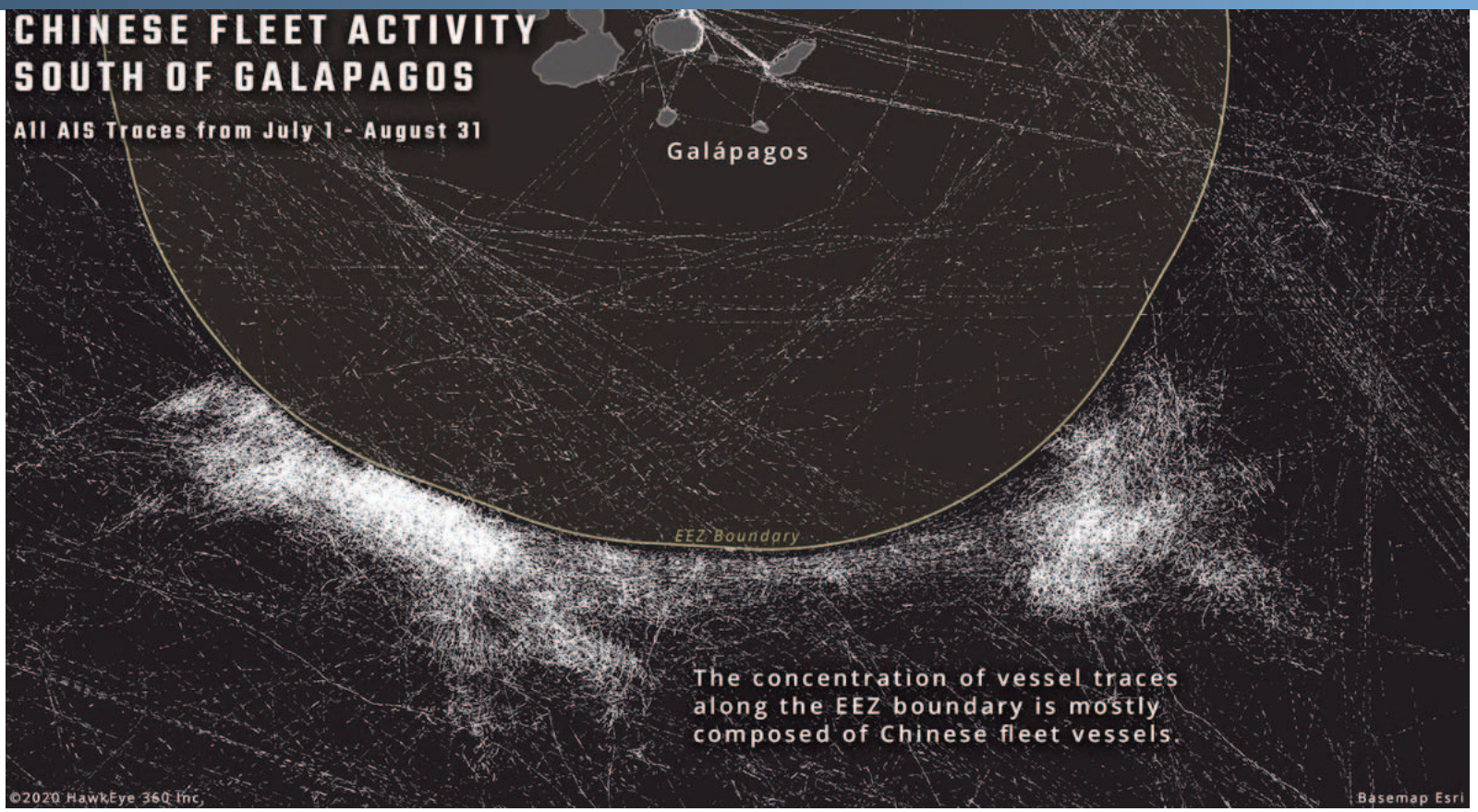

Figure 1.

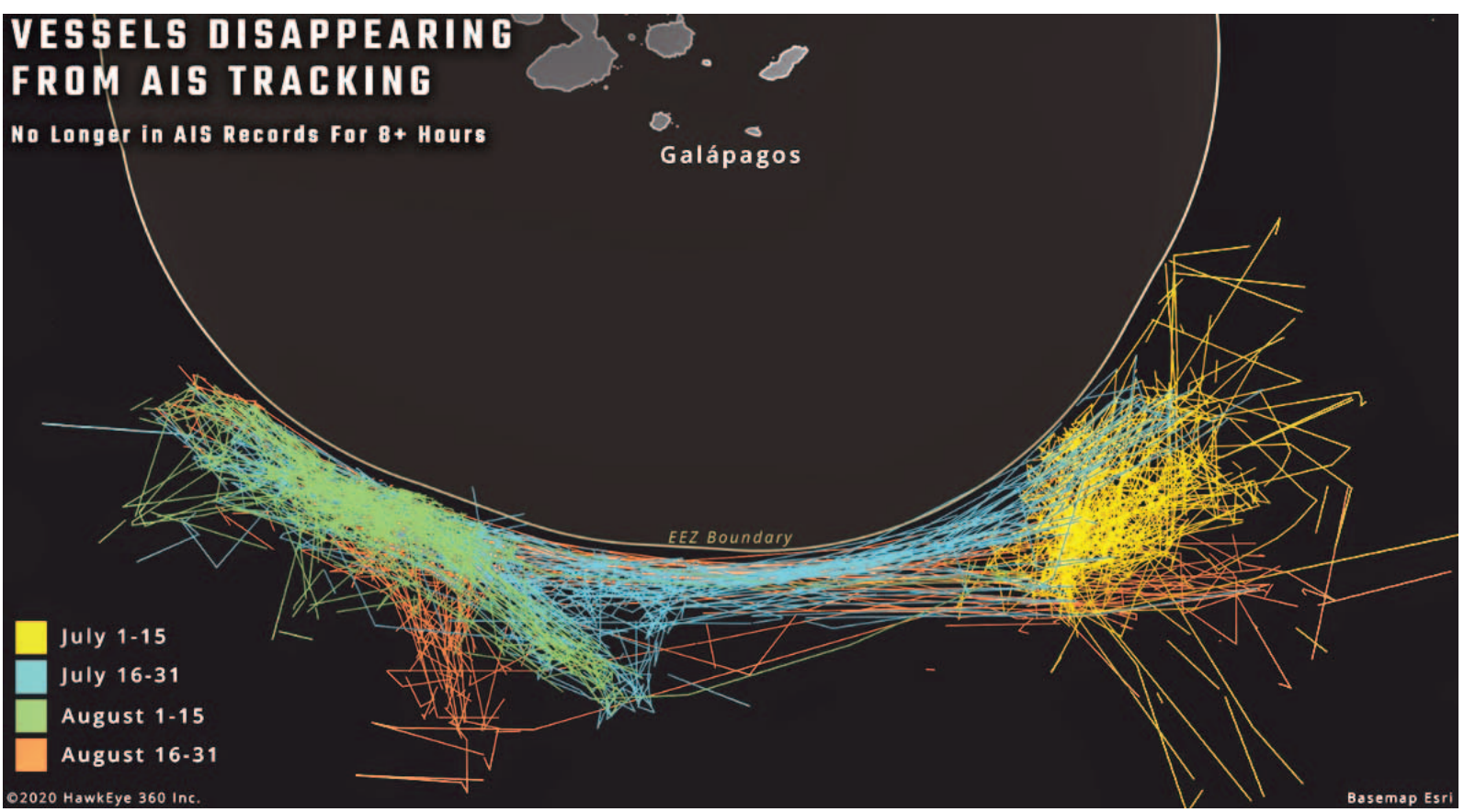

Figure 2.

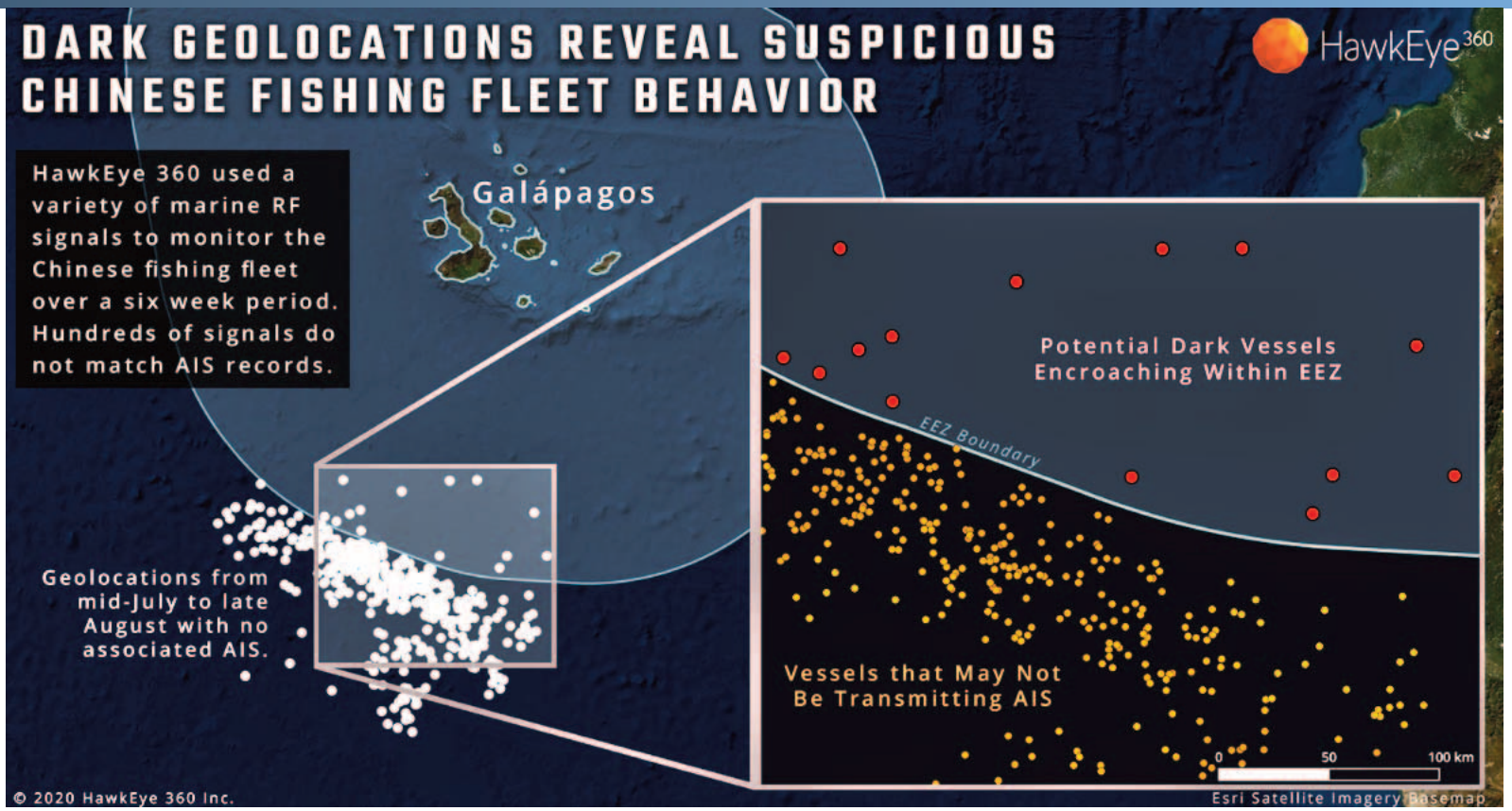

Figure 3.

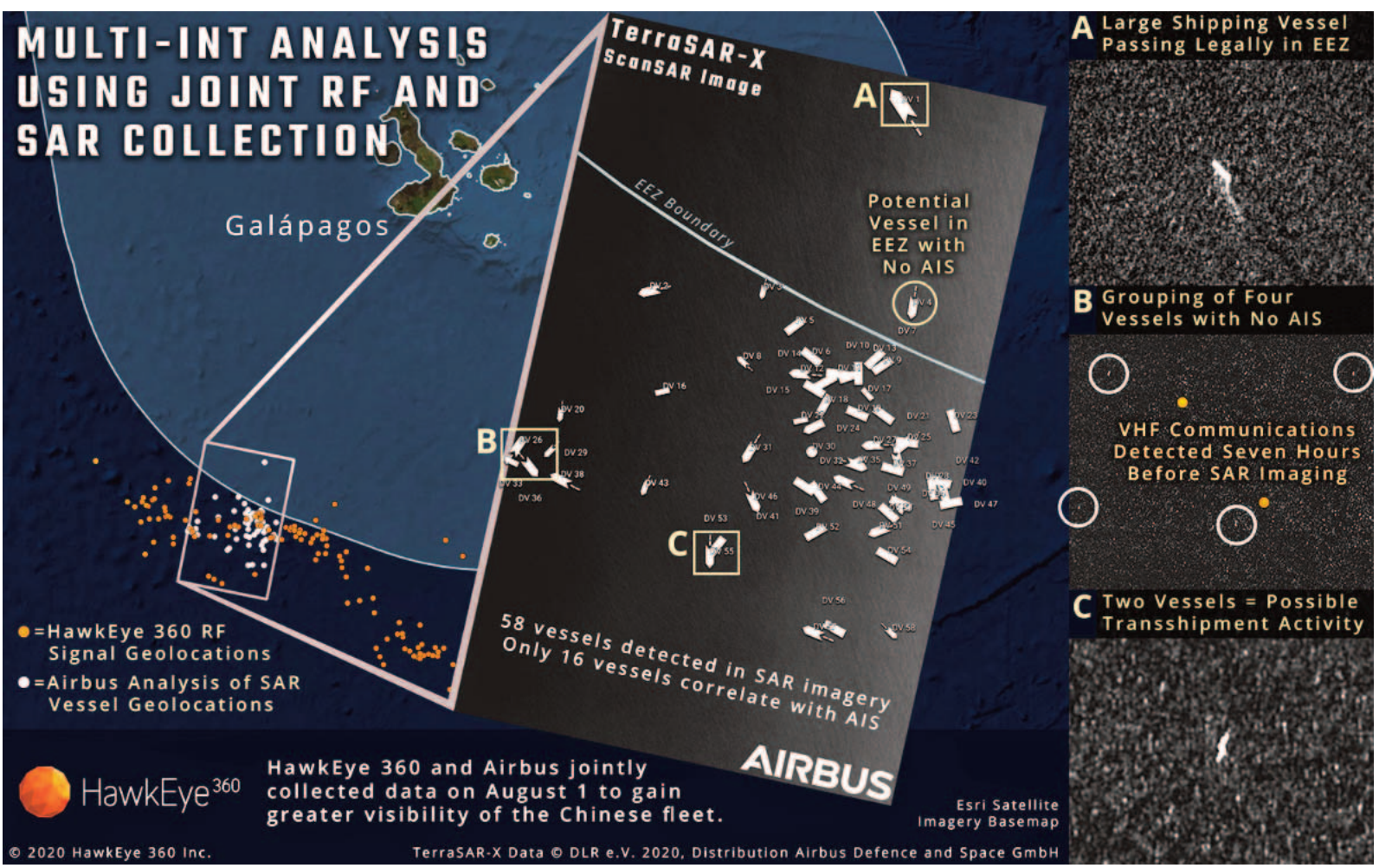

Figure 4..

Item B shows a grouping of four mystery vessels, all within 4-6 kilometers of each other. None of these vessels matched +/- 60 minutes of AIS records. But seven hours before the SAR collection, HawkEye 360 detected VHF radio communications between two vessels at this same place.

There were 46 vessels that transmitted AIS at some point within a 50 km radius. But after examining all these travel records, it seems likely that the four mystery vessels appearing in the image were dark for extended periods, perhaps even the entire day.

Item C potentially displays two vessels alongside each other. Although resolution of the SAR image makes it difficult to confirm, this could be an instance of transshipment, where supplies or fish are being transferred from one vessel to another.

The Takeaway

To an observer using AIS alone, it would likely appear that the Chinese fleet outside the Galápagos Islands was respecting international law. However, large gaps in AIS records create opportunity for vessels to engage in illegal behavior without notice.

HawkEye 360's geolocations of vessel activity reveal many instances of suspicious vessel behavior, including evidence that many vessels in the Chinese fleet stopped broadcasting AIS and may have encroached deep into the Galápagos EEZ. Using our RF data to tip and cue a SAR co-collect with Airbus, we were able to paint a more comprehensive picture of fleet activity.

With RF analytics, authorities monitoring the Galápagos — and those protecting valuable resources elsewhere — can see a more complete picture of maritime activity, allowing them to act quickly and confidently. Bringing these previously hidden activities to light provides a powerful deterrence to further illegal behaviors anywhere across the globe.

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The launch of the NRO's NROL-101 payload aboard an Atlas V rocket.
Photo is courtesy of United Launch Alliance.

United Launch Alliance (ULA) has successfully launched their Atlas V rocket with the National Reconnaissance Office (NRO) NROL-101 payload aboard on November 13 at 5:32 p.m., EST, from Space Launch Complex-41 at the Cape Canaveral Air Force Station in Florida.

This NROL-101 mission was the first ULA launch flying the new **Northrop Grumman** Graphite Epoxy Motors (GEM) 63 solid rocket boosters that burn solid propellant that augment the lifting capacity of rocket's first stage. The GEM 63s measure 63 in. (1.6 meters) in diameter and 66 ft. (20.11 meters) in length. Each GEM 63 produced 371,550 pounds (1.6 mega-Newtons) of max thrust to augment the 860,200 pounds (3.83 mega-Newtons) of thrust produced by the AMROSS RD-180 main engine to power the Atlas V rocket skyward. At liftoff, the combined thrust was nearly 1.8 million pounds or 8 million mega-Newtons.

The Atlas V's Centaur cryogenic upper stage is powered by **Aerojet Rocketdyne's** RL10 engine, which is built in West Palm Beach, Florida, and completed its 500th flight earlier this year. The highly reliable RL10 has long been a mainstay of U.S. national security and space exploration programs, a legacy that will continue with ULA's Vulcan Centaur rocket, which is expected to debut next year.

For pitch, yaw and roll control, the Centaur relies on 12 Aerojet Rocketdyne MR-106 reaction control thrusters that are built in Redmond, Washington. Pressure tanks provided by Aerojet Rocketdyne's **ARDÉ** subsidiary, located in Carlstadt, New Jersey, support both the Centaur as well as the rocket's first stage.

The Atlas family of launch vehicles has been one of the nation's workhorses since 1957, successfully launching 668 times. Originally designed by the U.S. Space Force (USSF)'s predecessor organization, it stood alert as the United States' first intercontinental ballistic missile during the Cold War era.

Since then, the Atlas peacefully launched the first manned spacecraft for Project Mercury, the first generation of Global Positioning System satellites, and various unmanned scientific missions for more than 60 years for both the National Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration.

With its introduction in 2002, the Atlas V variant has successfully placed 48 of 48 National Security space vehicles into their designated orbits. This launch marks the 86th flight of an Atlas V vehicle and the 71st Atlas V launch from SLC-41 at Cape Canaveral Air Force Station, Florida.

This was also the first launch of an Atlas V with the new Northrop Grumman-built Graphite Epoxy Motor (GEM)-63 strap on solid rocket boosters, and a preview of the larger GEM-63XL boosters that will be used on future Vulcan Centaur launch vehicles.

The GEM 63 strap-on boosters (*photo above*) were developed under a cooperative agreement with ULA to provide additional lift capability for the Atlas V launch vehicle. Each motor contributes 371,500 pounds of additional maximum thrust, and up to five GEM 63 motors can support a single Atlas V launch.

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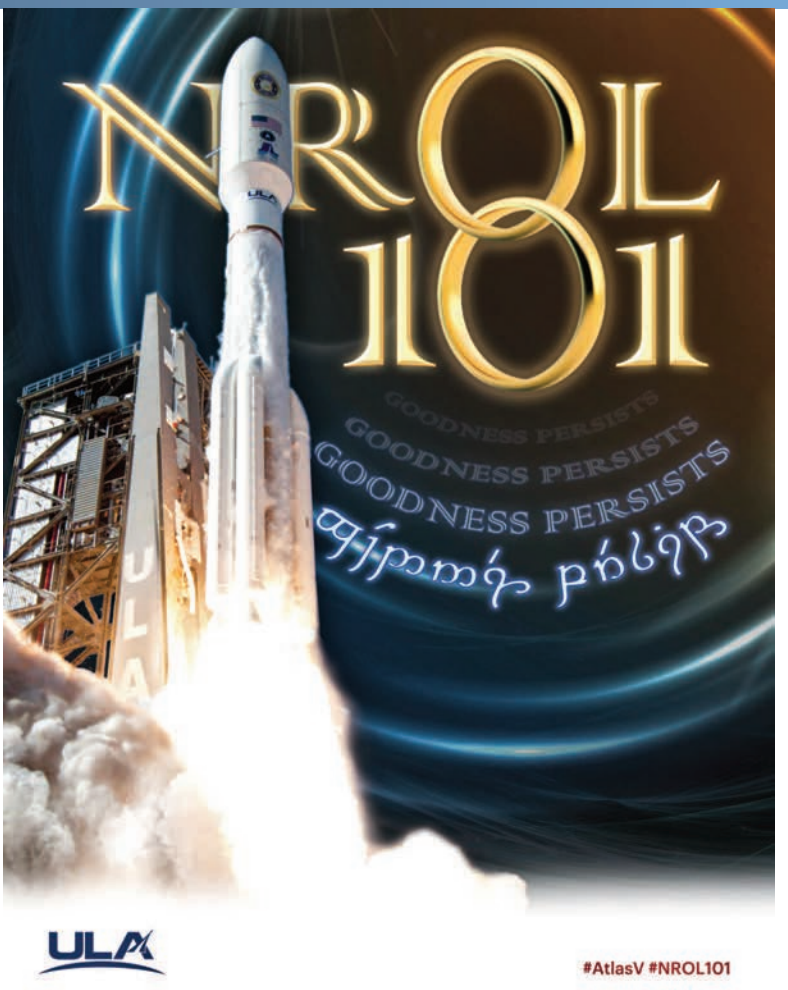

Northrop Grumman has been supplying rocket propulsion to ULA and its heritage companies for a variety of launch vehicles since 1964. The GEM family of strap-on motors started in the early 1980s with the GEM 40, which supported 132 Delta II launches with 1,003 motors.

The company followed with the GEM 46, which flew 63 motors on seven successful missions on the Delta II Heavy launches, and the GEM 60, which retired in August 2019 with 86 motors flown over 26 Delta IV launches. The GEM family has recently expanded with the development of the GEM 63XL variation to support ULA's Vulcan Centaur launch vehicle.

The company also manufactured the Atlas V rocket's Reaction Control System propellant tanks at its Commerce, California, facility, and eight retro motors at its Elkton, Maryland, facility that will assist first and second stage separation. To date, ULA has launched 141 times with 100 percent mission success.

ULA's next launch is the NROL-44 mission for the NRO from Cape Canaveral Air Force Station.

Executive Comments

Gary Wentz

"*ULA is proud to play a pivotal role in support of our mission partners and national security by keeping our country safe one launch at a time,*" said ***Gary Wentz***, ULA's VP of Government and Commercial Programs. "*This launch was the inaugural launch of our new GEM 63 solid rocket motors, an instrumental step for ULA to build flight experience in preparation for the Vulcan Centaur, our next generation launch vehicle. We thank our mission partners for their continued trust and teamwork. The NROL-101 mission will be ULA's 29th mission launched for the National Reconnaissance Office and the 17th NRO mission launched on an Atlas V.*"

Eileen P. Drake

"*We take our role in helping to launch critical national security assets into orbit for the National Reconnaissance Office very seriously,*" said ***Eileen P. Drake***, Aerojet Rocketdyne's CEO and President. "Our flight *proven and reliable RL10 upper-stage engines have supported these types of missions for nearly six decades, and we look forward to providing them for many years to come.*"

Col. Bongiovi

"*The United States' launch capability is the envy of the world and our USSF/industry partnership is a large reason why this is true,*" said Col. ***Robert Bongiovi***, Director of SMC's Launch Enterprise. "*We are thrilled to celebrate our 83rd consecutive successful launch of the nation's one-of-a-kind asset made possible through our proven mission assurance program.*"

Charlie Precourt

"*The GEM 63 rocket motors were developed to enhance the performance of the existing Atlas V launch vehicle while incorporating our flight-proven, heritage designs that provide a significantly lower cost for boost propulsion,*" said ***Charlie Precourt***, VP, Propulsion Systems, Northrop Grumman.