SATCOM for Net-Centric Warfare

# MilsatMagazine

2020 Year in Review – Flight 2

January 2021

*Cover image is courtesy of the U.S. Space Development Agency (SDA)*

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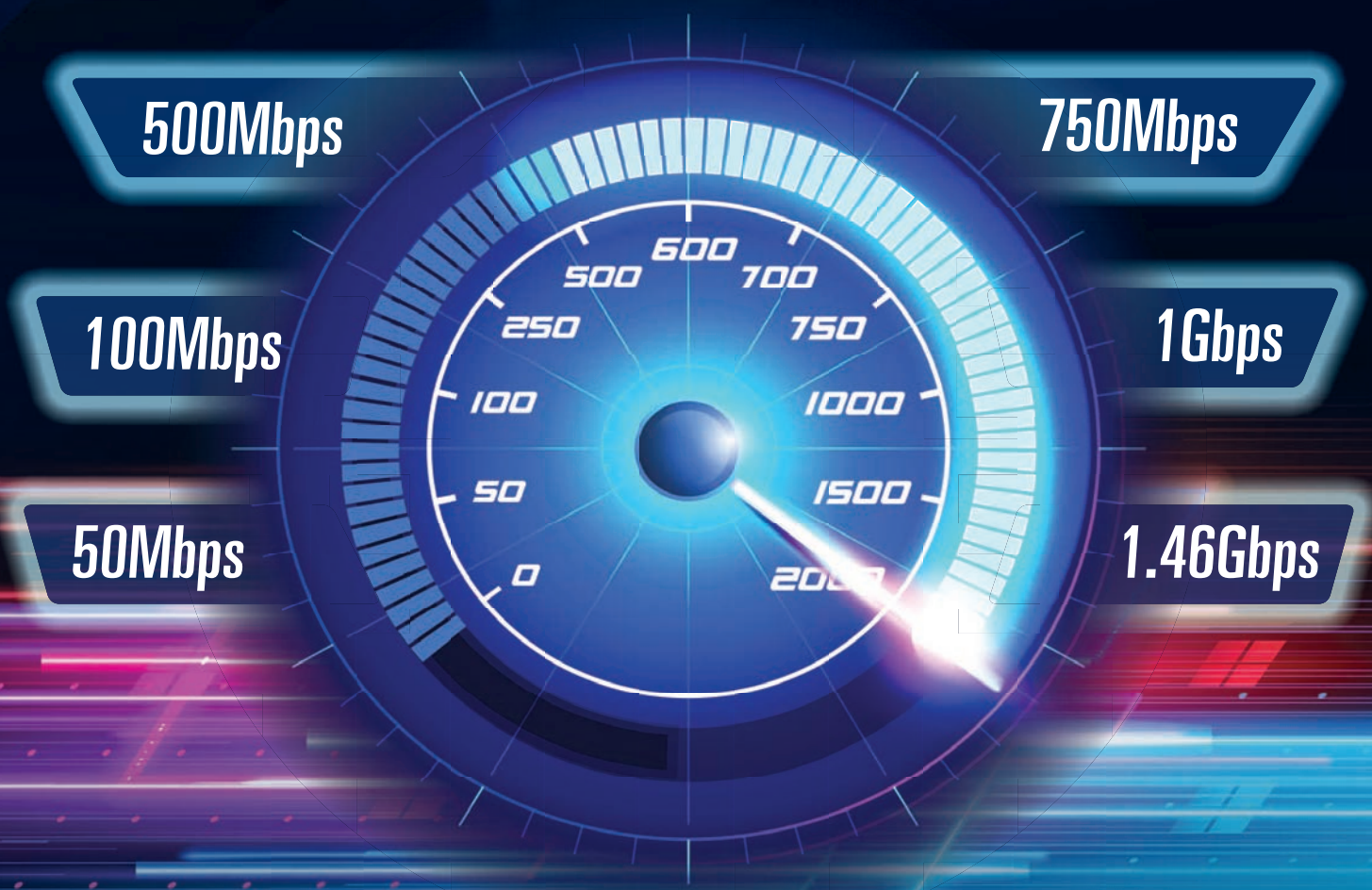


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## SpaceX Is The Recipient Of A Multi-Million $$$ Award From The SDA


**A nearly $155 million award by the *U.S. Space Development Agency* (SDA) has been made to *Space Exploration Technologies Inc*. (SpaceX) for launch services from Vandenberg Air Force Base for the agency's Agency's Tranche 0 Transport and Tracking Layer space vehicles.**


*A SpaceX Falcon rocket launches the NROL-108 mission.*

This award was made based on the Tranche 0 Launch request for proposal (HQ085021R0001) released on October 6, 2020, to which responses were due on November 9, 2020.

SpaceX will provide standalone launch services via two launches, with the first launch occurring in September of 2022, and the entire constellation on-orbit no later than March 31, 2023.

Work on this contract will be performed in Hawthorne, California; Vandenberg AFB, California; and McGregor, Texas. Fiscal 2020 and 2021 defense-wide research, development, test and evaluation funds will be obligated at the time of award.

` The ***Space Development Agency,*** Washington, D.C., is the contracting activity (HQ085021C0005).

## NASA's Landsat-9 USSF Developed ESPA EFS Passes Design Status Review 3

**The combined Landsat-9 Evolved Expendable Launch Vehicle Secondary Payload Adapter (ESPA) Flight System (EFS) team recently passed a major program milestone for *NASA*, known as Design Status Review 3.**

After a detailed assessment between NASA and the mission partners addressing safety aspects for the range and a "Do No Harm" assessment to the anchor satellite vehicle, the Landsat-9 EFS completed its third and final design review on December 15 and was deemed ready to proceed to the final stages of integration.

The ***U.S. Space Force***-developed EFS will fly with NASA's Landsat-9 Earth observation satellite and carry up to 18 critical National Security Space and Civil multi-manifest satellite vehicles that will be deployed independently of the anchor satellite; maximizing the value of the launch. The MMO originally designed the EFS to fly only mass simulators as a proof of concept, but has advanced the mission profile to reflect the demand for on-orbit capability.

The joint effort is a NASA Goddard Spaceflight Center (GSFC) activity, funded and manifested by SMC's MMO, located at Los Angeles Air Force Base in El Segundo, California.

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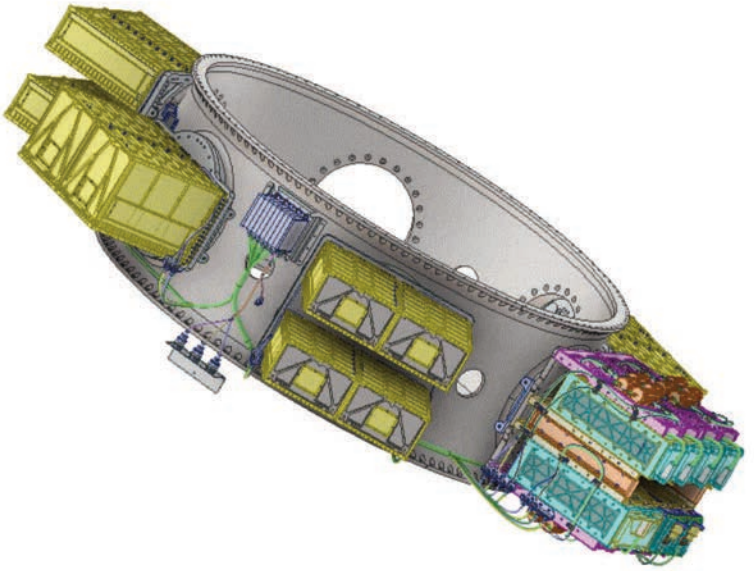
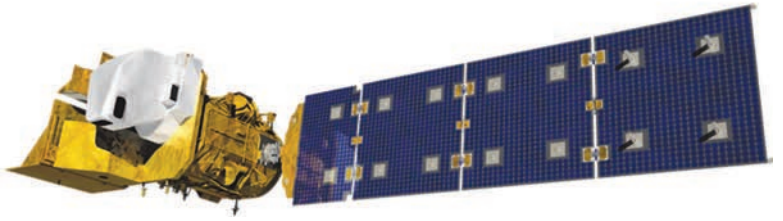


***Landsat-9 EFS. Image is courtesy of USSF SMC MMO.***

The next major milestone for the Landsat-9 EFS will be the integration and encapsulation of the Landsat-9 satellite vehicle. The NASA mission is scheduled to launch from Vandenberg Air Force Base in northern Santa Barbara County on United Launch Alliance's Atlas V 401 launch vehicle in September 2021.



***Landsat-9 EFS. Image is courtesy of USSF SMC MMO.***

*"The U.S. Space Force is utilizing our Mission Manifest Office's flexibility and efficiency to help our NASA partner make seamless manifest changes to a previously-planned mission,"* said Colonel *Robert Bongiovi*, Director of the ***Space and Missile Systems Center***'s ***Launch Enterprise***. *"This effort underscores MMO's ability to understand its customer and mission partner's programs and provide late-stage solutions for evolving capability needs."*

*"Facilitating the ability to make flexible mission sets during the Landsat-9 launch campaign demonstrates one of many things the MMO excels at,"* said Colonel *Brad Walker*, Chief of the National Security Space Launch Procurement Division at SMC.

*"The EFS highlights the Space Force's commitment to innovative mission manifest solutions that deliver critical capabilities to support the warfighter and advance science and technology resources for NASA. Our partnership between NASA/GSFC and the USSF/MMO provides a unique opportunity to exercise both agencies' strategic vision, creativity and individual skills."*


*The Mission Manifest Office is part of SMC's Launch Enterprise and is blazing a path for innovation in the space warfighting domain while continuing the SMC tradition of innovation in space. The MMO was established to provide a "one-stop" shop for the implementation of a routine, repeatable and reliable process for the multi-manifesting of U.S. Government and USG-sponsored payloads. The mission of the MMO is to use launch vehicle (LV) performance to maximize on-orbit capability. The MMO identifies DOD/Intelligence Community / Civil launch opportunities to enable and execute multi-mission manifesting mission design and late-stage additions and changes. The office provides agile and innovative solutions to increase launch opportunities for National Security Space (NSS) payloads in support of space warfighting construct and Launch Service Delivery Order objectives.*

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## Raytheon I&S Blackjack Sensor Passes Major Milestone

**Raytheon Intelligence & Space's sensor payload for the Defense Advanced Research Projects Agency's Blackjack program passed critical design review (CDR) on schedule.**

Blackjack is an LEO satellite constellation program that aims to develop and demonstrate the critical elements for persistent global coverage against a range of advanced threats.

During critical design review, the team demonstrated that vital sensor components – focal plane, cryocooler, telescope and electronics – are already in fabrication, which significantly reduces schedule risk.

The team also provided updated sensor analysis, which dictates optimal performance parameters for missions, like orbit and type of mission. It showed that the Blackjack objective constellation can deliver persistent overhead access to any point in the world with a high degree of fidelity. RI&S will continue to reduce integration timelines for rapid deployment, engaging with major subcontractors to be ready for production. RI&S is on contract to deliver two prototype sensor payloads and to support the systems integrator for integration with the Pit Boss mission management system and the space vehicle. It also includes launch campaign support and the on-orbit demonstration.

*"Our Blackjack design has required little change throughout reviews,"* said Dave Broadbent, VP and COO for Space & C2 Systems at RI&S. *"That design stability as well as procurement and integration of parts has been key to meeting DARPA's rapid delivery schedule."*

***Dave Broadbent***

## Machine Learning Opportunity for Global Weather Radar

**The USAF's *557th Weather Wing* is engaged on ongoing development efforts to leverage machine learning for a weather radar depiction across the globe, designated the Global Synthetic Weather Radar.**

557TH WEATHER WING

*"Radar data is extremely valuable environmental intelligence as it offers both operators and meteorologists insight into the state of the atmosphere,"* said *Chris Finnigsmier,* 557th WW's technical director. *"Unfortunately, radar images are limited to areas adjacent to physical radar systems and thus unavailable across vast swaths of the planet."*

Research and development on the GSWR started when the Massachusetts Institute of Technology's Lincoln Laboratory combined weather data from existing sources and applied machine-learning techniques to create synthetic radar-like mosaics in areas just offshore of the continental United States with no radar coverage.

US Air Force leaders recognized the potential of these efforts, especially in high interest areas outside the continental U.S., and sponsored MIT/LL to produce global radar-like mosaics.

The 557th WW's high-resolution weather model, combined with satellite data from U.S. and allied sources, along with commercial global lightning data, feed the GSWR's ability to conduct machine learning model training against actual precipitation data that has been collected by NASA.

If proven to be operationally viable, the 28th Operational Weather Squadron, located at Shaw Air Force Base in South Carolina stands to benefit greatly from this capability.

The 28th OWS is responsible for characterizing the weather environment for the Middle East theater, a part of the world where there is very little weather radar capabilities.

*"The 28th OWS, not unlike our fellow overseas-focused environmental intelligence squadrons, is challenged in having enough reliable data to craft the risk-based intelligence necessary to deliver decision-makers high-confidence assessments,"* said Major Andrew Williams, 28th OWS Commander.

He continued, *"(The 28th OWS) directly supports a strategic theater involved in multiple National Defense Strategy priorities, often with minimal verifiable data."*

The 28th OWS relies on the experience of its forecasters to overcome reliable data shortfalls.

*"The 28th's mission capability would be enhanced by having the capability of synthetic radar to increase the confidence of our short-range assessments over areas of interest in the (U.S. Central Command) area of responsibility,"* Williams said.

He added, *"As the theater continues to deal with violent extremism and countering malign influence, a GWSR enhanced through machine learning can help overcome these data gaps to maximize global operations."*

The ***1st Weather Group*** is scheduled to conduct an initial assessment of GSWR's operational capability, with feedback anticipated to go directly to MIT/LL developers and eventually inform *Air Force Materiel Command* and *Air Combat Command* whether it's operationally feasible and ready for an operational test and evaluation. The Air Force Weather Systems operational test unit, **2nd Combat Weather Systems Squadron**, also in the 557th WW, will lead the operational test once GSWR matures to that point.

If a 2nd CWSS-led operational test and operational utility evaluation prove this capability to be operationally feasible, this ML breakthrough for weather radar is an opportunity to fill the void across vast swaths of data-sparse regions in which U.S. air, space, land and sea forces operate.

*Article by David R. Hopper, 55th Wing Public Affairs, with contributions by Paul Shirk*

## U.S. Space Force Welcomed As the 18th Intelligence Community Member


*John Ratcliffe*

**Director of National Intelligence John Ratcliffe has welcomed the U.S. Space Force (USSF) as the 18th member of the U.S. Intelligence Community (IC).**

During an afternoon ceremony, Ratcliffe and Chief of Space Operations General John W. "Jay" Raymond announced the designation of the intelligence element of the U.S. Space Force as a member of the IC.

*"This accession reaffirms our commitment to securing outer space as a safe and free domain for America's interests,"* said Ratcliffe. *"American power in space is stronger and more unified than ever before. Today we welcome Space Force to the Intelligence Community and look forward to the power and ingenuity of a space security team unrivaled by any nation."*

The Space Force element is the first new organization to join the IC since 2006.

*General John W. "Jay" Raymond*

*"Today, we took action to elevate space intelligence missions, tradecraft, and collaboration to ensure the success of the Space Force, the Intelligence Community, and ultimately our National Security,"* said Gen. Raymond. *"This is a significant milestone, a clear statement that America is committed to a secure and accessible space domain. Our partnership will ensure the Space Force and the Nation remain always above any threat."*

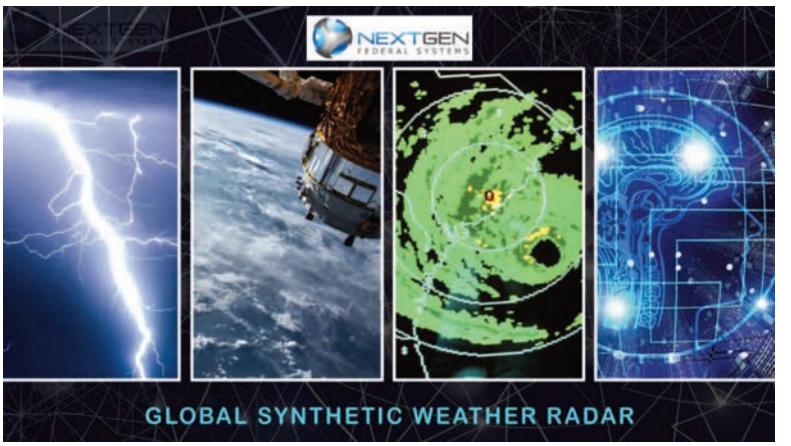
Ratcliffe highlighted how the addition of USSF to the IC marks a historic opportunity to further strategic change across the national security space enterprise.

*"Through sharing space-related information and intelligence, the IC and DoD increase integration and coordination of our intelligence activities to achieve best effect and value in executing our missions,"* said Ratcliffe. *"This move not only underscores the importance of space as a priority intelligence and military operational domain for national security, but ensures interoperability, future capability development and operations, and true global awareness for strategic warning."*

*"Today's change aligns our newest service with the other members of the Defense Intelligence Enterprise and will help ensure our efforts are coordinated and synchronized across all domains of warfare,"* said Ezra Cohen, acting Under Secretary of Defense for Intelligence and Security.

With the USSF addition, nine DoD components are members of the Intelligence Community.

## NextGen Federal Systems Secures USAF Global Synthetic Weather Radar (GSWR) Contract




***NextGen Federal Systems*** **has been awarded the Global Synthetic Weather Radar (GSWR) Research to Operations (R2O) contract by the US Air Force.**

MIT Lincoln Laboratory's (MIT LL) research effort established the viability of leveraging available observation data as input to Machine Learning (ML) algorithms to derive radar-like data. Operationalizing the GSWR research capability will provide awareness of potentially dangerous weather in regions where weather radar coverage is not available. This program will enable NextGen to make a significant contribution to the Air Force Weather mission and consequently to the safe and successful execution of military operations worldwide.

Partnering with ***Raytheon Intelligence & Space***, the team will cybersecure and modernize GSWR for operations; providing a modern, sustainable GSWR capability within the *Air Force Weather Virtual Private Cloud*. The NextGen team will use proven DevSecOps processes to deploy the ML training methodology and production engine to provide a robust, enhanced global precipitation weather radar forecasting capability.

This effort leverages NextGen's expertise in Machine Learning, Cloud Computing, Modern Software Practices, and Weather Effects Modeling. NextGen is positioned to apply revolutionary ML methods to an exponentially growing domain of previously insurmountable challenges to help our military in regions around the globe.

*"I cannot emphasize enough how important this work will be,"* said Jack Suther, Senior Systems Engineer at NextGen. *"When I was deployed supporting Operation Iraqi Freedom, we didn't have any weather radar for the first four months. To have had GSWR's capabilities would have been a godsend. GSWR will not only lead to more successful military operations, it will save lives."*

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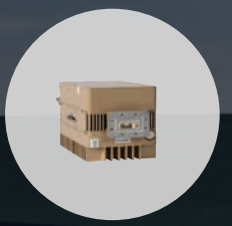

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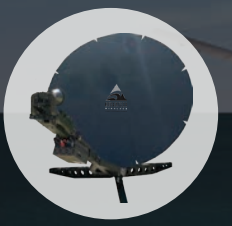

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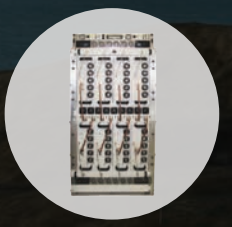

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## Peraton Collects USAF JADC2 Contract


***Peraton*** **has been awarded a $950,000,000 ceiling indefinite-delivery/indefinite-quantity (ID/IQ) contract for the maturation, demonstration and proliferation of capability across platforms and domains, leveraging open systems design, modern software and algorithm development in order to enable Joint All Domain Command and Control (JADC2).**

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

The contract supports the development of the U.S. Air Force's *Advanced Battle Management System* (ABMS), a component of the Department of Defense's JADC2 effort. The goal of ABMS, according to the Air Force, "*is to enable the Air Force and Space Force to operate together and as part of a joint team – connecting sensors, decision makers and weapons through a secure data network enabling rapid decision making and all-domain command and control.*"

"*Peraton has a long track record of supporting Air Force innovation and research, and we are proud to have been selected as one of the service's industry partners in developing the information backbone for the future of joint warfighting*," said John Coleman, President, Defense and Homeland Security sector.

"*The Air Force's Advanced Battle Management System is a critical network-centric component to enable future innovation within the Department of Defense's JADC2 effort*," said Kevin Schweer, VP, Defense Research. "*Peraton looks forward to continue partnering with the Air Force to provide innovative and enabling technologies to put the right information in the right hands at the right time, making U.S. forces and our allies smarter and enabling them to act faster in defense of our national and global security.*"

## U.S. Space Force Enters 'Year 2' With Momentum + Soaring Expectations

**U.S. Space Command commander Gen. John W. "Jay" Raymond and Senior Enlisted Advisor Chief Master Sgt. Roger Towberman present President Donald J. Trump with the Space Force flag in the Oval Office of the White House.**

***U.S. Space Command commander Gen. John W. "Jay" Raymond and Senior Enlisted Advisor Chief Master Sgt. Roger Towberman present President Donald J. Trump with the Space Force flag in the Oval Office of the White House. Photo by: Shealah Craighead***

From the publicly available view on the outside, the birth and creation of the nation's newest military service was going well; there was general agreement as to the need for the new service, its strategic importance and how it would fit in to the nation's existing and sprawling military enterprise.

Hidden, however, was a level of bureaucratic gamesmanship and "*churn*," worrisome enough that it ultimately forced the President to step in.

"*There are still some of you who are thinking more of representing interests and objectives of your individual service than of interpreting the broad national program and its requirements to your subordinates and to the Congress*," the President admonished senior military leaders.

President Harry Truman delivered that blunt directive in 1947 only months after the U.S. Air Force was born as the newest branch of a military long dominated by the Army and the Navy.

But now, as the year-old Space Force edges into its second year, that history stands in sharp contrast. This time, 73 years later, the internal struggles have been less fierce and have, for the most part, been addressed early and successfully. It has allowed the all-important roots of the Space Force to be "planted" and to take hold.

That was the message delivered recently by the service's highest-ranking officer, Chief of Space Operations, Gen. Jay Raymond in a session where he looked back to evaluate the Space Force's first year in existence and to discuss what comes next. Part of Raymond's job is to be a cheerleader. Yet even he was surprised by the distance covered since the Space Force was born on December 20, 2019.


*"We were up and running 'Day One.' And we have not let our foot off the accelerator ever since,"* Raymond said. *"We've been focused on five key areas that I think an independent service needs to focus on,"* he said, listing them as *"developing our people,"* formulating an official warfighting doctrine, writing the service's first budget, *"designing"* the blueprint for how the force is organized and deployed, and finally, presenting those forces to combatant commanders. *"The progress we have made far surpasses anything that I would have expected,"* he said.

The list of achievements is lengthy.

A partial inventory shows that over the past year, about 2,400 Airmen have officially transferred to the Space Force. Most are crucially important space operators. The first *"Space Force Detachment"* was formed at the Air Force Academy and established a new minor in space warfighting. The *"leadership team"* was *"built,"* comprised of a four-star, Vice Chief of Space Operations and four, three-star generals, who were nominated and confirmed by the Senate. The Space Force also added a Senior Enlisted Advisor.

The Space Force's first space warfighting doctrine was written and published. That blueprint emphasized speed, a heavy use of digital tools and joint operations. Raymond designed a new field command structure that eliminated two layers of command to increase *"decision speed."* That step embracing the doctrine's outlook and priorities.

In a clear move from a *"paper force"* to one with people on the ground and in operation, the Space Force successfully transferred all space missions and capabilities from the Air Force. Also completed was a study on how best to transfer space missions and capabilities from the Army, Navy, and other Department of Defense components.

The Space Force wrote and submitted its first budget, a $15.4 billion request for fiscal 2021. Understanding that acquisition is a critical function, Raymond and his partners moved to consolidate space acquisition *"under one roof,"* to streamline the process and provide unity of effort. *"This first year was all about inventing that service. This next year is all about integrating the Space Force more broadly,"* Raymond said.

Conscious of historic turf battles and the critical importance of space, Raymond said, he understood from the start how important it would be to collaborate with all services and work as cooperatively as possible.

*"We worked very closely with the Army and the Navy,"* he said, noting a successfully completed study examining how to fold in personnel and components of other services with minimal disruption, building out a force that ultimately will number 16,000 personnel. *"I think we're probably … 98 percent in agreement,"* Raymond said. *"There's a couple little things we're working through, but I would expect that you'll see some inter-service transfers this year. Again, to note, you can't break the Army, you can't break the Navy in standing up the Space Force. So we'll do this in a way that consolidates those capabilities where needed and strengthens our joint warfighting readiness on both the Space Force side and the other services. And that's part of that integration work for 2021"*

That next phase – and a major focus in Year 2, he said, is based on five, overarching priorities articulated in another milestone document, the **CSO *Planning Guidance***.

*"Empowering a lean and agile service, developing joint warfighters into world-class teams, delivering new capabilities and being able to do that at speed, which is critical; expanding our cooperation and partnerships … and then the fifth area is building the service as a digital service. The priorities for next year are going to focus on designing a force and the capabilities that (that force) will provide,"* he said. Moving in tandem, he said, is *"presenting those forces … as an independent service to the joint force."*

That's the plan. Whether it plays out exactly as hoped is unknown. Budget constraints could cause adjustments and there will be a new secretary for the Department of the Air Force as well as a new Secretary of Defense and other senior leaders in the Pentagon.

Raymond is aware of the uncertainties. But he insists his larger goal for moving the Space Force forward will not change.

*"What I will tell you (is that) isn't going to change my focus or the focus of our team,"* he said. *"And that (focus is) on building a service that delivers national advantage. … It has always been known that the U.S. is more secure when you have freedom of access to space and freedom to maneuver in space.*

*" It provides so much for our economy. It provides so much for our national security. And what we're going to do is keep focused on building that service, building the partnerships … and provide our nation"* the force it needs to defend its vital national interests in space, General Raymond concluded.

*Article by Charles Pope, Secretary of the Air Force Public Affairs*

**The Secretary of the Air Force, on behalf of the Office of Secretary of Defense, selected *Redstone Arsenal*, Huntsville, Alabama, as the preferred location for the U.S. Space Command Headquarters.**

The Department of the Air Force conducted both virtual and on-site visits to assess which of six candidate locations would be best suited to host the U.S. Space Command Headquarters based on factors related to mission, infrastructure capacity, community support and costs to the Department of Defense.

Huntsville compared favorably across more of these factors than any other community, providing a large, qualified workforce, quality schools, superior infrastructure capacity, and low initial and recurring costs. Additionally, Redstone Arsenal offered a facility to support the headquarters, at no cost, while the permanent facility is being constructed.

***www.spacecom.mil***

# COMMAND CENTER: RICK LOBER

## Vice President and General Manager, Hughes Network Systems

*Rick Lober, Vice President and General Manager at Hughes Network Systems, LLC (HUGHES), leads the company's Defense and Intelligence Systems Division (DISD) in serving U.S. and allied defense and intelligence organizations worldwide with advanced SATCOM solutions, including fixed VSAT and Mobilesat systems, network management, ground and airborne communications on the move, and classified programs.*

*Under Mr. Lober's leadership, the Defense team has won programs such as: SATCOM for the General Atomics Predator UAV; mission management for the U.S. Air Force Space and Missile Command's Protected Tactical Enterprise System (PTES) and Enterprise Management and Control (EMC) program; the application of Artificial Intelligence and Machine Learning techniques for the U.S. Army's Narrowband SATCOM network; and specialized terminal development for the various U.S. Forces.*

*Mr. Lober. Would you tell us what prompted you to join Hughes Defense and Intelligence Systems Division to further your career?*

***Rick Lober (RL)***

I joined the Hughes team because I am passionate about developing technologies that allow our warfighters to have increased capabilities that meet their mission requirements at an affordable cost. Hughes takes commercial-off-the-shelf (COTS) technologies and applies them to the unique needs of our soldiers, with specific focus on SATCOM solutions that can be adapted to suit military markets. The company employs the smartest innovators that I've ever had the pleasure of working with, and I consider myself lucky to count them as my colleagues.

I also enjoy start-up opportunities, and the ***Hughes Defense and Intelligence Systems Division*** (DISD) has been this type of organization. While the Hughes Aircraft company, our legacy namesake, had been a long-standing provider of defense applications, Hughes Network Systems only made a serious run at the defense market over the last 10 years. Together with an incredibly talented team, I helped create our DISD group to focus exclusively on the defense community. This was an opportunity to grow a new division with the backing of the world's largest VSAT operator and SATCOM technology provider.

The entrepreneurial spirit at Hughes has allowed me to grow in my career, mentor others as well as bring all the advantages of the Hughes commercial SATCOM acumen to the defense sector.

*What challenges are presented when a commercial company, such as Hughes, works with military/agency/government (MAG) procurers of product to develop timely solutions for our nation's warfighters? How are such challenges overcome?*

***RL***

I would say that the biggest challenge in working with MAG customers is the pace. The ***Department of Defense (DoD)*** is a large organization that operates at its own unique pace. It's important to have a long-term perspective when working in this market, especially when compared to commercial industry.

Luckily, the way to overcome this challenge is simply to exercise patience and understanding in how the process works. Patience is not only related to the time needed to get things done, but also about evolving the mindset of DoD leaders and users. It has been exciting to see the DoD move more quickly in recent years using more agile approaches to acquisition.

Today, the DoD is becoming a more modern, data-oriented service, and it's really a privilege to be in a position to support that evolution – especially knowing how important it is to maintain our leadership relative to other nations that are also gaining significant technological know-how. The landscape is changing, the market is changing, and the DoD has the opportunity to create new partnerships focused on the speed of technology. It's exciting to work with the DoD to help in this transformation, knowing that the warfighter and our national security will reap the benefits.

*Do you believe the newly formed U.S. Space Force and U.S. Space Command will quickly work to reduce time-to-field of crucial on-field product and technologies within the MILSATCOM environs?*

***RL***

Absolutely. The ***U.S. Space Force*** and the ***U.S. Space Command*** are helping the DoD manage and operate space resources more efficiently. As a result, military users will have the resources they need when they need them and where they need them – especially at the tactical edge.

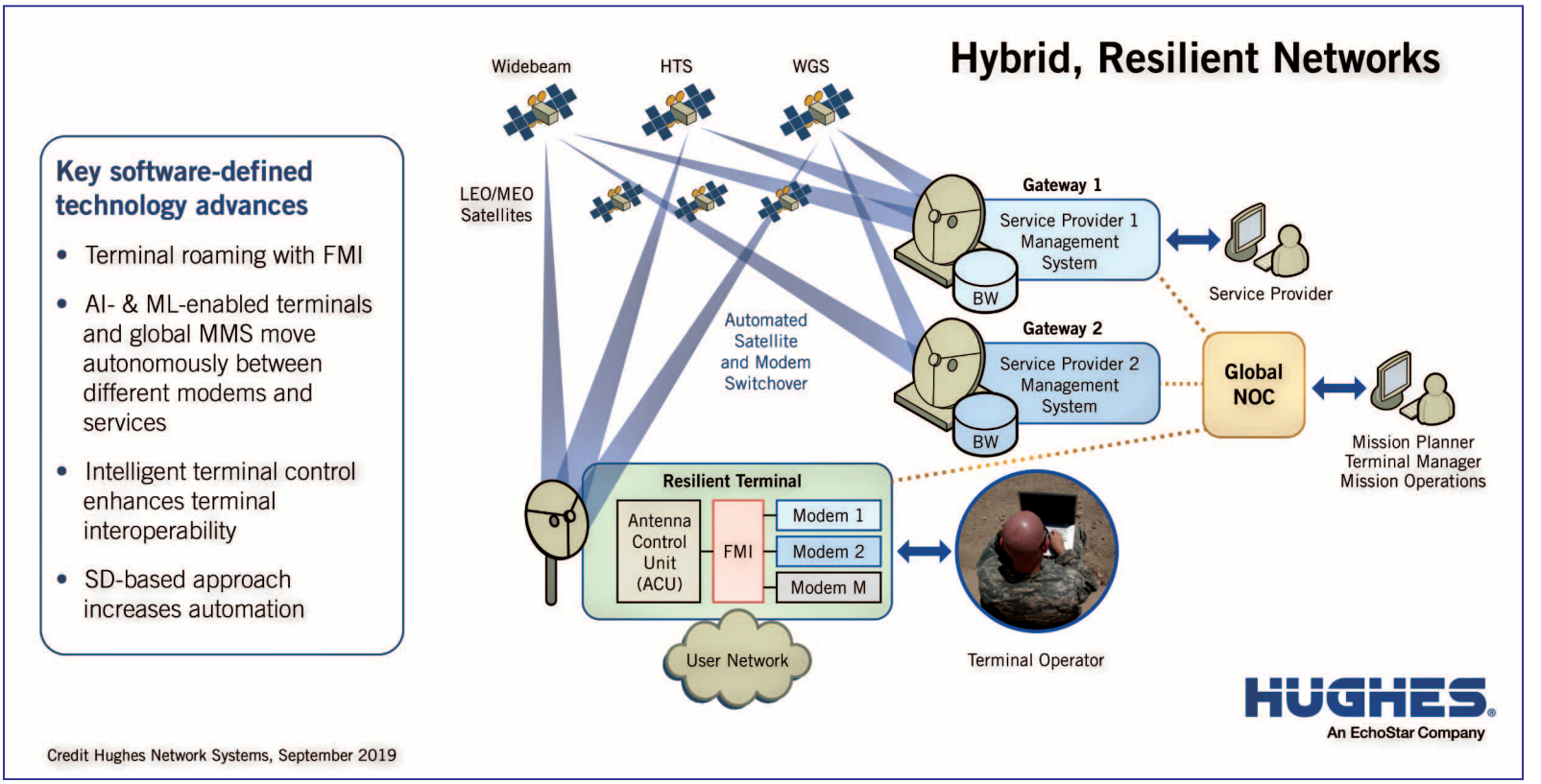
We are seeing progress and agility coming from several organizations, including the ***Space Development Agency*** (SDA), the ***Air Force Research Lab*** **(AFRL)**, the ***Space Force Space and Missile Systems Center (SMC)*** and the ***Space Force Commercial Satellite Communications Office*** (**CSCO**). I believe this momentum will help speed technology deployments and give warfighters access to new, more secure and resilient technology.

*Mr. Lober, would you tell our readers about the substantive changes that occurred within Hughes Defense during 2020 and the firm's national security customers as well as within DoD.*

***RL***

Well, 2020 didn't end up as any of us expected! But that being said, we stayed very busy throughout the year focusing on our customers and keeping them connected. We have seen strong momentum from our DoD customers resulting in significant follow-on orders from the Army, Space Command and Coast Guard along with major primes.

The changes to our defense business focused on continuing to improve the customer experience, especially by meeting their increasing requirements for mobility services and more sophisticated



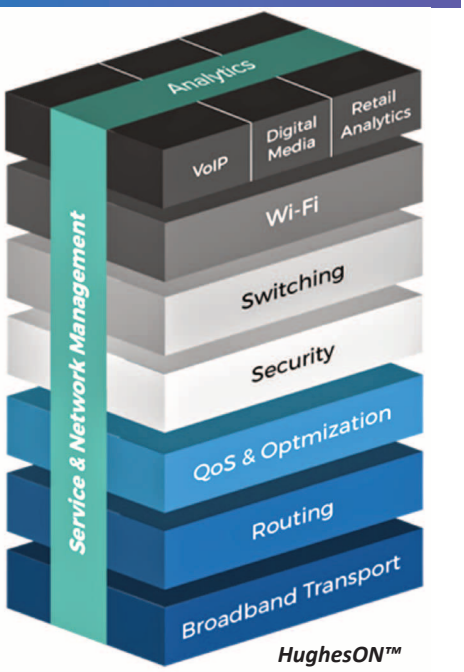
network management. To that end, we have evolved our application of *Artificial Intelligence* (AI) and *Machine Learning* (ML) techniques in many new ways this year — bringing a lot of benefit to DoD and commercial customers in optimizing networks and freeing valuable resources to focus on other areas of network management.

One example of this focus on mobility and network management is the work we did this year on the *U.S. Air Force Enterprise Management & Control* contract, which we received late in 2019. We have been testing the networking prototype which uses our *Flexible Modem Interface* (FMI) capability and our software-defined network management to prove the technology elements required under this contract. We have also delivered additional capabilities based on input from the customer at SMC.

More specifically, we held a major capstone demonstration for this contract in July showing how FMI and network management can autonomously deliver the flexibility and resilience needed by the Air Force. Our software-defined technology learned from the data in the satellite communications (SATCOM) network and then, seamlessly routed data to the best terminal, modem, satellite and service provider needed at any specific time. Our advanced system exemplified how quickly these 'self-healing' actions can enhance connectivity to users—delivering data within hours or just a few minutes compared to the weeks or months that DoD users currently need to access a new circuit.

Time matters when warfighters and decision makers must fight at mission speed, even in a contested environment, and I think the military audience for this demonstration appreciated how the network can support real-time transmissions. They also saw how flexible networking can apply to UAVs, which need reliable, timely transmissions to plan targets and maintain situational awareness. We demonstrated this by driving a Humvee outfitted with our ***HM400*** advanced, software-defined modem and a small, ***GetSat*** Ku-band antenna to show rapid switching from satellite to satellite to ensure connectivity.

The adoption of AI techniques is helping the company to streamline network operations across our commercial and DoD customer base. We recently announced the commercial availability of our AI for IT operations (AIOps) solution for *Wide Area Networks* (WANs). This new capability is integrated into the company's ***HughesON***™ ***Managed Network Services*** for our commercial and government customers. The Hughes AIOps feature is already in use across more than 32,000 managed sites. The technology automatically predicts and preempts — or 'self-heals' — undesirable network behavior, preventing service-disrupting symptoms in 70 percent of cases. Hughes is the first managed services provider to deliver a self-healing WAN edge capability to enterprise customers and we can deliver these benefits to the DoD as well.




*Talking about the Hughes Defense team, can you tell us about your specific successes during 2020?*

***RL***

Our team achieved several significant goals during 2020 and we continue to grow at a very fast pace. We received a follow-on contract from the U.S. Coast Guard to integrate *Beyond Line of Sight* (*BLoS*) communications for their HC-27J aircraft, which is critical to Comms-on-the-Move (COTM) missions for ISR and human and disaster relief. Another important win last year came from ***General Atomics*** and the U.S. Army to support their ***Gray Eagle, MQ-1ER*** unmanned aircraft system. The Army is modernizing the communications for this platform; and our HM400 software-defined modems integrated together with the DoD's waveform technology will give the Army much-needed resiliency in all environments. We also made great progress on our Network Management work for the Army's Narrowband systems and with ***Boeing*** on the *U.S. Air Force Protected Tactical Enterprise System* (PTES) program.

Another hallmark of our success this year was the exciting demonstration of our ***HeloSat*** through-the-rotor technology aboard a flying *Black Hawk* helicopter. Before HeloSat, helicopters could only get connectivity, either at low data rates which are useful for voice communications (but not data or video), or at higher data rates with interruptions from the blades blocking the signal. To solve this problem, our engineers created a specialized, software-defined waveform that can transmit through the rotor blades.

This summer, a few hundred military and industry leaders from around the world witnessed our successful BLoS, high data rate, full-motion video (FMV) SATCOM capability as we livestreamed the flights.

During one of the demonstrations, we achieved rates of more than 17 megabits per second without packet loss, both up to and down from the helicopter using an FAA approved, fuselage-mounted antenna at both Ku- and Ka-band.

It was pretty sensational to see the helicopter lift off from an airfield in Tennessee and then watch full-motion, high-definition video 'surveillance' from the Black Hawk while I sat at my computer in Maryland with people from Spain and Dubai also watching the demo.

***Photo of a Black Hawk helicopter.***

*Can you describe what has given your group this momentum in 2020, especially during the pandemic?*

**RL**

We are lucky here at Hughes in that we are an essential business, offering services and technologies that people need to stay connected – not just for work and school at home, but for military personnel stationed far away from home.

Very early in the pandemic, we were called upon to set up connectivity for soldiers who had to quarantine after returning from their deployments — and our team got in their cars and drove the equipment to the base because shipping it would have taken longer, and these people needed the internet to connect with their families. That's the kind of dedication and commitment that motivates all of us at Hughes — it's about always responding to our customers' needs, sometimes beyond our contracted requirements.

We strive to fulfill all customer requests, and to meet all cost and schedule goals while offering state-of-the-art communications technology. Most importantly, we offer our customers open systems with standard industry interfaces, and always give an open and honest opinion regarding the best solution to meet their requirements, even if that does not include Hughes technology. Our customers appreciate receiving honest and technically accurate answers to their questions.

As we continue to pursue this customer-focused approach, we have moved toward becoming a systems integrator/solutions provider that uses a turn-key approach versus just selling a product.

*What progress have you seen in the DoD's effort to create an enterprise-wide satellite communications network and will it bring the resilience they need now?*

**RL**

Our team has continued to support the U.S. Air Force as they work more closely with industry partners to leverage commercial innovation. For their network modernization effort, we are playing an important role through the EM&C program. Our FMI technology and our advanced, open-systems network management will help create the unified enterprise network that U.S. Space Force *General Raymond*'s SATCOM vision proposes. We have had many discussions with the Air Force and the Space Force about how to make their SATCOM networking more resilient.

During these discussions, we have demonstrated advances in software-defined networking, both for individuals and large enterprises. Hughes currently supports more than 1.5 million worldwide users and thousands of enterprises around the globe, delivering always-on connectivity where dynamic software and AI and ML techniques ensure 24X7 connectivity, even in remote locations. We hope to apply this expertise in managing complex and highly efficient commercial networks to numerous DoD managed services programs that are planned in the near future.

*Will airborne mobility applications growth continue?*

**RL**

Yes, absolutely. Our team has focused on mobility for airborne platforms for several years now using an open systems approach because military users want the same connectivity and data access everywhere they go. This is why we're bringing wideband, high data rate comms to helicopters and UAVs. Some of these platforms have typically relied on low data rate transmissions using L-band capacity which works well for voice communications but not for full-motion video, which is critical for Intelligence Surveillance and Reconnaissance. We believe that all helicopters will have access to high data rate connectivity on and off the aircraft within less than 10 years. We also know that airborne platforms need flexible technology that meets each aircraft's size and weight requirements. We are constantly studying and testing technology, antennas and terminals that meet military environmental, size, weight and power requirements. We look forward to supporting smaller UAVs as technology becomes smaller and lighter.There has been a great deal of activity among the new, Low Earth Orbit (LEO) satellite constellations.

*Can you share your thoughts on LEO for the DoD as well as how Hughes sees this industry development and market segment?*

**RL**

With today's increasing demand for global connectivity across all sectors of the market, we are entering into a new world that needs hybrid networks. No single transport can meet all the demand. On top of that, a single-threaded system is simply untenable in a military environment (not to mention a commercial situation).

The DoD needs to ensure that their communications and data networking are resilient, and hybrid networks provide that redundancy. LEO systems bring some great benefits, including lower latency and broad global reach, *e.g.*, including the polar regions — a complement to GEO systems which bring capacity density and a low cost-per-bit.

Our task is to show our military and national security agencies how they can use hybrid networks to fulfill all these requirements across land, air and maritime mobile applications. To this end, we recently demonstrated in-flight roaming across MEO and GEO satellites with *SES* and *Thales*, and our ***JUPITER™*** System supports aero roaming, among JUPITER-driven systems worldwide.

***Artistic rendition of a Hughes JUPITER-3 satellite.***

*Mr. Lober, what do see as the most critical issues that need to be addressed for MILSATCOM going forward?*

***RL***

Hughes has seen progress over the last few years regarding acquisition and access to SATCOM capabilities. Despite these steps forward, some critical issues must still be addressed.

Firstly, DoD should better manage the satellite communications networks it already uses so troops on the battlefield are always connected, even when those networks are under attack. This issue should be considered in the U.S. Army's recently announced RFI regarding commercial best practices and innovative business models for possible replacement of the existing logistics network operating design.

The Army buys bandwidth access and ground terminals under several different contracts, making their satellite transport network management very inefficient and costly. Hughes manages many satellite networks for thousands of enterprises and millions of individual users, using software-defined capabilities and advanced technology such as AI to ensure speed, resiliency and redundancy.

We are glad to see that the Army is interested in these industry-leading technologies that can help the DoD better manage its satellite networks. This leads to a few other problems that DoD needs to resolve.

Just like the Army, all DoD services use stove-piped systems based on proprietary technologies that cannot interoperate with other systems. Hughes is working with the Army on their Narrowband transport network and the Air Force on the Enterprise Management and Control program to show them the operational advantages, resiliency and security of open-systems architectures.

There is one more critical item that DoD needs to address: acquisition of SATCOM capabilities, especially commercial SATCOM. Much-needed, advanced technology cannot be leveraged quickly enough to support the speed of today's missions. Acquisition must be streamlined so innovative SATCOM technology can reach the warfighter faster. Hughes is working to help the Space Force, the Space Command, the SDA and other organizations address all these challenges.

*Lastly, given your experience in the industry, when you review your career, what products or technologies that you have been involved in developing bring a true sense of satisfaction to you with the knowledge that the final goal of such efforts was successfully achieved?*

***RL***

A most interesting question... my career has always involved radio communications, from VLF to SATCOM for either intelligence or global communications applications. I have been blessed to work with some of the most talented engineers and leaders in this area of our industry.

Over the years, this technology has evolved from analog designs to those that use digital signal processing and software- defined implementations. At Watkins-Johnson, I was proud to lead the program that developed the world's first, low-cost, fully digital HF receiver for intelligence applications. While I worked at Cubic, I led a team that worked to bring cost-effective, high-speed line of sight communications to ISR platforms through a product called TCDL, breaking into a market that was dominated by one sole source provider.

Today at Hughes, our team is supplying a vastly improved SATCOM modem to various versions of the ***Predator UAV*** and has come up with a unique solution to high-speed communications for rotary wing aircraft — all through advanced signal processing and software-defined radio techniques.

Finally, there are numerous classified programs that I have been proud to lead. All of these efforts deliver advanced capabilities to our warfighters who depend on intelligence and communications to ensure mission success.

Moving forward, we are excited about introducing modern network management, software-defined networking and AI/ML technologies to the DoD. This is an area in which Hughes is a leader and continues to excel. Our defense team sees these innovative technologies as a real opportunity for the DoD to improve their current and future communications systems.

***government.hughes.com***

HUGHES

# COMMAND CENTER: JOHN SERAFINI

## Chief Executive Officer, HawkEye 360

*John Serafini has more than a decade of experience investing in and leading national security oriented technology companies. John is presently the CEO of HawkEye 360, a leading developer of space-based radio frequency (RF) collection, mapping, and analytic capabilities. He previously served as Senior Vice President of Allied Minds where he led the formation, financing,and management of HawkEye 360, along with other Allied Minds companies such as BridgeSat, Federated Wireless and Percipient Networks (WatchGuard acquired). A former Airborne Ranger-qualified U.S. Army infantry officer, John is a graduate of the US Military Academy, Harvard Business School and the Harvard Kennedy School of Government.*

*Over the past year, how has this new commercial radio frequency (RF) geospatial intelligence (GEOINT) made an impact for defense and security needs?*

**John Serafini (JS)**

Commercial RF GEOINT is about innovation. Delivering new and unique capabilities to the warfighter, to the analyst, and to the decision maker. HawkEye 360 is providing a commercial RF GEOINT solution as quickly and as efficiently as possible, bringing new opportunity for visibility and situational awareness to satisfy defense and security needs.

Allow me to share a few public examples where HawkEye 360 has created a series of intelligence reports about real-life issues. In April, we monitored Wuhan to assess maritime activity as a barometer of the economic impacts of the COVID-19 lockdown and discovered a slow recovery that was counter China's optimistic proclamations

In June of 2020, we discovered a buildup of Chinese forces in the Galwan River Valley near India around the same time as a deadly border skirmish, uncovering large-scale activity that people were not expecting. In September, we examined a massive Chinese fishing fleet that was encroaching on the sensitive Galapagos Islands, providing better understanding about dark ships and potential illegal fishing within the Galapagos Exclusive Economic Zone.

The US Government and allied governments are recognizing the value of commercial RF GEOINT. One publicly announced program in which we are engaged is RF GEOINT study contract from the National Reconnaissance Office (NRO) to examine the integration of commercial RF capabilities and products into the NRO's geospatial intelligence architecture. And in the latter half of 2020, we were able to publicly announce our involvement in a RF GEOINT pilot program for the United States National Geospatial-Intelligence Agency (NGA).

*HawkEye 360 is preparing to launch its second cluster of satellites. How will these additional satellites better serve the U.S. government and allies?*

**JS**

HawkEye Cluster 2 are next generation satellites. These are larger, more power, more capable than the first satellites we launched in 2018 to demonstrate our capability. Not only will they be more accurate, they will simultaneously collect multiple types of signals and gather as much as ten times more data than our first-generation satellites. We're excited to be launching the most cutting-edge commercial solution to meet the demands of our growing list of government customers.

Cluster 2 will be launching out of Cape Canaveral on a SpaceX Falcon 9 rocket this January. We plan to have those three satellites operational and delivering data within a couple months. Not long afterwards, we have multiple other clusters launching.

HawkEye 360 is fully financed for the launch of fifteen more satellites in 2021 and early 2022. In fact, the satellites for Clusters 3 and 4 are almost done and we're aiming to launch those mid-2021. We'll deploy our constellation very quickly over the next 18 months.

*Intelligence analysts are often overwhelmed by too much data. In what ways does RF GEOINT help fix this problem?*

**JS**

Commercial RF GEOINT contributes a unique perspective that is currently lacking. RF activity is an excellent means of assessing human behavior. The data from our satellites improves how we monitor and interpret global activities. So instead of sorting through stacks of EO or SAR imagery, an analyst can use RF GEOINT to determine where to focus attention, serving as an excellent tip and cue for other modalities. It is also valuable for examining patterns and changes over time. Or effectively tracking movement of RF emitting assets, such as vessels.

*What is HawkEye 360 doing to make it easier for analysts to gain value from RF GEOINT?*

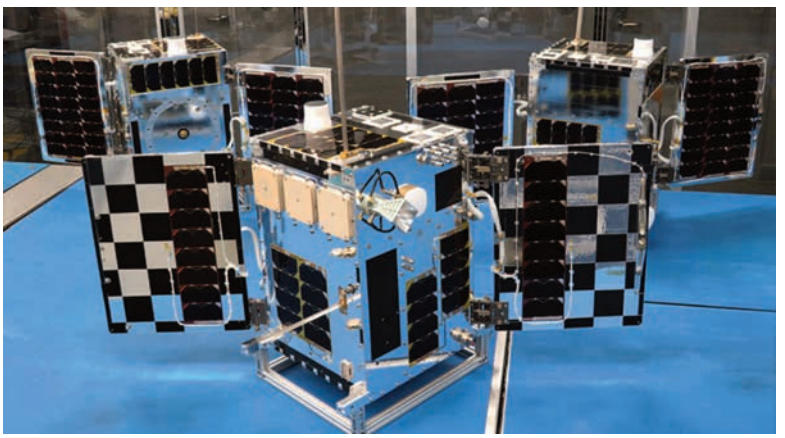


***Photo of a cluster of Hawkeye 360 smallsats. Image is courtesy of the company.***

**JS**

Since commercial RF GEOINT is such a new concept, we find it takes time for analysts to become familiar on how to leverage this unique data. To accelerate this process, we've developed a software platform so analysts can derive value from the data almost immediately. This web-based solution is called Mission Space. We've customized Mission Space to intuitively display RF data, analyze and produce insights from that data, and automate intelligence activities. This is going to help analysts generate answers faster, which is critical for mission success.

We've also introduced HawkEye RF Data Explorer. Our data is already formatted to display in almost any mapping software. But this ArcGIS Add-In will make it much easier for users to ingest and manipulate our RF data in Esri's leading GIS software. We want to provide tools that improve analysts workflows so they can integrate RF GEOINT as part of fused, multi-intelligence reporting.

*What should the US government be doing to take advantage of commercial innovation for defense and security needs?*

**JS**

The US Government has long embraced traditional formats for acquisition, where they seek to solve specific requirements at specific points in time by building large and very expensive infrastructure. But there is a delta between the requirements requested by our forces and the resources available. The only way the US Government can fulfill that need is to incorporates commercial, so they can do a lot more with a lot less.

We want the government to think more innovatively and leverage commercial services in a hybrid architecture. We're building and deploying our innovative smallsat constellation with private funds instead of taxpayer dollars. To be most effective, the government needs to update its approach to procurement to bring commercial services to the warfighter.

*Where do you see HawkEye 360 in the next five years?*

**JS**

HawkEye 360 is unique in that we control an advanced sensing platform, we process the data into useful analytics, and we deliver the results through innovative software solutions. We'll continue expanding both the breadth and depth of what the company is able to offer to our customers. We'll build out our full constellation, increase the number of signals we identify and locate, and enhance our tools for analysts. We have exciting plans

***www.he360.com/***

# MILITARY OPPORTUNITIES DRIVE GROWTH


**Despite the COVID-19 Pandemic and all of the changes that it has brought, Comtech Xicom Technology saw a 30 percent increase in orders driven by new and existing military programs.**

2020 was a year of challenges and milestones at Comtech Xicom Technology, Inc. The company started the year with a major development contract for a military airborne solid-state power amplifier (SSPA) and ended with an enormous development contract for a new military Q-band traveling wave tube (TWT) power amplifier

Between those two goalposts was a year like no other. In March, Xicom announced a slate of new products aimed at commercial and military SATCOM terminals and looked forward to a big year of opportunities. The new product announcement came days before state and county governments began ordering shutdowns.

Xicom is an essential business and reopened quickly after implementing appropriate hygiene/distancing measures. Their military customers are also essential and they soon sprang back into the new 2020 version of business.

The keys to Xicom successfully responding to this unprecedented situation have been to remain focused and flexible: focused on the safety and well-being of employees, suppliers and customers as well as on the critical needs of customers for high quality, high performance satcom amplifiers; and flexible in how challenges are met as they arise. All employees who could work from home immediately began to do so and only those workers needed in the factory for essential production were called back into the COVID-safe environment. Engineering projects were re-prioritized for success. New business opportunities were identified, planned and executed. Supply chain and manufacturing processes were evaluated and optimized. All leading to a 30 percent growth in 2020 orders.

Throughout 2020, Xicom invested in new products and markets by developing a suite of technology building blocks that take advantage of advances in device technology and be used to quickly release new products. Flexible baseline products are now released and new products with high commonality are being added. Focusing on common designs enhances flexibility in the supply chain and manufacturing process to improve customer response time.

In early 2020, military SATCOM networks were in the midst of a transformation in response to changes in threats and the emergence of near-peers with greater capabilities. With the personnel designing and procuring the new systems suddenly working from home, changes in processes for specification, procurement, verification and certification of new equipment put significant delays into new system deployment timelines.

This had two effects on Xicom: delays in the adoption of new mil-spec products and an increase of projected demand for existing mil-spec products.

## MILITARY MOBILE AND TRANSPORTABLE MARKET TRENDS

The trends toward smaller, lighter and easier-to-ship transportable terminals for MILSATCOM continued in 2020, with multiple larger programs moving from terminals designed onto specific vehicles or large pallets to terminals that can be packed into multiple shippable cases and assembled quickly without specialized skills.

These new terminals are aimed at follow-on and replacement programs for many of the Army, Marine, and Special Operations SATCOM terminals. Despite delays in many of these programs, several have started or completed their information gathering process to understand what could be available in the market in advance of issuing solicitations in 2021.

### *SSPA/BUCs forMilitary Transportable Applications*

*In 2020, Xicom focused on releasing its industry-leading gallium nitride (GaN)-based Bobcat line of small/lightweight yet powerful block upconverters (BUCs) which pack into checkable/man-portable cases and feed-mount on antennas. These Ka-band, Ku-band and X-band Bobcat BUCs form the foundation of a flexible, expanding product suite that's continuing to increase in power and add frequency configurations along with additional features.*

*Xicom's focus on keeping manufacturing costs down plus small size/low weight and low power consumption, makes the Bobcat line perfect for new and demanding commercial and military systems. Military reliability and commercial manufacturing go hand-in-hand to deliver successful COTS products for both markets.*

## AIRBORNE MILSATCOM MARKET TRENDS

2020 saw a significant increase in interest in amplifiers for airborne MILSATCOM systems worldwide. This is based largely on the draw of the wide Ka-band-banduency for transmitting high volumes of sensor data, but also the ability to provide multi-band terminal hardware in a cost-effective way. These airborne terminals are high capability, including the ability to switch between military satcom bands and in many cases between using commercial and military satellite capacity.

### *SSPA/BUCs for Airborne MILSATCOM Applications*

*Comtech Xicom quickly responded to the expanding use of Ka-band in airborne MILSATCOM with new variants of their established Falcon airborne solid-sate products to provide the needed band-switching and features specific to the MILSATCOM requirements. Xicom's extensive switchable band capability for the commercial and MILSATCOM bands have the company well positioned for this growing market. Xicom is expanding available options for power levels, frequency sub-bands, and other features using their technology building blocks.*

*New Falcon products announced in 2020 will increase linear power levels to 50W at Ku-band and 40W at Ka-band in ARINC compliant packages. Xicom also focused on certification in 2020, with new Ka-band Falcon products successfully completing DO-160 certification testing for 20W and 25W of linear power. These commercial products are of interest for airborne MILSATCOM terminals as well as the higher capability, custom multi-band product recently developed for use on a large military airborne program.*


## KA-BAND GEO, LEO/MEO MILSATCOM MARKET TRENDS

Military SATCOM system engineers around the world are looking at how to take advantage of new and exciting GEO and LEO/MEO Ka-band SATCOM systems.

Developing terminals capable of switching between existing MILSATCOM capacity and new GEO and LEO/MEO capacity will add a great deal of flexibility and resiliency to their networks along with all the additional capacity. For the LEO systems the lower uplink transmit power needed, compared to GEO systems, enables use of SSPAs where previously TWTAs were often required. This is yielding a large new demand for low-cost, high-power SSPAs.

***High-Power Multi-Band Ka-Band SSPAs***

*In 2020, Xicom expanded its Puma GaN solid-state product line using a suite of high-power Ka-band GaN modules, waveguide designs combining varying numbers of these modules, and extremely flexible upconverters accommodating many sub-band possibilities across both the military and commercial Ka-bands. The results are several new high power Ka-band GaN Puma SSPA/BUCs that provide very high phase noise and dynamic range performance, enabling implementation of higher order modulation schemes needed to maximize use of the available spectrum.*


***Puma 120Ka AC powered SSPA***

## FIXED/STRATEGIC MILSATCOM MARKET TRENDS

Government customers continue to maintain large, fixed networks to communicate and forward data globally. Networks in all satellite bands, from L- to Q-band, were being enhanced and upgraded including a renewed interest in S-band, extended C-band, extended Ku-band and an ongoing demand for higher power in the traditional X-, Ka- and Q-bands.

***High-Power High-Frequency TWTAs***

*Xicom is the leader in millimeter wave TWTAs and ended the year by increasing the output power capability of its Q-band TWTA product line for new military applications. This new amplifier will be in production in in 2021 and delivers the highest power level available in the marketplace. The company has also developed a 650W Ka-band peak amplifier and shipped dozens of 250W V-band high-power TWTAs. These major development programs show Xicom's dedication to supporting military customers across the mm-wave spectrum.*


***XTD-190Q 190W Q-band TWTA***

## 2021 WILL BE A COMPELLING YEAR

Comtech Xicom Technology continues to lead the industry in MILSATCOM communications. With many new products in the pipeline, Comtech Xicom Technology will continue delivering innovation that meet military customers' needs. The company's flexibility in adapting to changes in the marketplace, and its focus on robust and reliable products for military SATCOM users, will enable growth well into the future.

***xicomtech.com***

# A TIME TO BUILD

**The arrival of the novel coronavirus in March of 2020 changed the world. At the same time, my world also changed when I was promoted to President of Comtech's Xicom Technology division. It has been an extraordinary year for me to say the least. Transitioning into a new role with the challenges of a global pandemic made me appreciate the talented, adaptable, and forward-thinking team at Comtech Xicom.**

With COVID protocols in place before the virus spread was declared a pandemic, we were able to quickly adjust to operating as an essential business while keeping our employees safe. This kind of forward thinking has been a pillar on which Xicom continues to build.

During this year we have seen the airborne and mobility market segments slowed, while other areas such as GEO HTS, LEO and MEO constellations have prospered. Having a robust, adaptable, and diverse product line of TWTAs, BUCs and SSPAs ensures Xicom's long term success.

Since joining the Xicom team 5 years ago, we have taken a closer look at how we design and build our products. Creating an environment of continuous improvement has paid off, particularly with a decline in warranty repair rates and an improvement in first pass yields. None of these successes could have been accomplished without great employees and a robust business system.

Building on our solid technological foundations and infrastructure, Xicom is well positioned for the next generations of HPAs and BUCs. We have built and continue to invest in a state-of-the art chip-and-wire assembly area enabling maximum performance and flexibility to adapt to new challenges. This approach gives us the most efficient designs and allows us to be first to market with the latest generation of devices.

Our in-house machine shop makes high-performance and broad band combining networks in the smallest packages possible. These capabilities, coupled with extremely talented engineers and advanced analysis tools, enable the creation of cost effective, compact, and highly manufacturable power amplifiers and BUCs.

***xicomtech.com***

*Author Mark Schmeichel is the President of Comtech Xicom Technology Inc. He has 25+ years of experience in RF amplifier, RF systems, electronics, power electronics and mechanical engineering, in the telecom and SATCOM industries at both large and small companies that have included Motorola, Andrew, MCL (Miteq) and Teledyne.*

## Savoring Success


**Building on our 2019 acquisition of Mountain View, California-based *Glowlink Technologies*, 2020 can be summed up for us as "sleight of hand."**

That term is most associated with mastering moves for performance before an audience where the movements of the hands are precise and well-studied to bring about success in coin tricks and card tricks.

Although sleight of hand brings "*magic*" and tricking of the audience, there is *no* trick to our 2020 product innovations for our customers. Similar to the learned characteristics of sleight of hand, the studying, engineering, preciseness and mastering of incorporating Glowlink technology with iDirectGov technology is our 2020 success story.

This story began with integrating Glowlink's technology and assimilating the Glowlink team into a new culture while maintaining their existing values. The seamless integration into the iDirect Government products and family happened successfully in 2020.


This acquisition endowed us with a team of engineers on the west coast. Together with our existing east coast engineering team, we delivered a significant software release to our customers with enhanced security features – our ***Evolution***™ ***4.2.2.0***. This was no small feat on several fronts.

First, our engineers on both coasts needed to understand and learn the combined technology capabilities to build products to suit our customers' needs for secure SATCOM.

Second, this path of learning came in the middle of a pandemic with travel bans and closures that required virtual collaboration. The iDirectGov engineers came together

virtually and seamlessly, and their collaborative efforts included superb engineering in mastering the integration of two high-level and technical advancements.

Despite these challenges, our team delivered software with the most advanced security features available to the government SATCOM market, including information assurance (IA) and cybersecurity as a part of a multi-layered approach to security. This was a proud moment for us and the engineering team.

Evolution 4.2.2.0 integrates the *Communication Signal Interference Removal* (CSIR™) technology into our ***9-Series*** modem. The CSIR technology integration and its capability to mitigate interference from

***iDirect Government's 9350 modem.***

a SATCOM network are game changers. Although we have integrated CSIR into our own modems, we are continuing to explore incorporating this technology into other modems, HF radios, GPS antennas and many other potential use cases where this interference mitigation technology can benefit the *U.S. Department of Defense* (DoD). The possibilities are endless.

Evolution 4.2.2.0 is a security-feature-rich release. In addition to CSIR technology, it includes *SHIELD Information Assurance* (IA) that provides IA protection on our 9-Series satellite modems, augmenting the existing IA packages available on our servers through our SCAP offering. SHIELD is available through individual remote licenses or as part of our *Premium iSupport* offering.

To have a truly global and secure SATCOM network, our defense, homeland security, first responders and other government users need the capability to control the beams on which they are operating, along with the satellites. We addressed this requirement through the new beam selection tool and dual-mode offerings.

Now, satellite operators can choose automatic beam selection or manual operation based on signal strength. The dual-mode feature enhances global coverage with the capability to operate on both government and commercially owned satellites. This gives our customers options for SATCOM selection and use.


## COVID-19 IMPACT

In light of the pandemic, we have seen a shift in our market and among our customers. Security concerns have increased with people moving to more remote environments, and with this, the abilities of hacker opportunities have increased. This scenario made our latest software release timely, as it included enhanced security features.

Relative to the world market, we are fortunate. The pandemic caused a global slowdown, and in many parts, a shutdown to various parts of the economy. We had a three-month slowdown before the U.S. government was able to pick back up.

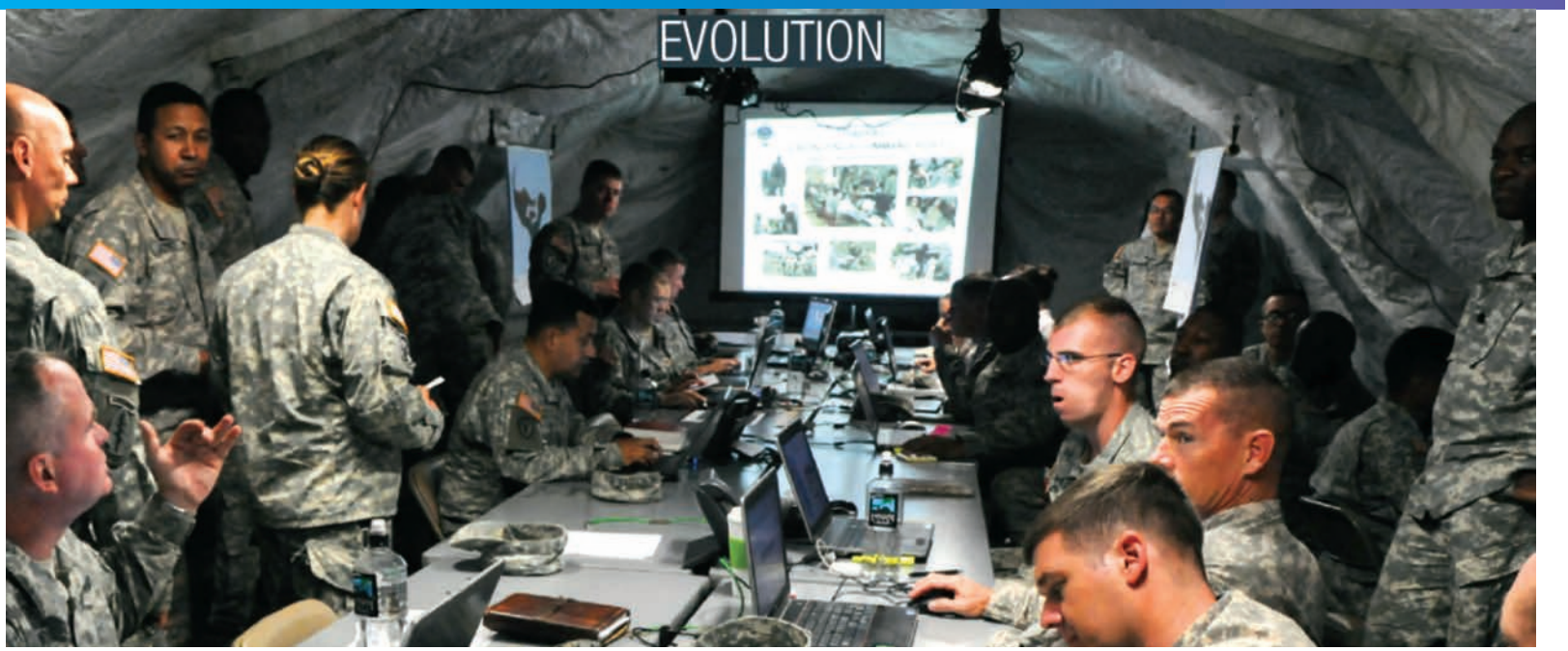
Relative to our products, there has been pent-up demand for some time and closures due to the pandemic had an impact on us. The current 9-Series product line, available in the last two years, is replacing our 8-Series modems, which were available for more than 10 years. The government is now upgrading to the 9-Series and implementing the new features available, including increased security, speed and network flexibility.

We were concerned at the start of 2020 about supply and shipping logistics for our products, considering the tremendous amount of closures. The majority of our products are made as they are ordered here in the United States, and we don't prefer to have a large backstock because of the ever-evolving market. When we saw the shutdown of the economy, we throttled back the supply chain.

The main problem we confronted was that our material supply chain — and that the manufacture our products — went through a series of closures as virus cases popped up. However, the factories we use have done a great job at protecting their employees and that allowed us to ramp up manufacturing in June and July and have products delivered based on our need.

Our company's success in 2020 relates to how quickly we have responded and adapted to the new normal during the ongoing pandemic. This year has brought about a collaborative effort — our employees have banded together and worked seamlessly, even when remote, to rise to the challenge at hand with impressive results.

I worried the most about our engineering team because their work entails constant collaboration; however, the team has done an outstanding job at continuing to move the needle forward on our many ongoing projects, even remotely.




## BEST PLACES TO WORK 2020

For the second consecutive year, we have been named one of *Washington Business Journal*'s ***Best Places to Work 2020***. In my opinion, this is an impressive win as it is entirely employee-feedback driven, and companies are ranked according to that feedback.

For iDirectGov, the achievement validates that we focus and care greatly about our customers, but we care about our employees also, and this is what allows us to obtain and retain the best employees. Our organization focuses on hiring people who are good at what they do, and then we provide them the opportunity to have a solid life-work balance.

## AHEAD FOR 2021 AND BEYOND

This year, we will increase our engineering staff, which will be a huge asset. Our focus will be on our new ***Revolution*** modems, which will be dramatically smaller and flexible in design, can be mounted in many configurations and will boast size weight and power (SWaP) enhancements. They are intended to be ideally suited for airborne, drones and embedded into antennas. Additionally, we expect it will be a paradigm shift in technology, and its release is just a few years away.

We also plan to integrate Glowlink's other flagship products, such as the geolocation and spectrum monitoring tools, into our existing products. Our talented engineers are reviewing the product roadmap for these solutions as well as new innovative ways for their use beyond the traditional uses.

We are looking at potentially providing a geolocation service. This would be an annuity for which our customers would pay a monthly or annual subscription fee. We would place antennas around the world to provide information and have a dedicated network operations center that could provide the location of an interference, based on subscribing customer requests. These products are still in play, and the market can continue to expect innovative solutions from iDirectGov.

The year will display big moves for iDirectGov as the industry leader in government satellite communications. We plan to provide fresh and innovative products that solve the security challenges being faced in the government sector and beyond.

Our ever-evolving product portfolio and enhancements will bring security, flexibility, agility, transmission security and efficiency to warfighters, first responders, disaster recovery personnel and field operators.

***idirectgov.com***

iDirect **GOVERNMENT**

*Author John Ratigan serves as the President of iDirect Government, located in Herndon, Virginia.*

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## 2020: A Pivotal Year


*Image is courtesy of Kymeta.*

**The year 2020 was certainly a pivotal one for *Kymeta*. Despite the unprecedented challenges presented by COVID-19, the company made major advancements in our antenna technology, closed an equity round, completed our first acquisition, developed a bundled *Satcom-as-a-Service* (SaaS) solution, and launched the new *Kymeta™ u8* product line, all the while focusing on the health and safety of our employees and customers.**

Each of these developments has enabled Kymeta to increasingly focus on the complete customer experience — the driving force behind our decision-making and development as a company going forward.

We are excited to start delivering the next phase of our world-class, forward-thinking platform in 2021.

Last year witnessed Kymeta's engineering team make dramatic technological advancements with the Kymeta u8 terminal, including a doubling of the antenna's gain, coverage of the full Ku-band spectrum, and realize near-theoretical scan loss performance — all while reducing cost from the first-generation product. The u8 is the only flat-panel, land-based solution of its kind that fully supports always-on broadband communications over both satellite and cellular while mobile. This always-on feature, enabled by the SD-WAN platform integrated into the terminal and combined with our satellite network, results in a global seamless connectivity experience.

We also developed and launched ***Kymeta Access*** which is available as an online portal and tablet app and provides u8 customers a next-generation, interactive interface for monitoring, controlling, and supporting their terminals and service.

Satellite and cellular connectivity are provided and managed by the u8, a single integrated hardware component that easily mounts onto virtually any vehicle or moving platform. This single piece of hardware provides a local point of presence to the Internet and is as easy to operate as turning on the system.

*Image is courtesy of Kymeta.*

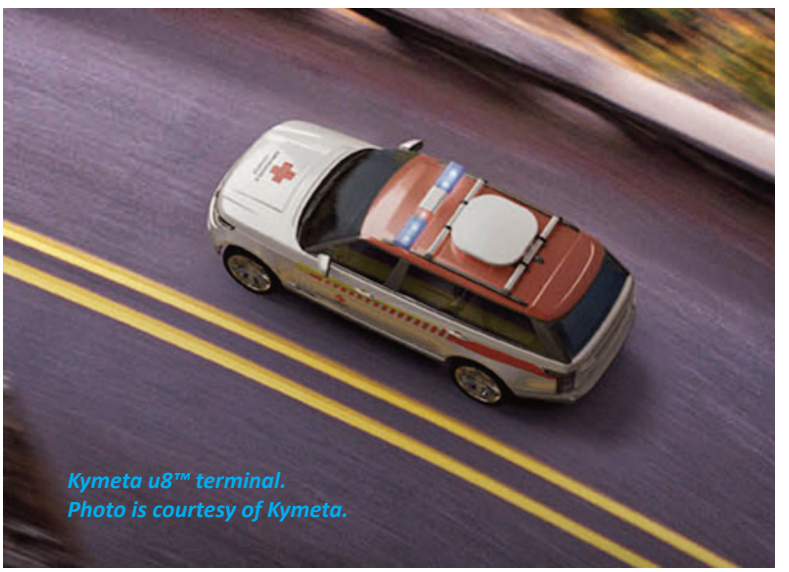
When the u8 powers up, it can automatically connect to the local cellular network and the optimal *Kymeta Broadband satellite network*. In a few minutes, by just powering on the device, the user is connected on both satellite and cellular via best-case routing, with full control via the App or Portal to switch between the two. This can be done easily while in motion or while paused.

In early March of 2020, we announced a bundled connectivity solution that is as easy to purchase as a mobile phone plan and is comprised of the u8 antenna platform and ***Kymeta Connect***™, a unique offering combining satellite and cellular hybrid connectivity. The bundling of our revolutionary u8 product, Kymeta Connect service and back-end suite, including Access, into one monthly service provides a flat-panel SaaS solution that no other company can currently provide.

August brought validation of the company's developments with the close of an equity round including high-profile investors such as *Bill Gates*, who announced a $78 million investment. That month also saw Kymeta close on the purchase of ***Lepton Global Solutions,*** a leading provider of customized satellite communications solutions to government and military customers and now a wholly-owned direct subsidiary of Kymeta. This partnership brings Kymeta's satellite network management expertise fully in-house and enables the ability to provide complete, bundled solutions to the market based on best-in-class technologies and tailored customer-centric services.

In September, we launched our beta program for u8 terminals and November noted our official launch of the u8 family of products and accessories as we started to ship units in Q4 2020 to customers and execute on our growing sales backlog.

Our next generation solutions will revolutionize capabilities across our user base. For public safety and emergency responders, personnel en route to a scene will arrive connected to the best networks available and ready to begin working immediately with access to all of the content and communications they need.


*Kymeta u8™ terminal.*
*Photo is courtesy of Kymeta.*

Industrial workers or farmers with the Kymeta Connect platform integrated into their work trucks can access information and content reliably no matter how remote the job site, increasing efficiency by accessing communications, analytics, IoT devices, and other critical elements at the edge.

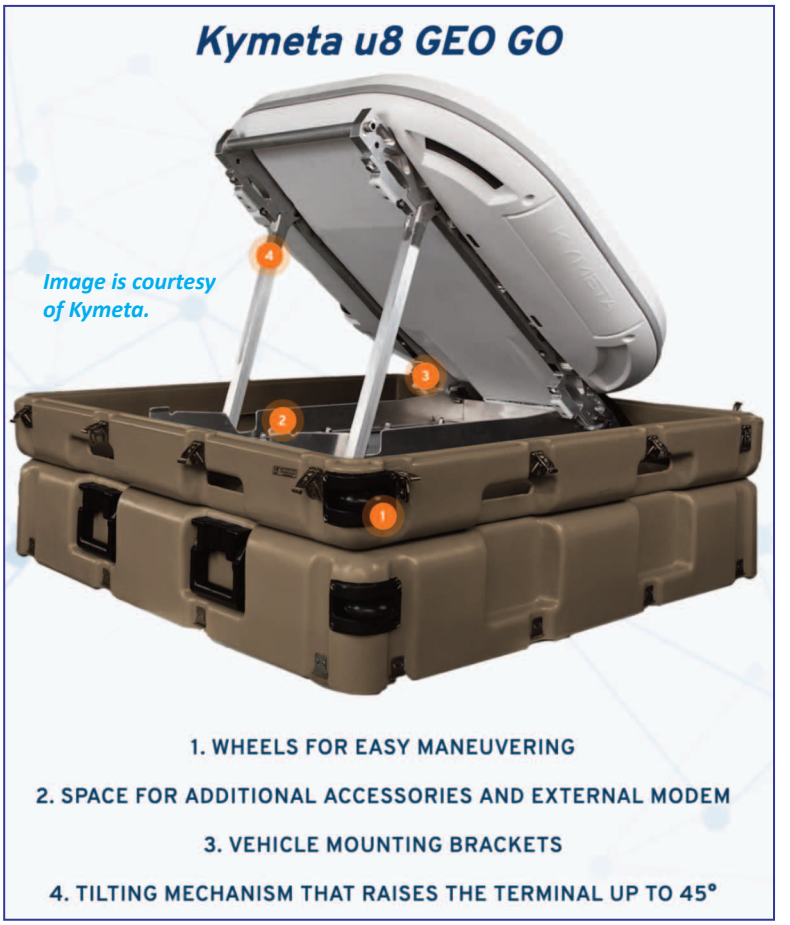
Businesses can now function from anywhere with the Kymeta Connect platform. Integrated onto company vehicles or recreational vehicles, Kymeta's business-grade connectivity platform is available on the road or at a campsite far off in the mountains. No longer are personnel tied to local connectivity.

As seen through these different use case examples, there is a global need for these types of connectivity solutions everywhere. The technological innovation and development happening at Kymeta right now will evolve connectivity innovation around the world and what the future of global connectivity looks like.

These developments are crucial toward both accomplishing our company mission of completing the connectivity fabric and helping narrow the global digital divide. Kymeta next-generation solutions are positioned to bridge that gap.

We are entering 2021 ready to deliver on an expansion of our u8 product family, including the ***u8 GO*** and ***u8 950mp*** modem variant for additional users and applications. The easily maneuverable u8 GO, offered for both the ***iQ200*** and ***950mp*** modem types, can support communication while in the case, on the ground, or mounted on a vehicle for easy deployment in a multitude of use cases.

The transportable configuration has been custom designed for the u8 terminals, and the mount hosting the terminal within the case is a vehicle mount, offering easy-in, easy-out transformability.




The multi-function hardened case is tested to *MIL-STD-810H* transportation standards and comes with hardened tie-down points. The 950mp modem variant offers Government users who require the security features of the 950 modem the same revolutionary software-defined, electronic beam steered antenna system with the ability to operate on *iDirect*'s Government platform.

We plan to continue our great momentum and product developments during 2021. You can look forward to learning more about Kymeta customers leveraging our solutions, new products, and capabilities as the company moves into this new year.

***www.kymetacorp.com***

KYMETA
MAKING MOBILE GLOBAL

*Isabel is the Vice President for Kymeta Connect and Government Programs and was a co-founder and Managing Partner of Lepton Global Solutions, a Kymeta company. In addition to overseeing the company's day-to-day operations and finance, Isabel also manages business development and strategic efforts with her partner, Rob Weitendorf. Isabel started Lepton in 2012 after several years on the business development team at MTN Government Services, now a part of Global Eagle.*

*Isabel is a graduate of the University of Virginia, where she studied Foreign Affairs with a focus on the Middle East. She returns to Charlottesville regularly.*

*Image is courtesy of Kymeta.*

# LEONARDO DRS: YEAR IN REVIEW

## Integration Advancements in Satellite-Based Information & Communication Technology


**For the 20th consecutive year, Leonardo DRS has maintained its position as the #1 SATCOM integrator for the U.S. Department of Defense. As a leader in satellite-based Information and Communication Technology (ICT) for defense, intelligence, and federal/civil markets, Leonardo DRS provides tailored end-to-end global satellite communications, fiber and wireless terrestrial back-haul, managed network services, cybersecurity, network operations, and enterprise IT for mission-critical, no-fail solutions.**

Leonardo DRS has continued as the industry leader in 2020 by focusing on customer success. This includes its logical approach to complete ICT system integration, its unwavering dedication to fulfilling mission requirements, its pursuit of innovation, and its commitment to providing best value solutions.

### 2020: A YEAR OF GROWTH DESPITE GLOBAL CHALLENGES

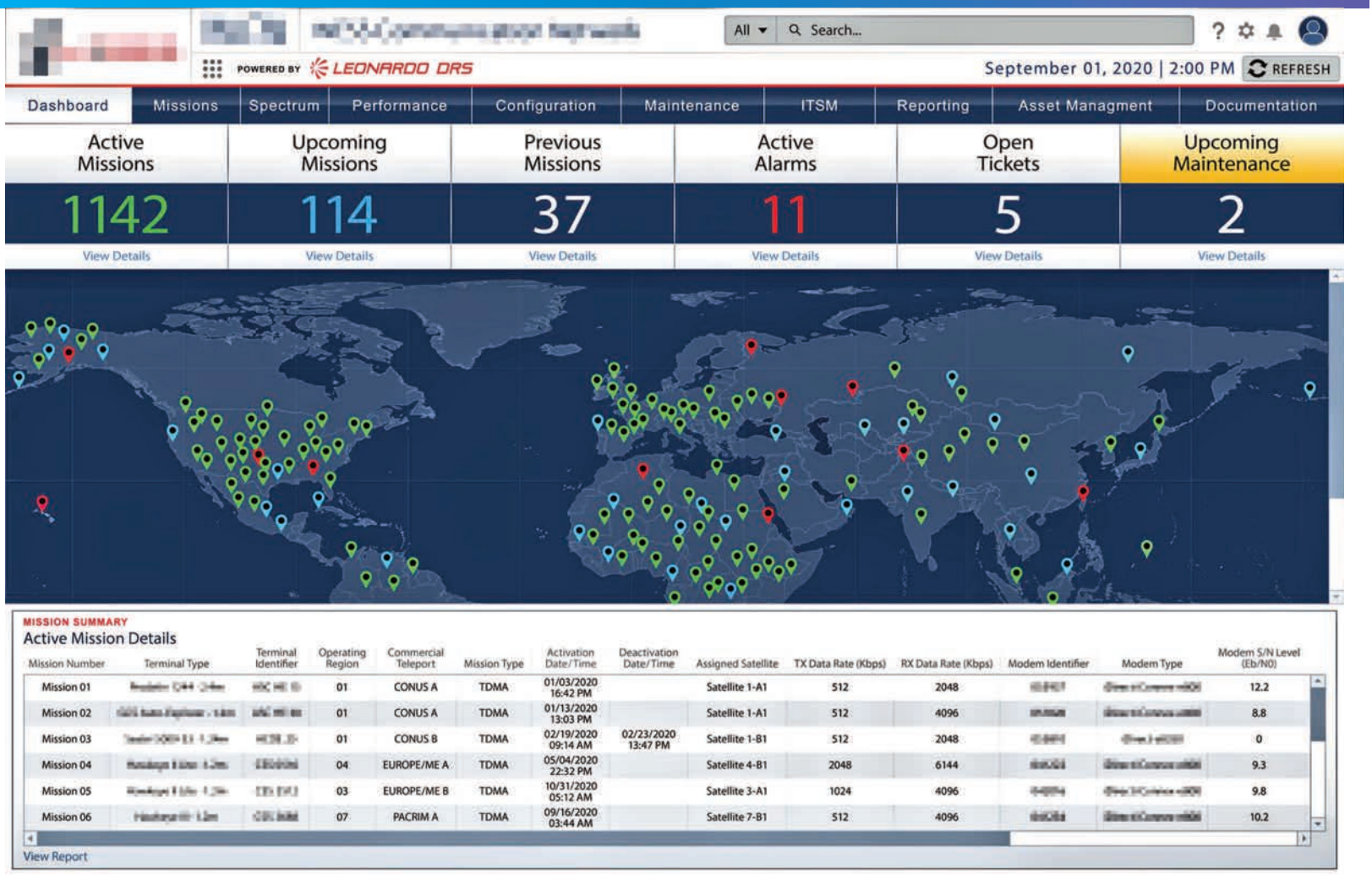
Throughout 2020, Leonardo DRS continued its culture of excellence while positioning the business to take advantage of opportunities and setting customers up for success in the coming decade. Its long-standing industry relationships, extensive product and service knowledge, team of experts, and commitment to innovation, quality, and excellence are the driving forces that keep Leonardo DRS delivering transformational solutions to its customer's year over year.

With this foundation of customer-centric quality in operations and service delivery, Leonardo DRS' significant achievements in 2020 include:

### EXPANSION OF THE LEONARDO DRS ICT

Ecosystem's capabilities: Because SATCOM customers need their devices, terminals, and systems to work anywhere at any time, they require a no-fail solutions approach. This is where an ICT integrator like Leonardo DRS is needed to facilitate the highest levels of system confidentiality, integrity, and availability. Over the past year the company has expanded its ICT Ecosystem network by:

- ***Adding the Inmarsat Global Xpress service to provide customers with global, mobile, and broadband connectivity***
- ***Increasing ISR capabilities by integrating geospatial intelligence satellites and analytic services with eGEOS, the global distributor for one of the largest and most advanced radar satellite constellations available today.***
- ***Integrating Inmarsat L-Band Tactical services for radio agnostic and transparent voice and data beyond-line-of-sight communications***
- ***Introducing electronically steerable antenna solutions for low profile communications-on-the-move applications***
- ***Implementing software defined networks for increased security and resiliency***
- ***Extending the terrestrial reach of their Global Communications Network to Northeast Asia***
- ***Launching the Leonardo DRS ICT Portal for customer monitoring of their entire network***




***A screen shot of the Leonardo DRS ICT Portal.***

Through this ICT Ecosystem, Leonardo DRS offers a shared services platform, which has significant advantages in reducing costs to their customers, improving security services, and introducing new technologies and services with dedicated technical and support resources.

## INTRODUCTION OF THE LEONARDO DRS ICT PORTAL

The ICT Portal offers a consolidated view of management and operations so customers can see in near-real time how the network and the personnel managing the network are performing. Portals are designed around each customer's needs, but can include views into trouble ticket status, network status down to the end-user device, performance metrics, status of projects or upgrades, and status of personnel critical to managing the network.

Each customer portal can also provide visibility into cost accounting, to ensure a program is operating within budget. The company's customer portals comply with NIST security standards and *Risk Management Framework* (RMF) to meet customer requirements.

The Leonardo DRS ICT Portal uses the same agnostic and holistic approach that the ICT Ecosystem is engineered with, providing customers a comprehensive and flexible monitoring and reporting solution. Customers now have the advantage of not only having a single source for managing, operating, and troubleshooting the network from end-to-end, they have a single window where they can see the network for themselves in near-real time.

This gives military customers a tremendous advantage, allowing them the information to control decision-making in the fast-paced environments in which they operate. Such a customer portal becomes not just a source of information, but an invaluable tool in decision-making.

## SUCCESSFULLY MAINTAINING CONTINUITY OF OPERATIONS DURING COVID-19 RESTRICTIONS

Leonardo DRS transitioned a major *Department of Defense* (DoD) SATCOM contract from *Government Furnished Equipment* to *Contractor Furnished Equipment* (CFE) at six global teleports in 90 days, well ahead of the 120-day requirement. Not only did this require a detailed listing of CFE, it also required the addition of a new commercial teleport in support of a new space segment solution. In


spite of COVID-19's impact on travel, the Leonardo DRS team also successfully completed a technology refresh of close to 5,000 satellite user terminals in less than two months.

## 2021: POSITIONING FOR A DECADE OF MASSIVE GROWTH AND TECHNOLOGICAL ADVANCES

The next ten years will see major changes in the communications world, in terms of both offerings and risks. Leonardo DRS intends to position itself to take advantage of these changes and to maintain the technological edge of their customers through the following initiatives in 2021

### AUGMENTING THE ICT ECOSYSTEM WITH LOW EARTH ORBIT (LEO) SATELLITES

Leonardo DRS is collaborating with partners rolling out LEO offerings to their customers, which will yield great value in both the cost and throughput capabilities of COMSATCOM.

With an eye to the future, the company is exploring burgeoning possibilities of integrating LEO satellites into its ICT Ecosystem by establishing new research partnerships with the major LEO satellite operators. The company is also working with LEO providers to develop host nations agreements and to obtain frequency clearances, landing rights, service management, and field services in order to support the massive terrestrial network required by the LEO constellations.

### INTEGRATING LEO, 5G, AND INTERNET OF THINGS (IOT)

There will soon be 30 billion devices and 50 billion machines online. This essentially means everyone, and every "*thing*" will be connected, across every geography, supporting every application from consumer broadband, mobile gaming, and connected cars to global business networks, ships, planes, soldiers, first responders, and connected farms.

To connect tens of billions of users and things, there has to be a system that has high capacity and high throughput, which is where 5G comes in. 5G is far more than just a faster version of the 4G/LTE standard; 5G is a "*network of networks*" and defines a new and common network architecture, which all access technologies can adhere to.

When integrated with LEO's high capacity and lower latency capabilities, 5G's high-speed, high-capacity, and ultra-low latency capabilities will dramatically change how two systems can interoperate to carry huge communication loads, including IoT. Leonardo DRS is collaborating with leaders in these fields and is poised to make a major difference in the integration of these revolutionary technologies in 2021.

### COMPLETING THEIR CENTRALIZED OPERATIONAL EXCELLENCE INITIATIVE

Leonardo DRS has begun a formal initiative to further improve their process functions and follow best practices with utmost customer focus. Performing with excellence has always been at the heart of the Leonardo DRS strategy. Their wide spectrum of contracts, products, and services to various customers, branches of DoD, and Government result in varied expectations from their customers.

***Mounted Family of Computer Systems (MFoCS) II. MFoCS II integrates Tactical Sensors, Tactical Networking, Tactical Applications, Tactical Logistics, and Systems of Systems.***

In 2021, multiple focus teams will complete work on developing common and standardized practices such as new product development, performance metrics, and program management across all Leonardo DRS business units. For Leonardo DRS, Operational Excellence not only means utmost quality and service, but also a culture of creativity, inclusivity, and integrity, which in turn leads to their customers' success.

## CONCLUSION

Leonardo DRS is dedicated to supporting the military by delivering a "*no-fail*" ICT Ecosystem with the objective of ensuring all operations are reliable, resilient, and secure. Achievement of this objective is based on a commitment to building in multiple redundancies to ensure automatic alternate routes are always available and that data reaches its endpoint securely and uncorrupted.

The company's *Global Communications Network*'s massive terrestrial infrastructure assures customers that Leonardo DRS' network is scalable and meets the most demanding network service requirements, currently and through the future, which is a direct result of its singular pursuit for operations excellence.

***www.leonardodrs.com/GES***

LEONARDO DRS

*Author Gus Anderson served in the U.S. Army for 29 years as a Telecommunications Corps officer. During that period, he commanded numerous tactical and strategic communications organizations, to include the 509th Signal Battalion, Vicenza, Italy, and the Regional Signal Group SHAPE, NATO HQ (Belgium). He retired as a Colonel in 2008.*

*Currently, Gus Anderson leads the Leonardo DRS Global Enterprise Solutions business development organization, helping grow customer and market understanding of the Leonardo DRS Information and Communications Technology (ICT) Ecosystem — a global network that provides secure managed satellite and terrestrial services to major DoD, US Federal, and international agencies.*

*Leonardo DRS provides tailored, end-to-end, global satellite communications, fiber and wireless terrestrial back-haul, managed network services, cybersecurity, network operations, and enterprise IT for mission-critical, no-fail solutions.*

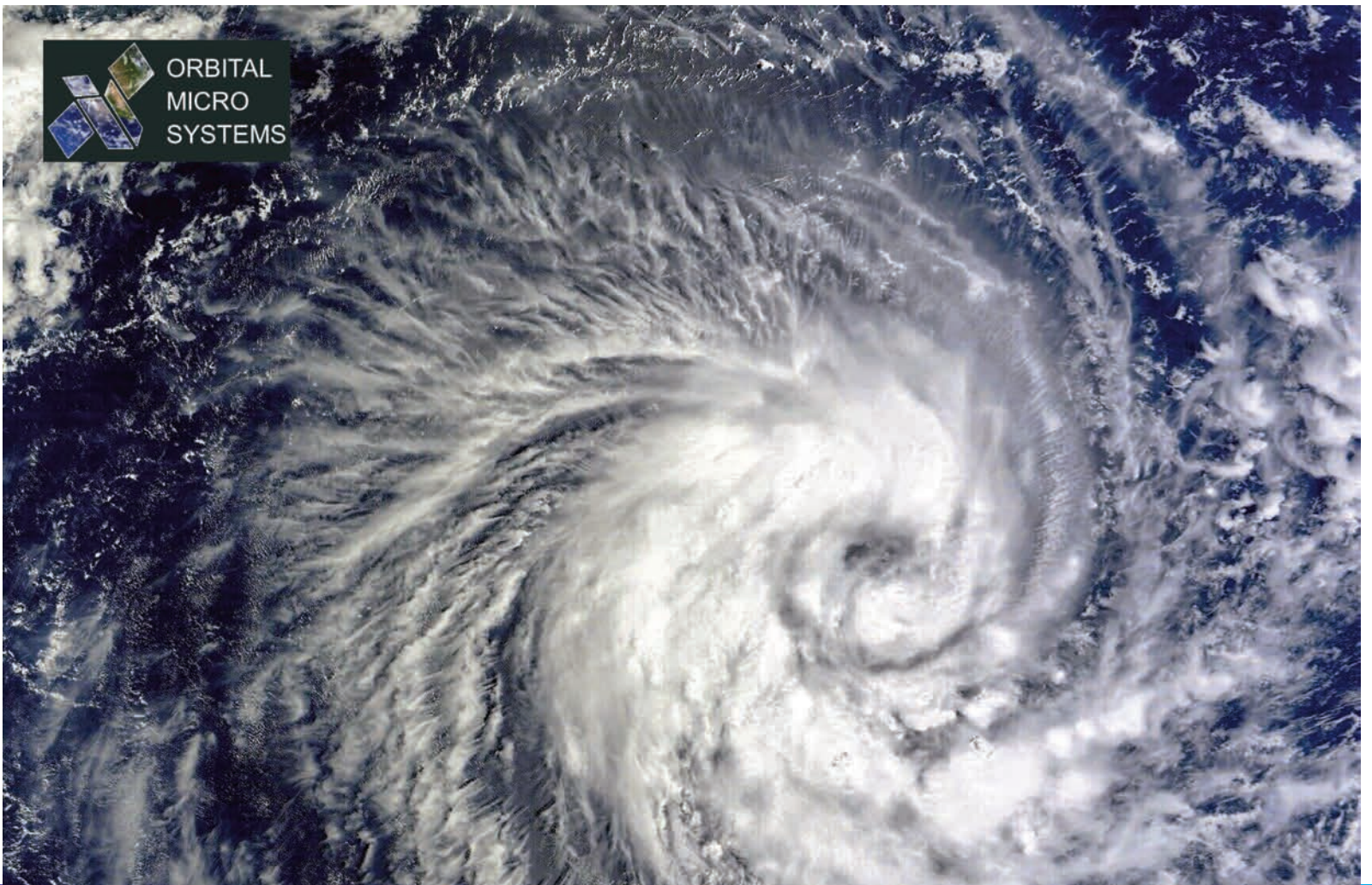
## A Year of Traction and Transition

***Orbital Micro Systems*** **(OMS) was founded with a vision to build state-of-the-art Earth Observation (EO) systems and algorithms to solve difficult environmental and climatological problems affecting multiple industries that range from military/agency/government (MAG) to commercial market segments.**

OMS saw an upswing in demand for services and its unique satellite-collected EO dataset in 2020 and is well-positioned to accelerate growth in the coming year. Building on momentum from its successful commissioning of the ***IOD-1 GEMS*** satellite (*artistic rendition to the right)* in the second half of 2019, the Boulder, Colorado- based company secured multiple contracts and awards this past year with government and commercial customers.

OMS' *Global Environmental Monitoring System* (GEMS) is a partially deployed constellation of LEO satellites which will offer global weather observations at revisit rates approaching 15 minutes when fully commissioned.

IOD-1 GEMS is equipped with the first, commercial, passive microwave radiometer on-orbit, providing regular weather observations which augment data available from government-operated satellites. Filling some of the temporal and geographic observation gaps left by existing satellites, the OMS satellite has captured unmatched observations of weather structures and storms such as Super Typhoon *Hagibis*. The company is currently producing the flight hardware for its *GEMS2* satellites that will possess additional capabilities.



## MILITARY AWARDS AND RECOMMENDATIONS

As a member of the *Catalyst Space Accelerator* sponsored by the ***Air Force Research Laboratory*** (**AFRL**), OMS identified opportunities with the U.S. Air Force and U.S. Navy for data from its GEMS constellation. Subsequently, the company received a $1.8 million *Phase III Small Business Innovation Research* (SBIR) contract award from the *Air Force Life Cycle Management Center* (AFLCMC) under the *Commercial Weather Data Pilot* program. In addition, working with AFRL, the company received a $750K Phase II SBIR contract to further support the development of its novel ***WeatherLock*** forecasting algorithm.

The company was also awarded a $1.5 million Phase II SBIR contract for the development and build of flight hardware for GEMS2 and enabling demonstration of the *OMS Weather Record* product that uses real-time anomaly detection and Machine Learning (ML) to analyze microwave brightness temperature data and issue severe weather alerts within minutes of detection.

Having garnered significant support across multiple agencies, OMS was nominated by the ***U.S. Space Force*** to participate in the *2021 Defense Exportability Features* program to explore the opportunity for exportation and standardization of GEMS microwave sounding data, WeatherLock, and Weather Record products to serve the needs of allied militaries as well as the *U.S. Department of Defense* (DoD).

In addition, OMS' reputation for excellence in satellite instrument design and microwave radiometer calibration brought them a sub-contract award through ***Ball Aerospace*** for the *Weather Satellite Follow-on Microwave* (WSF-M) mission to support the calibration of a key instrument subsystem for a U.S. Space Force project.

Throughout the year, OMS continued to work with its military customers on key projects, achieving positive results such as passing *Critical Design Review* (CDR) for its GEMS2 sensor and CDR for its Weather Record technology demonstration.

## GLOBAL FOOTPRINT

Through its work with complementary programs sponsored by industry, government and defense partners in the U.S. and the U.K., OMS has been successfully creating new services and technologies that benefit multiple users and industries.

The company has been selected to provide the primary payload for a multi-payload, multi-stakeholder international project under the *U.K. Satellite Launch Program*. Working with prime contractor ***Lockheed Martin***, OMS will deliver its GEMS2 instruments for the first launch from U.K. soil.

The company has also made strides in applying ML and Artificial Intelligence (AO) to the rapidly expanding volume of EO and weather data being gathered by satellite-based and terrestrial sensors. The company has established the ***International Center for Earth Data (ICED)*** in Edinburgh, Scotland, with the mission to normalize fair market access to high-quality earth observation data from multiple public and private sources. ICED provides an alternative framework for handling high volume, complex remote sensing data and algorithms and commercial data transactions. ICED operates under an open source philosophy that respects the IP rights of data producers and algorithm developers while reducing barriers to the use of public and private data sources.

Through ICED, multiple disparate datasets — including the unique GEMS data — are aligned and gridded in time and geolocation, empowering analysis for multiple applications in government, military, commercial transportation, and insurance use cases.

Most notably, OMS empowered its UK partner company, *Weather Stream, Ltd.*, in July of 2020 as a separate entity with a mission to drive global business development for weather intelligence products, including GEMS data and access to ICED. Weather Stream is headquartered in the U.K. and serves global clients.

## THE YEARS AHEAD

OMS is well-positioned to complete the GEMS constellation by 2025. The organization expects it will have a growing, positive impact on the industries that rely on timely and accurate weather data, along with helping military and government agencies achieve operational goals. The next year should see the company continue its expansion, satisfy more contract milestones and accelerate the delivery of unique and impactful solutions.

***https://www.orbitalmicro.com***

*Michael Hurowitz serves as Chief Executive Officer and Chief Technology Officer for Orbital Micro Systems (OMS). In these roles, he sets the strategic direction for the organization and oversees the company's numerous research and development programs. Michael is privileged to lead a world-class team of engineers and scientists who constantly innovate to bring the companies vision to life. Hurowitz brings nearly 20 years of early stage technology transfer and product development experience to the OMS leadership team. Prior to co-founding OMS, he worked with numerous university spin-out companies in multiple roles from early stage employee to co-founder.*

*To date, Michael has worked with over 100 startup companies, 35 Fortune 500 companies, 25 university research groups, and 15 federal agencies. Michael is deeply passionate about helping scientists turn their ideas and research into commercial products and services. He serves as a volunteer mentor for the University of Colorado Venture Partners team. Hurowitz holds a Bachelor of Science degree in Engineering Physics and Public Affairs from the Colorado School of Mines and is an instructor at the University of Colorado.*


*Artistic rendition of Maxar's WorldView-3 satellite.*

# AGILITY AND ACCESS

## The Keys to Collecting Images for Time-Dominant Missions

*By Dr. Walter Scott, Chief Technical Officer, Maxar Technologies*

**Outside of technical circles, the most well-understood measuring stick for the utility of satellite imagery is resolution. It's a metric kind of like home runs in baseball — it tells you a lot about a player's value, but it doesn't tell the whole story.**

A player who can hit 30 home runs in a season can probably make a major league roster — but is such a player worth signing to a 10-year mega-deal to build franchise around? That depends on other factors, such as their on-base percentage, age and durability, are they a liability in the field, etc.

Resolution is no vanity metric. Many missions — particularly national security missions — require imagery with enough detail to characterize activities on the ground with high confidence. It's rarely good enough to know something is there or something is happening if you can't tell what it is.

Since Maxar launched the world's first 30 cm commercial imaging satellite in 2014, this has become the gold standard for resolution that most customers have desired.

Beyond resolution, there are a host of other technical characteristics that ultimately relate to speed of access — how quickly can I get the image that I need?

We recently got a great look at Rocket Lab's Electron launch vehicle about four hours before it carried 30 satellites into orbit — *the captured image is on the following page*.

Our WorldView-3 satellite was not passing directly over the New Zealand launch site; it was more than 440 miles to the east, requiring us to tilt the satellite 47 degrees from nadir (straight down) to get the shot.

The target was more than 200 miles farther away than if it were directly beneath the satellite, and yet, due to WorldView-3's large optical telescope, the resulting image still has 48 cm resolution — and we were able to collect it because of the satellite's ability to point rapidly in any direction to take a shot, what we refer to as the satellite's "*agility*," combined with its ability to still collect good resolution at a distance, which we refer to as its "*access*."


*Rocket Lab Electron Rocket before launch at LC-1 in Mahia, New Zealand on November 20, 2020.*

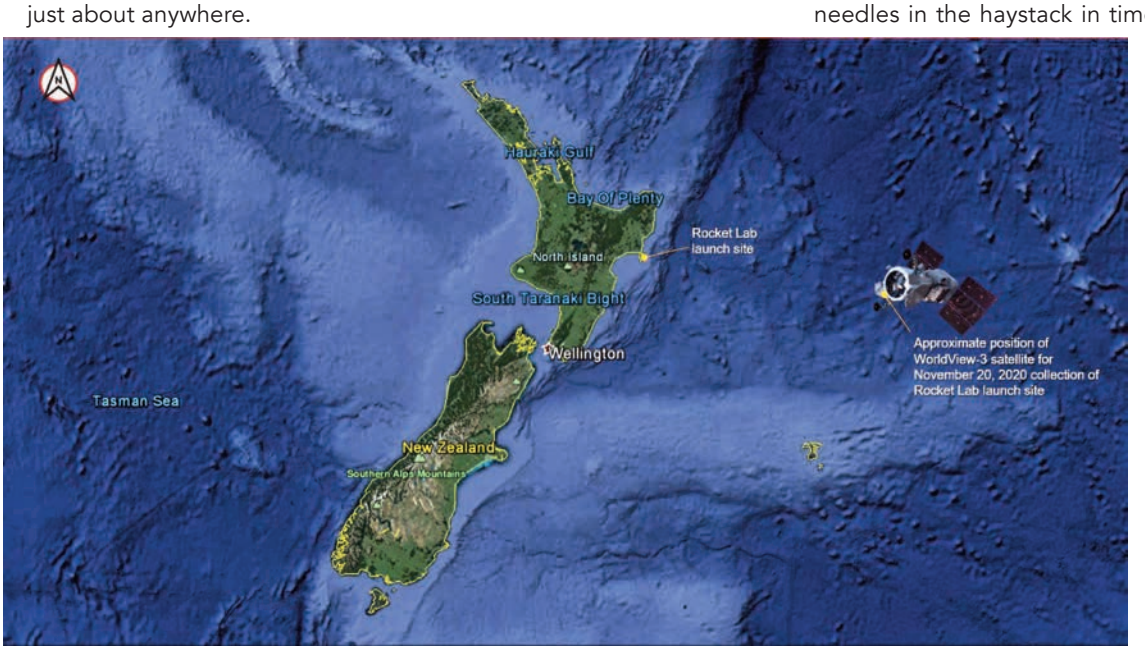
This image was actually not that difficult to collect. The entire world knew exactly where the rocket would launch from and when, so we had plenty of time to factor that into our collection plans. It gets harder and more complex when we have less information about where or when a certain activity will take place.

Hypothetically, intelligence agencies might suspect that a rogue nation is planning to test a new missile sometime in the next few weeks. If that missile happens to be on a mobile launcher, it could be just about anywhere.

That's when the real value of agility comes into play. On timelines of 20 minutes or less, we can re-task our constellation based on the most current information. Maxar's ability to collect large areas in a single overhead pass (think all of Belgium) also factors into a scenario like this, because you may only have a general idea of where to look.

Those terabytes of imagery can be downlinked, processed, and securely distributed minutes after they have been collected. Then we can apply AI and ML tools to narrow the search space and find the needles in the haystack in time to affect the mission. Plus, when we launch our WorldView Legion satellites this year, everything gets faster and better.

Pretty amazing stuff, right? While I wish I could say it was easy, these things are only made possible by the large infrastructure investments the company has made, our deep commitment to innovation and the trusted partnerships with our customers we have forged over many years. Maxar has built the team to win championships.




***WorldView-3 location of high off-nadir collection of the Rocket Lab launch site in Mahia, New Zealand on November 20, 2020.***

**www.maxar.com**

MAXAR


# MANAGING NETWORK COMMUNICATIONS @ THE EDGE OF THE BATTLEFIELD

## The Single Pane of Glass Approach

*By Charlie Kawasaki, Chief Technical Officer, PacStar*

**NetOps and Cyber SA demand rapid and continuous innovation to meet evolving threats to Department of Defense (DoD) information dominance, as well as to address the challenges that program managers and technical operations personnel face with network management**

The promise of the networked battlefield is now a reality. Actionable intelligence can be shared over the network in real-time, from the command post to ground vehicles on the move, to ships at sea, to the manned and unmanned aircraft and satellites above, and to the warfighter at the edge of network.

Meanwhile, the setup and management of deployed military networks becomes more complex as they leverage mature commercial enterprise technologies, and in some cases even use unsecured in-country cellular and telecommunication systems. It often takes days to get a battlefield network up and running, but Army leaders believe that in future operating environments, against a peer threat, forces will have to move on an hourly basis.

Stationary bases such as those established in Iraq and Afghanistan won't meet requirements. Battlefield networking is a mission-critical service, but cyber is now a contested domain. Commanders rely on the network for visibility into all facets of battle, so Networking Programs must ensure network availability and defense against cyber attack.

The goal for next generation Army command posts programs is for networks to be powered up and receiving live feeds in five minutes. Wireless networking capabilities will be key to meeting this goal, making it possible to set up and tear down the network in only minutes, instead of hours or days after warfighters establish operations in a new location.

The simplification of battlefield information technology (IT) and cybersecurity will be essential so that lightly trained personnel can rapidly set up a network in the field. Likewise, network management must be simplified to ensure that the battlefield network stays up and running and commanders have a single, clear view of the network's health and status at all times.

Gaps in understanding tactical network architecture, network status, cyber posture, and the spectrum/EW environment can hamper a commander's ability to make fully informed decisions at the tactical edge. U.S. DoD must retool its management of network, communications, and spectrum to maintain tactical overmatch in the cyber warfighting domain.

Programs advancing concepts, such as *Joint All Domain Command and Control* (JADC2) and *Cyber Situational Understanding* are starting pilots to address subsets of well-known challenges in these spaces. The complexity of gathering and fusing data from multiple sources — particularly in *disconnected, intermittent and limited* (DIL)

environments — necessitates progressing toward the ultimate vision of a unified network, one step at a time.

Today, tactical programs have a critical need for ***Cyber Situational Awareness*** (SA) across defense information systems. Cyber SA enables cyber professionals and decision makers to gain a clearer picture of what is happening across DoD networks, and ultimately, a bird's-eye view of the entire digital ecosystem.

Network operations (**NetOps**) encompasses not only Cyber SA, but also a broader operational framework that includes network planning, management, configuration, and monitoring to operate, manage, and defend defense networks. Tactical NetOps programs can play a key role in enabling mission success for warfighting in the cyber domain. They have access to the network architecture, network health data, and the 'pipes' to distribute that data to commanders wherever they are. Advances in NetOps tools hold the key to providing understanding in the cyber domain, enabling commanders in the future to have complete cyber understanding.

The goals and gaps outlined above apply to vehicle-based networks, in addition to command post networks. The DoD is currently making major efforts to develop comprehensive "*standards-based communication*" for these platforms, such as the U.S. Army's ***Vehicular Integration for C4ISR/EW Interoperability*** (VICTORY) initiative. While

the resulting standards help improve interoperability, data bus functionality and messaging services within ground vehicles, there are few solutions to the challenges involved in configuring and managing the overall theater and battlefield networks that connect all the platforms and warfighters.

## COMMS MANAGEMENT CHALLENGES

Today's deployable comms teams use "*best of breed*" solutions, including a large number of satellite and radio technologies from multiple vendors. These teams have to deal with multiple vendor user interfaces, extensive training requirements, complex and error-prone configuration and long setup times. Associated with these challenges was the need for multiple IT professionals to deploy in the field, and high training expense for users.

NetOps and Cyber SA demand rapid and continuous innovation to meet evolving threats to DoD information dominance, as well as to address the key challenges that program managers and technical operations personnel face with network management, including:

***DoD overwhelmed by NetOps tools***

*Achieving its strategic vision for network management requires DoD to address the proliferation of NetOps tools. By some estimates, one DoD organization alone is using more than 140 NetOps tools, and in some cases, these solutions are duplicative. Simplifying network management requires a more unified, intuitive experience that has not existed in the past. At the same time, these tools should leverage open standards able to deliver a common look and feel. so that new capabilities can be easily integrated and utilized with minimum training.*

***Staffing and Training***

*The volume and sophistication of tools require network specialists capable of managing networks. These specialists are difficult to recruit, train, and retain.*

***Pace of innovation***

*DoD is excelling at rapidly fielding high-impact technology and leveraging the pace of innovation from the commercial sector. The flip side is that rapid adoption of new network technologies creates integration challenges and increases the network management learning curve. No one network vendor has all of the solutions, which results in the use of multiple user interfaces and disparate tools that drive up complexity.*

***Expanded network***

*Increased automation to manage network operations and manage cyber vulnerabilities is required as networks and their attack surfaces grow with the addition of more sensors and IoT devices.*

Network management solutions for NetOps and Cyber SA Requirements Network management solutions that unify NetOps and Cyber SA capabilities should be able to deliver on several key requirements:

- *Use open or industry-recognized standards for network management and data storage; examples include, but are not limited to, Simple Network Management Protocol (SNMP), Secure Shell (SSH), flow data, logging (SYSLOG), JSON, SOAP)*
- *Provide a configurable GUI (drag/drop, drop-down menus, etc.), visual map of network and services*
- *Provide visual fault indication with context available surrounding the fault (location, device, interface, service, IP, etc.)*
- *Provide configuration management functions (baseline, backup, and alerts of configuration change)*
- *Provide the ability to assess the security posture of network devices and remediate deficiencies (i.e., OS versioning, deviation from a previously determined security template)*
- *Work in a hierarchical model construct (company, brigade, battalion, etc.) which can be configured to restrict or delegate read/write functions of the tool*

## AUTOMATING NETOPS AND CYBER SA

Fulfilling the vision of converging NetOps requires a solution that offers the ability to view the entire network through a single pane of glass while sharing access with deployed operators at any echelon. Such a solution should provide the following benefits:

***Ease and Speed Setup Time***

*Provide an intuitive user interface, making communications set-up and operation quick, easy to learn, and recall. Solutions should include customizable user interfaces and roles-based access control – with tailorable access to features, depending on user experience level – to reduce training time and costs.*

***Reduce Configuration Errors***

*Significantly reduce configuration errors and assist organizations to maintain uptime, performance, and compliance with cybersecurity requirements.*

PacStar

# IQ-Core® Software

*Intuitive Communications Management*

PacStar developed IQ-Core Software to address the growing problem of communication system management complexity.

***Simplify Troubleshooting***

*Simplify troubleshooting through integrated tools for both entry-level and advanced network administrators, to reduce reliance on contract Field Service Reps.*

***Save Time***

*Automate complex, time consuming and error-prone tasks with powerful wizards, using common user interfaces across hardware and software components.*

***Provide Cyber Situational Awareness***

*Deliver enhanced network and cyber SA at the core and edge of the network with extensive real-time status, alerts, and auditing.*

***Facilitate Remote and Distributed Management***

*Facilitate remote management with the ability to monitor and change device configurations and troubleshoot from anywhere in the world.*

***Streamline Innovation***

*Interoperate with a broad range of the most popular tactical and enterprise communications hardware, systems, and protocols- to streamline upgrades and adoption of new COTS technologies at the edge of the battlefield.*

***Field Proven***

*Reduce acquisition risk because widely deployed, proven, and certified for DoD use.*

An example of a single pane of glass solution for managing and automating NetOps and Cyber SA that is available today is provided by ***Curtiss-Wright's PacStar IQ-Core Software***. This software, which is currently being integrated into the Army's tactical network, addresses the growing problem of communication system management complexity.

IQ-Core Software is a comprehensive secure-communications management software that is designed to manage enterprise mobility solutions, tactical networks, and remote communications solutions, including supporting operations in disconnected, intermittent, and limited environments.

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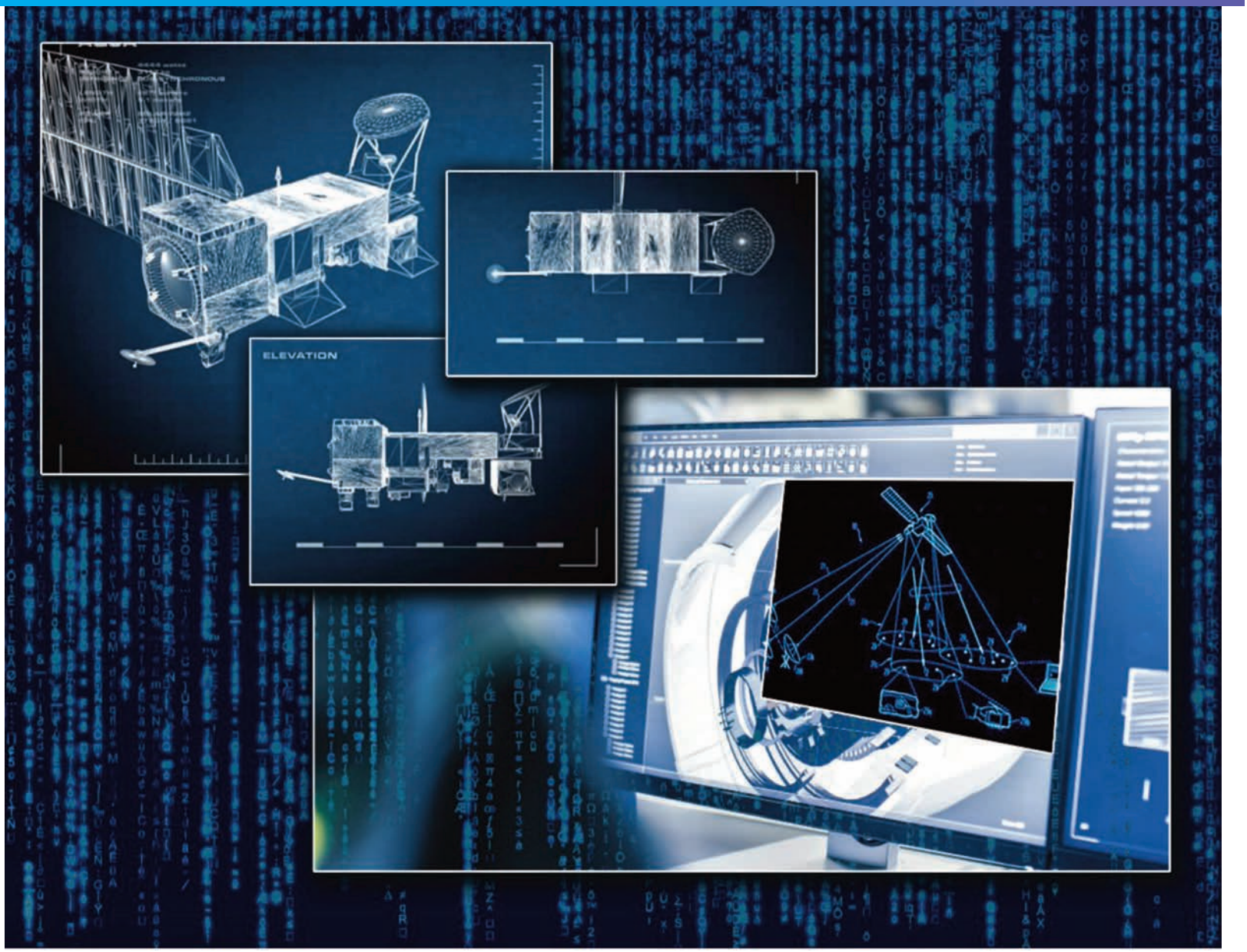
*Author Charlie Kawasaki joined PacStar in early 2005 to lead the company's technology strategy and future product roadmap for its proprietary product lines. Charlie current leads PacStar strategic initiatives – investigating and developing new integrated solutions and technologies to meet customer needs, in particular, focused on areas such as Commercial Solutions for Classified (CSfC), Cybersecurity, and Edge Computing. Charlie works closely with technology and product teams from our largest partners to create joint solutions, leveraging PacStar core technologies to create optimal tactical and expeditionary solutions. Charlie also serves as a technical and product evangelist raising awareness for PacStar solutions in our target markets and customers.*

*Charlie has extensive experience in product development, software engineering, technology licensing, patent development, business development, product marketing, general management and M&A. Charlie has over 35 years experience in early stage technology companies, creating dozens of software products for Internet infrastructure, cybersecurity, PC management, and relational databases. Charlie served as CEO of RuleSpace, Inc., which created AI-based Internet parental controls applications used by companies such as AOL, Yahoo and Microsoft. Before RuleSpace, he held product development and engineering management roles at companies including The Palace, Inc., Creative Multimedia Corp., Central Point Software, Inc., Asymetrix Corp. and Microrim, Inc. In 2019, he was named Outstanding Industry Collaborator*




# DIGITAL ENGINEERING EMERGING AS CRITICAL ENABLER FOR INNOVATION, SPEED @ SMC

**Space and Missile Systems Center (SMC) officials say digital engineering is the key to a faster, more agile and more innovative acquisition system.**

Digital engineering will go beyond individual computer models to use shared data to create a digital thread that can represent all aspects of complex systems; if a change is made in one segment, the ripple effects of that change are reflected in the rest of the system.

***Lt. Gen. John F. Thompson***

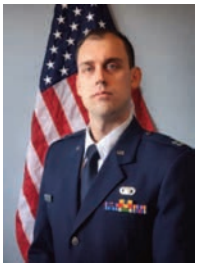
"*Digital engineering isn't just drawing something on an iPad and calling it digital - it's a change in the way we execute acquisition processes,*" said Lt. Gen. ***John F. Thompson***, Commander of the Space Missile Systems Center and USAF Program Executive Officer for Space. "*SMC is moving away from the old way of doing things via paper-based documentation requirements and engineering reviews. Our software development teams are creating digital dashboards, tools and metrics that assess and measure whether systems are ready for milestone review.*"

SMC's ***Portfolio Architect Directorate*** is responsible for establishing the system-of-systems engineering architecture and the investment strategy and framework for the $10 billion space portfolio that informs and prioritizes what SMC acquires and rapidly delivers to the warfighter.

"*Digital engineering probably means different things to different people, but for Portfolio Architect, it's going to be a critical enabler for us in the U.S. Space Force to get more bang for the buck as we talk*

***Deidra Eberhardt***

*about greater efficiencies and affordability*," said Ms. ***Deidra Eberhardt***, deputy director for the Portfolio Architect Directorate. "*This capability will help us to uncover those efficiencies, find those alternative architectures through trade space, and ensure that our superior contribution to the warfighter.*"



***Captain Jeff Choate***

"*It's about getting more value from the integration of data*," said Capt. ***Jeff Choate***, lead, cross mission data with Portfolio Architect. "*We have lots of data – what we're trying to do is get the data to 'play well together' – get it out of the contractor stovepipes and the individual team stovepipes.*"

"*While portions of the technology aren't exactly new, combining them is, and is at the heart of a digital engineering ecosystem*," Choate said. "*If we have a modeling and simulation tool, a lot of these teams might post it on local servers and not share it. We're trying to create enterprise-wide workflows and get the visibility of the data and all these digital artifacts, digital twins, digital government reference architectures. We're working towards digital standards for what contractors actually give us when bidding for a new contract.*

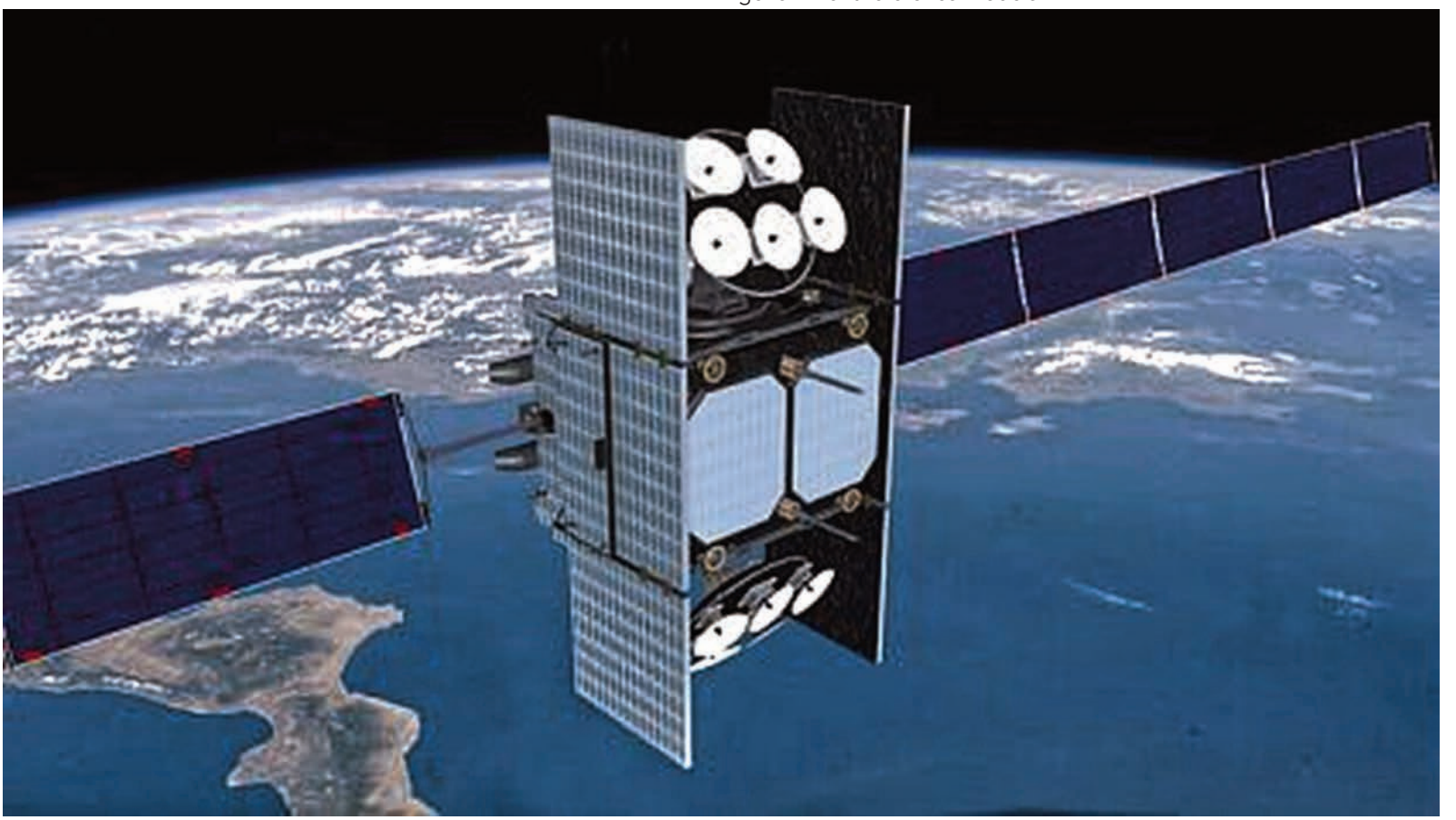
"*It's about 'How can we create a workflow that accepts digital artifacts from a contractor so we can quickly feed that impact of a contractor delivery or a contractor's proposal and speed up that analysis, and see the impacts on the entire state architecture. And if a milestone is delayed for one of our key systems, throw red flags immediately and develop solutions'*," Choate added.

One of SMC's digital engineering flagship programs is the ***Protected Anti-Jam Tactical SATCOM*** program, or **PATS**. The program provides worldwide, *Beyond-Line-Of-Sight* (BLOS), Anti-Jam, *Low Probability of Intercept* (LPI) communications to tactical warfighters in both benign and contested environments. The PATS System Integration Team integrates and synchronizes capabilities from space, ground and end-user modem equipment programs to realize the PATS capability.

***Phil Tran***

"*I view digital engineering as a way for us to do traditional systems engineering, but find ways to digitize it and find efficiencies*," said P***hil Tran***, PATS technical director.

In PATS, digital engineering is helping the program increase speed and agility by helping transform its robust PATS digital product suite to a more modernized and integrated USSF digital engineering ecosystem. Digital engineering also allows multiple teams and vendors to build out architecture simultaneously using government reference models.



***To provide anti-jamming MILSATCOM for warfighers across the world, the U.S. Space Force incorporates a protected tactical waveform — known as the protected Anti-Jam Tactical SATCOM aboard WGS satellites. Artistic rendition is courtesy of U.S. Space Command.***

Just as going from paper-based technical requirements to diagrams can more quickly show how components fit together, being able to digitize that information allows engineers to rapidly model how one change will affect other components in a system — a process that previously might have taken months or weeks — in a matter of days or hours, Tran said.

A digital twin contains the necessary information and capabilities of a real system in a digital environment to allow engineers to understand gaps before building the hardware, and see how changes in one component of the design will affect the rest of the system, Tran explained, "*Though we certainly don't have all aspects of the complete digital twin done at this stage in the lifecycle, we develop iteratively maturing 'risk reduction' elements of the digital twin to help programs model future capabilities, and to see if certain investments are worth pursuing further.*

"*Components of our risk reduction digital twin could be a CAD (Computer-Aided Design) model, an MBSE (model based systems engineering) model, or a video game simulation*," Tran said. "*Our risk reduction digital twin provides useful system component representations for end users early in development to give them an early 'look and feel' of the eventual fielded system and enables them to have early relevant input they traditionally have had to make by wading through documentation.*"

For example, what if a particular type of satellite system launches to a GEO orbit, but SMC wanted to see how the system would perform in a different orbit? By creating an appropriate digital model, engineers could experiment at a much lower cost than launching a physical prototype, and potentially discover and prevent fatal design flaws while still working digitally. Being able to do this quickly — without taking time away from other mission priorities — also means more opportunities for innovation.

Another digital engineering challenge for the USSF and SMC will be to "*own the tech stack.*"

That means making sure all the technological platforms are USSF-owned and all the data is accessible – while still allowing access to trusted space industry partners, Choate explained.

With a USSF digital engineering ecosystem, those industry partners will be able to submit digital models in their proposals that USSF can then use to decide how to get the best capability and value for its investment, Eberhardt said. Having that conversation digitally will be so much more informative for both sides and enable a quicker, more rapid return on the architecture.

That's why SMC has identified a few programs, such as PATS, to serve as pathfinders for the new digital engineering revolution.

"*There's a lot of innovation going on to create these digital environments, and we're choosing them to be the early adopters to figure out workloads, processes, and how to make this work across the entire enterprise*," Choate said.

"*Machine learning will allow development teams to begin automating processes, allowing engineers to focus on other, less tedious tasks, and speed up the design process*," General Thompson said. "*In addition, access to these simulations and digital representations will be available not only to government personnel, but trusted industry partners for collaboration.*"

*Just in.. SMC has successfully tested their Protected Tactical Waveform (PTW) over SES's O3b Medium Earth Orbit (MEO) satellite communications constellation late last year.*

*PTW, a United States Government-owned, frequency-agnostic waveform capable of providing flexible, adaptive, anti-jam communications, is used by the Protected Anti-jam Tactical SATCOM (PATS) family of programs.*

*This recent test, complemented by previous testing of PTW over DoD and commercial Geosynchronous Earth Orbit (GEO) satellites, demonstrates the viability of increasing overall PATS resilience by using both commercial and government satellite constellations across multiple orbits.*

*The test used Digital Engineering PTW modem prototypes developed by MIT Lincoln Laboratory as well as terminal antenna equipment and satellite resources provided by the SES Company. The test team successfully established the PTW link on each O3b satellite during its pass. Potential follow-on testing, in coordination with SES and the Luxembourg Ministry of Defence notionally planned for this summer, features modem upgrades to support a more seamless, reliable PTW service over O3b and guide future implementation by industry partners.*

*Planning has also begun to expand PTW testing to include O3b mPOWER, SES's next-generation MEO constellation, which will offer significant enhancements beyond the existing system including an innovative planning system that allows dynamic allocation of bandwidth and power in near-real-time.*

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

*Contact Space & Missile Systems Center at* ***SMC@Spaceforce.mil***

# *SMC 2nd Lt. Space Acquisition Immersion Pilot (SAIP) Program Acclimates New Officers to USSF, Acquisitions*

***Despite restrictions from the COVID-19 pandemic, newly commissioned USSF Second Lieutenants continue to get a comprehensive introduction to the world of space acquisitions and the USSF through a special immersion course offered at the Space and Missile Systems Center at the Los Angeles Air Force Base.***

At the direction of the Chief of Space Operations, Gen**. John W. "Jay" Raymond, and under the leadership of Lt. Col. Laila Barasha**, SMC ran the first USSF 2Lt. Immersion Course in July of 2020 for more than 40, newly commissioned officers. The four-week course — conducted entirely virtually — was designed by SMC's Commander's Action Group to help prepare new accessions for their first USSF assignments.

The immersion program focused on a wide range of space-related topics, presented via briefings from subject matter experts and senior leaders, assigned readings from selected books, and video presentations. Following the four-week course, the officers began an 8 to 16 week-long industry immersion opportunity and conclude with their entry into formal *Undergraduate Space Training* (UST.)

***Major Gregoy Hartman***

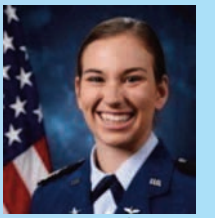
The second course in November was three weeks long and included both new officers and civilians. The summer course included more participants, due to a large number of officers receiving commissions through the *U.S. Air Force Academy* and ROTC programs, said Maj. **Gregory Hartman**, who became the Space Acquisition Immersion Pilot Program (SAIP) manager after Barasha.

"*This course is their first introduction to space and is meant to kick-start their Space Force experience," Hartman said. "It's a challenge to conduct the program virtually; however, it's my job to make them feel welcome and connected no matter the method of interaction. We're showing them some of the cool and exciting things that the USSF is doing and prevalent in their everyday lives.*

*Ms. Joy White, executive director of SMC, said, "We're building a new military service, a new warfighting culture from the ground up, and this immersion program — in addition to the other trainings these officers receive — is an important part of that process.*"

In addition to senior leader speakers and virtual space acquisition immersion, the second class of new officers got to experience virtual briefings of space industry partners including *Amazon Web Services*, *Boeing*, *Northrop Grumman*, *Raytheon* and *Virgin Orbit*'s *VOX Space*, in-person, socially distanced tours with *United Launch Alliance* (ULA), *Space Exploration Technologies Corp.* (SpaceX) and VOX were also part of the opportunities. Hartman said.

The new officers also were mentored by SMC Colonels and learned from SMC subject matter experts from across the acquisition enterprise on the technology being acquired and relevance to the USSF mission. After the course concluded, some went on to be embedded with space industry partners and others started working in various positions at SMC.



***2Lt Kristy Eslinger***

2Lt ***Kristy Eslinger***, 22, came to *Vandenberg Air Force Base* after graduating from the U.S. Air Force Academy. With a six-month delay until her UST start date, she was able to participate in the immersion program. She said the best part of the program was experiencing first-hand how the space industry works with USSF.

"*Just having that exposure to what they do is so important,*" Eslinger said. "*Working with contractors is half of the business, and until you work with them, you have no idea how they work with the USSF. I interviewed and received a role on the Dragon Mission Management Team, where I worked on NASA's crewed mission program. I worked with NASA and engineers at SpaceX to ensure that all parts of the Falcon 9 rocket and Dragon capsule are certified and ready for launch during the Crew-1 and Crew-2 missions.*"

A Second Lieutenant is the entry-level commissioned officer rank in the USSF. While they wait to take their UST classes, these officers may be assigned to a variety of duties on base. The SAIP program is meant to prepare this incoming cadre of USSF professionals as future space leaders and acquirers by exposing them to the world of space acquisitions, Hartman said.

Because the USSF is designed to be a flatter, leaner and agile military branch, these new officers must be capable of understanding the threats and requirements of space while translating them into meaningful solutions, Hartman added.

The new officers gain exposure to space acquisitions from both a government and an industry perspective, develop a blended acquirer/operator mindset and learn to understand the senior space leadership perspective for developing, managing and fielding space warfighter capabilities, Hartman said.

A third session of the SAIP Program is planned for summer 2021, Hartman said. Eventually, the program will transition to the ***USSF Space Training and Readiness Command*** (**STARCOM**.)