

SATCOM for Net-Centric Warfare

Milsat Magazine

February 2020 issue

THIS ISSUE...

SMC: YEAR OF SUCCESS

KRATOS: COUNTERING THREATS FROM SPACE

MAXAR: LEVERAGING COMMERCIAL INNOVATION

WTA: HACKING THE HACKER

DISPATCHES

**UNITED STATES SPACE COMMAND
KRATOS DEFENSE
L3HARRIS
GET SAT
2ND SOPS
ORBIT COMMUNICATIONS
COMTECH EF DATA
MAXAR TECHNOLOGIES
BOOZ ALLEN HAMILTON
RAYTHEON
SCHRIEVER AFB**



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FEATURES

Dispatches

United States Space Command	4
Kratos Defense & Security Solutions	6
L3Harris.....	7 + 9
Get SAT	8
Space & Missile Systems Center.....	10
2nd SOPS	11
Orbit Communications.....	12
Comtech EF Data.....	12
Maxar Technologies	14
Booz Allen Hamilton	16
Raytheon	16
Schriever AFB (Team Schriever)	18
Momentus Space	19

Features

A Year of Success for the USAF's SMC	20
by Dr. Paul LaTour, Lt. Col., USAF	
Offsetting Threats and Challenges from Space.....	24
by Matt Langenbahn, Kratos Defense	
How the USG Leverages Commercial Innovation.....	28
by Tony Frazier, Maxar Technologies	
How Hackers Target Your Satellite Company	32
by Robert Bell, World Teleport Association	
Smallsat Launches Continue to Increase.....	34
By Andrew de Mara	

ADVERTISER INDEX

Advantech Wireless Networks	5
AvL Technologies.....	17
CPI SatCom.....	9
Gilat Satellite Networks.....	3
iDirect Government	7
National Association of Broadcasters (NAB)	19
Satnews Publishers Digital Editions.....	27
SpaceBridge	13
Space Foundation — Space Symposium	31
W.B. Walton Enterprises, Inc.	15

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DISPATCHES *Key allied space partnerships expanded by USSPACECOM*



National security in the space domain continues to expand its operational coordination and capabilities between the U.S. Space Command and allied nations.

A multi-national space force, a strategic defense partnership between several nations including the United States, Canada, Australia, and the United Kingdom, operate together at the Combined Space Operations Center.

Additional nations collaborating on space operations with the CSpOC include Germany, France and New Zealand.

USSPACECOM maintains strong international alliances and partnerships to conduct operations in and through the space domain. The CspOC reports to the Combined Force Space Component Command.

CspOC is a subordinate command to the newly re-established USSPACECOM and executes the operational command and control of space forces to achieve theater and global objectives.

It operates 24-hours a day, seven days a week, continuously coordinating, planning, integrating, synchronizing and executing space operations; providing tailored space effects on demand to support combatant commanders; and accomplishing national security objectives.

Recently, New Zealand space operations representatives attended CFSCC's weekly Products Brief (CPB), the operational forum where Coalition space strategy is synchronized, and CFSCC's Master Space Plan and Combined Space Tasking Order are communicated and approved.

This was the first time the CPB occurred at the truly "Five Eyes" level of integration.

Five Eyes is a military term used to describe intelligence sharing and collaboration between Australia, Canada, New Zealand, the UK, and the United States.

The second historic milestone occurred when Deputy Director of CSpOC, Group Captain Darren Whiteley – a Royal Air Force officer from the United Kingdom – signed the weekly Combined Space Tasking Order.

This was the first time a coalition partner signed the order under Operation Olympic Defender (OOD) tasking the CFSCC subordinate units.

OOD, which is a multi-national effort intended to strengthen deterrence, optimize space operations, improve mission assurance, enhance resilience and optimize space assets by engaging with U.S. government partners and allies, involves sharing information, data and resources.

It is a method for partners to leverage and synchronize existing capabilities.

CSpOC stood up in July of 2018 to create a unity of effort in space operations across the Department of Defense, U.S. interagency, allies, commercial and civil space partners.

Adding allies to OOD, builds upon the success of the CSpOC and enhances the overall command's capability to collectively defend vital assets in space.

Retaining U.S. and allied space superiority requires a combined approach. USSPACECOM's existing partnerships with allied and commercial entities are foundational to its combat effectiveness.

Through these partnerships with the CSpOC, USSPACECOM will continue to broaden and strengthen its mission throughout its assigned Area of Responsibility, but most especially within USSPACECOM's subordinate commands.

Captain Whiteley said that allied partnerships are critical to defending the nation's assets at home and in the space domain. The threat is expanding and international collaboration is essential to strengthen deterrence against hostile actors. Through these partnerships, depth can be expanded and the effects on evolving threats can be multiplied.



Squadron Leader, Jamie Maika, of the Royal Australian Air Force operating at the CSpOC at Vandenberg Air Force Base, California. This multi-national space force includes a strategic defense partnership between the United States, Canada, Australia, and the United Kingdom. Additional nations collaborating on space operations with the CSpOC include Germany, France and New Zealand. U.S. Space Force photo by Staff Sgt. J.T. Armstrong.

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DISPATCHES *Kratos to engage with U.S. Army for advanced comms*



The Global Tactical Advanced Communication Systems (GTACS) II contract is being designed to help the Army deliver a single, cohesive and interoperable tactical network. Photo is courtesy of the U.S. Army.

Kratos Defense & Security Solutions, Inc. (Nasdaq: KTOS) will participate in a multiple award, (IDIQ contract for U.S. Army advanced communication systems.

The new Global Tactical Advanced Communication Systems II (GTACS II) contract vehicle will allow multiple companies to compete for as much as \$5.1 billion over a ten year period to support the U.S. Army Program Executive Office Command, Control and Communications-Tactical (PEO

C3T) and Project Manager Tactical Network (PM Tactical Network). The GTACS II contract will provide an acquisition vehicle for Kratos' broad array of communications technology, including satellite solutions for signal processing to advanced cybersecurity products,

command and control, virtual communications, SATCOM and tactical, protected communications.

Kratos has assembled an elite sub-contractor team, including large and small companies to address GTACS II mission requirements.

Members of the sub-contracting team were chosen based on specific strengths that complement Kratos capabilities to provide innovative, flexible, open-architecture tactical communications solutions.

The team includes TMC Design Corporation, Navigator DevelopmentGroup Inc., Modern Technology Solutions, Teledyne Brown Engineering Inc. and Ball Aerospace and Technology Corporation.

The U.S. Army seeks to rapidly develop technology to support networked battle command solutions

GTACS II will support the funding and is expected to run through January 5, 2030 with a five-year base period and a five-year option period.

This contract vehicle may be used by other agencies and organizations in support of their missions.

Frank Backes, SVP, Kratos Space, said the company has a unique combination of terrestrial airborne, and space communication capabilities.



The Global Tactical Advanced Communication Systems(GTACS) II is a 10 year, \$6 billion multiple award, indefinite delivery/indefinite quantity (IDIQ) contract. Photo is courtesy of the U.S. Army, Amy Walker, PEO C3T Public Affairs.



DISPATCHES *L3Harris' 550 VSAT fleet to be upgraded for USSOCOM*



Chris Aebli, President, Global Communication Systems, L3Harris, said this agreement extends the service life of the company's customer's existing terminals and highlights the priority USSOCOM places on ensuring their deployed users are equipped with the latest in VSAT technology.



U.S. Special Operations Command (USSOCOM) has awarded L3Harris Technologies a five-year with options, \$100 million contract to upgrade and extend the service life of its existing fleet of approximately 550 L3Harris Very Small Aperture Terminals (VSAT)—the contract was received in December of 2019.

L3Harris will provide software, hardware and warranty upgrades that will extend the life of existing Hawkeye III Lite VSAT terminals and deliver significant cost savings.

The VSATs originally were secured through the Satellite Deployable Node—Family of Terminals or Satellite Deployable Node—medium contracts for the program.

The Hawkeye III Lite auto-acquire VSAT is a light-weight, tri-band flyaway system that can be deployed in a matter of minutes by Special Operations Forces.

They provide vital communications reach back capability to SOCOM headquarters and other government entities.

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DISPATCHES *Get SAT Dual SAT terminal achieves successful demo and deployment*



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solution, are the lightest and most compact all-in-one 'on-the-move' solutions serving the Global Xpress network.

The company is proud to be part of a solution that delivers government users access to reliable, redundant, assured wideband capability on terminals that have been proven to operate in the world's harshest environmental conditions.

In U.S. government operation since July 2014, Global Xpress has established itself as a gold standard for reliable communications across land, air and sea for assured mobile connectivity

and interoperability with government satellite systems.

Get SAT has completed a successful demonstration and deployment of the firm's Dual SAT terminal solution for U.S. government agencies.

This innovative solution employs Get SAT's lightweight micronized Milli SAT LM terminals using Inmarsat's worldwide Global Xpress Ka-band network. The solution significantly reduces installation costs and efficiently manages COTM (Communications-On-The-Move).

Dual SAT provides an antenna diversity solution for mobility platforms where obstructions such as ship's superstructures would cause blockage for a single antenna system.

A fully automated software switching system that requires no external components, Dual SAT's two terminals operate redundantly as a single system to ensure complete high-speed connectivity.

When the primary antenna is blocked, the alternate antenna

is switched seamlessly to provide services.

This solution is ideal for the roll on, roll off requirements of Special Operations and Executive Staff onboard Afloat Forward Staging Bases (AFSB).

The micronized, ruggedized and portable Milli SAT terminal replaces large, bulky alternatives that consist of multi-modem and control units. This solution leverages Get SAT's highly efficient flat panel antenna technologies to enable fully autonomous operation for high bandwidth data rates.

Following certification, the roll on, roll off solution is truly a one-person operation.

Get SAT's micronized communications terminals are based on the company's patented fully-interlaced InterFLAT panel technology that transmits and receives signals on the same panel.

Meeting the demanding requirements of full-time usage in

harsh environments, these rugged satellite on the move (SOTM) terminals offer significant savings in size, weight, and power usage.

According to Get SAT CEO *Kfir Benjamin*, Get SAT's Dual SAT solution proves that there is no obstacle that can hold back any SATCOM-On-The-Move (SOTM) application.

Benjamin noted that the company's miniaturized package enables true, unblocked, constant, crisp communications.

Get SAT's solution drastically reduces installation time and costs while easily integrating with pre-existing on-board systems.

Steve Gizinski, Chief Technology Officer, Inmarsat Government, added that Global Xpress has established itself as the de-facto solution for reliable, interoperable high-throughput communications across the government sector for mobile connectivity nearly anywhere.

Gizinski added that the Get SAT terminals, including the Dual SAT



DISPATCHES *L3Harris PDR success*

L3Harris Technologies (NYSE:LHX) has reached a major milestone in the U.S. Air Force's Navigation Technology Satellite-3 (NTS-3) project and has passed the preliminary design review that defines the spacecraft's path to delivery and allows the program to move to the next phase of development.

NTS-3 is an experimental program examining ways to improve the resiliency of the military's positioning, navigation and timing capabilities. It will also develop key technologies relevant to the Global Positioning System (GPS) constellation, with the goal of future transition to the GPS III program.

In collaboration with the Air Force Research Laboratory (AFRL), Space and Missile Systems Center (SMC) and the United States Space Force (USAF), L3Harris is combining experimental antennas, flexible and secure signals, increased automation, and use of commercial command and control assets.

The Space Enterprise Consortium selected L3Harris for the \$84-million contract in 2018 as the prime system integrator to design, develop, integrate and test NTS-3, including ground mission applications.

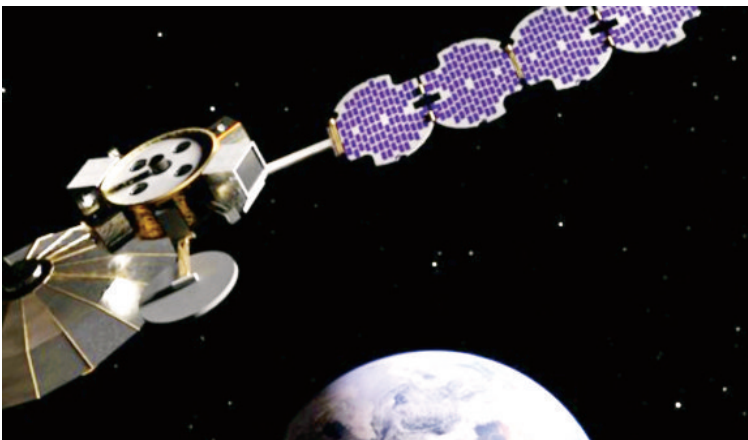
L3Harris has more than 40 years of experience transmitting GPS navigation signals.

The company's technology has been onboard every GPS satellite ever launched.

Arlen Biersgreen, Air Force NTS-3 Program Manager, said the NTS-3 vanguard is an experimental, end-to-end demonstration of agile, resilient space-based positioning, navigation, and timing. It has the potential for game-changing advancements to the way the U.S. Air Force provides these critical capabilities to warfighters across the Department of Defense.

The commitment demonstrated by United States Space Force to partner with AFRL and support technology transition was a key element in NTS-3 being designated as an Air Force vanguard in September 2019.



Ed Zoiss, President, Space and Airborne Systems, L3Harris, noted that the company has moved from contract award to finishing an early design review in under one year, which is an amazing accomplishment for a satellite development program that normally takes twice that amount of time. L3 Harris has proven the company can move quickly to support the U.S. Air Force's go-fast mission requirements.






Artistic rendition of the NTS-3 in geostationary orbit. NTS-3 will be based on Northrop Grumman Innovation System's ESPASat bus, building on Eagle's flight heritage. Image is courtesy of 2d Lt. Jacob Lutz, AFRL/RV

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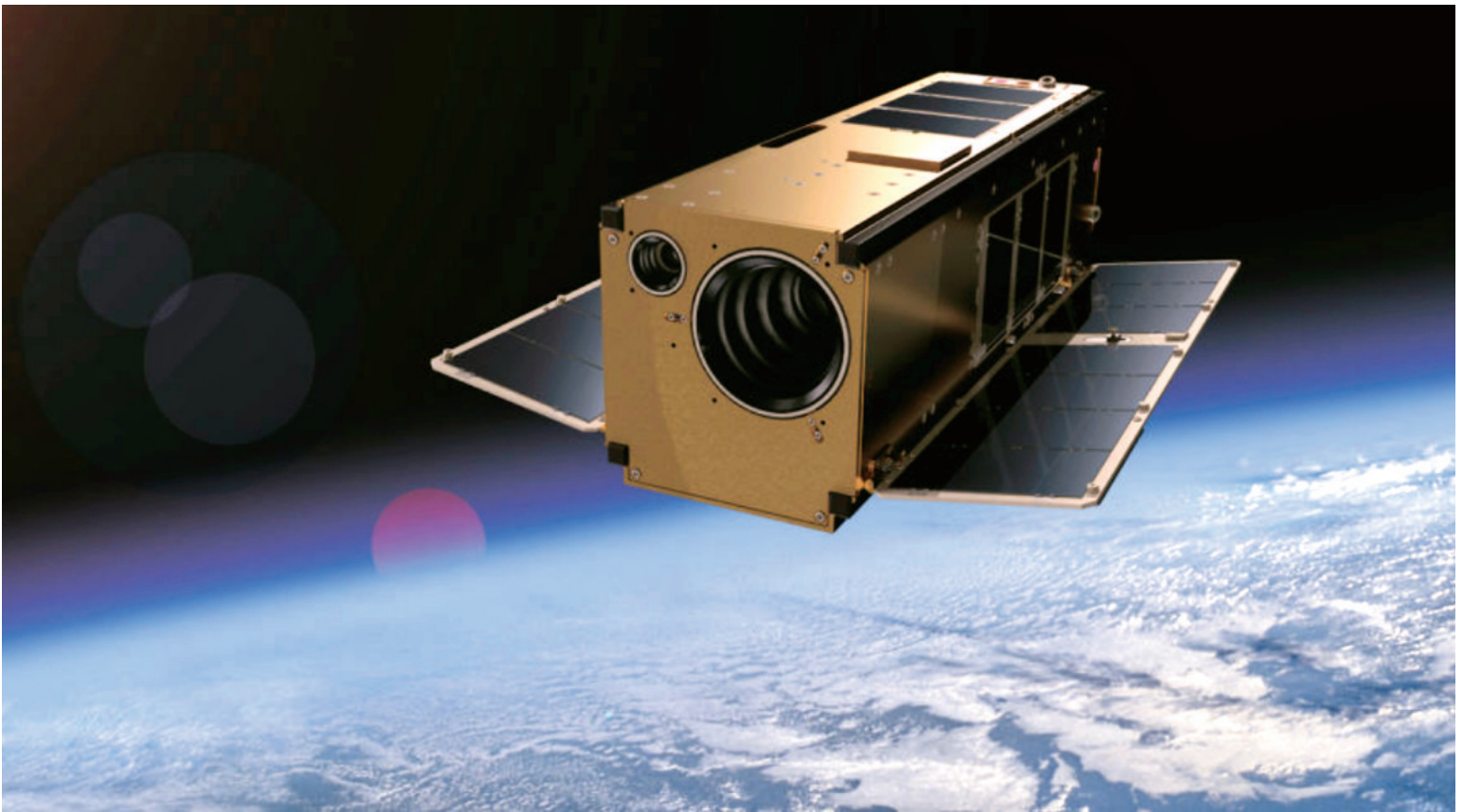
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DISPATCHES *SMC deploys Aerospace's Rogue smallsat from ISS*



Mission accomplished on behalf of the U.S. Space Force's Space and Missile Systems Center and its mission partners as they successfully deployed Aerospace's Rogue Alpha and Rogue Beta CubeSats from the

Northrop Grumman Cygnus capsule at 1 p.m. and 4:10 p.m. respectively, on January 31, 2020, marking the beginning of the program's mission experiment plan.

The plan involves the two satellites using their short-wave infrared sensors to create a baseline for processing cloud backgrounds and inform future Low Earth Orbit satellites.

The U.S. Air Force will also use this program's unclassified data to investigate potential uses of the capability.

Colonel *Dennis Bythewood*, Program Executive Officer for Space Development, said that the Space and Missile Systems Center is proud of this team's accomplishments and the speed at which this program developed.

The cubedats were designed, built, and tested by The Aerospace Corporation, a national nonprofit corporation that operates as a federally funded research and development center dedicated to advancing the nation's missions in space.

Jeff Emdee, general manager of the Space Development Division at The Aerospace Corporation said each three-unit cubesat is about the size of a shoe box and contains both visible and infrared sensing, as well as a laser communications downlink, that will allow them to explore operations in low Earth orbit to benefit future system concepts.



DISPATCHES *Satellite SVN-74 healthy and active*

Setting SVN-74 healthy and active means the satellite will be available for use by military and civilian GPS users around the world as part of the constellation currently maintained by the squadron.

This makes the satellite the first iteration in the GPS III family to join the active constellation following its launch December 23, 2018.

Captain Ryan Thompson, 2nd SOPS assistant director of sustainment, said various training modules and upgrades were instrumental in making the satellite operational.

"In order to operate GPS III, we first had to install Architecture Evolution Plan 8.0," he said. "This allowed our squadron to control the new satellite without a next generation operational control system. The 2nd SOPS training and evaluations

flight was able to expeditiously give our operators top-up training that allowed them to become comfortable with the new satellite."

The GPS III vehicle family provides new capabilities vital to ensuring the fidelity of the constellation and signal in the contested, degraded and operationally limited environments.

According to the Lockheed-Martin press release, GPS III satellites have three times better accuracy and as much as eight times improved anti-jamming capabilities than their predecessors, and a design life extending 25 percent longer than the newest GPS satellites on-orbit today.

GPS III's new civil signal will also make it the first GPS satellite to broadcast a compatible signal with other international global navigation satellite systems, such

as Galileo, improving connectivity for civilian users.

2nd SOPS is already preparing for the second GPS Block III vehicle in orbit, awaiting its day to become healthy and active.

"There are vehicles currently projected to be put into the constellation and then, following this, there will be the Block III-F follow-on vehicles," said Captain Kaoru Elliot, 2nd SOPS assistant Director of Operations. "With those vehicles in place, all of those capabilities will come into the next decade."

A third vehicle for GPS III is scheduled for launch later this year.

"It [GPS Block III vehicle two] is being managed currently by Lockheed-Martin," Elliott said.

"They are the ones actually getting the satellites up there and, once it is up in orbit, they make certain everything is good before handing it over to us."

Story by
Staff Sgt. Matthew Coleman-Foster,
50th Space Wing



Second Lt. Kelley McCaa, 2nd Space Operations Squadron satellite vehicle operator, and Airman 1st Class John Garcia, 2nd SOPS satellite systems operator, set satellite vehicle number-74 as healthy and active to users, January 13, 2020, Schriever Air Force Base, Colorado. USAF photo by Staff Sgt. Matthew Coleman-Foster.

DISPATCHES *Multi-purpose, airborne terminal debuts from Orbit Communications*



Orbit Communication Systems Ltd. (TASE: ORBI) has developed a new, Ka-band, multi-purpose, airborne terminal.

The compact Multi-Purpose Terminal (MPT) 30WGX, featuring a 30 cm. (12-inch) antenna, will be able to deliver high-throughput wideband

communications via the Inmarsat Global Xpress worldwide network for a broad range of airborne platforms. Built to fulfill "anytime, anywhere" connectivity requirements, the lightweight, small-footprint terminal combines high performance with Orbit's reliability to address new opportunities in military aircraft and Unmanned Aerial Vehicles (UAVs).

Following certification, volume production of the 30WGX terminal is planned for Orbit's U.S.-based facilities.

Orbit's MPT 30WGX terminal complements the company's 46 cm. (18-inch) MPT 46WGX terminal, which will shortly enter full-scale production.

Once certified, it will be similarly optimized for use with Inmarsat's Global Xpress system and will be interoperable with military Ka-band services, affording unique capabilities and flexibility.

Stav Gizunterman, VP of Sales and Marketing at Orbit, said the company is very pleased to be partnering with Inmarsat to develop innovative new airborne capabilities. This new terminal, which complements the firm's MPT 46WGX, will help open up service offerings to an expanded range of aircraft.

Steve Gizinski, CTO, Inmarsat Government, added that the company is pleased to be working with Orbit to introduce innovative and forward-looking satellite solutions that support today's complex missions. Orbit's innovation and expansion of their MPT terminal line ensure that airborne users will have access to reliable wideband mobility for increased agility and worldwide portability.



DISPATCHES *U.S. DoD contractor orders Comtech EF Data satellite modems*



During Q2 of fiscal 2020, Comtech Telecommunications Corp. (NASDAQ: CMTL) announced that their Tempe, Arizona-based subsidiary, Comtech EF Data Corp. (part of Comtech's Commercial Solutions segment), received a \$2.9 million order for satellite modems from a major U.S. Department of Defense ("DoD") contractor.

The order specified the DMD2050E MIL-STD-188-165A/STANAG 4486 Edition 3 Compliant Universal Satellite Modem, which will be used to support the U.S. Army Project Manager (PM) Tactical Network.

The DMD2050E Satellite Modem is designed to comply with the widest possible range of U.S. Government and commercial standards and is compatible with the largest number of satellite modems in the industry.

The modem is fully compliant with MIL-STD-188-165A (all terminal types), fully complies with STANAG 4486 Edition 3, as well as the IESS-308, IESS-309, IESS-310 and IESS-315 commercial standards.



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Artistic rendition of World View Legion satellites on-orbit. Image is courtesy of Maxar.

Maxar Technologies (NYSE:MAXR) (TSX:MAXR) has revealed that the Defence Geographic Agency (DGeo) of The Netherlands Ministry of Defence signed a multi-million dollar, multi-year subscription to SecureWatch, the company's cloud-based geospatial intelligence (GEOINT) platform.

DGeo will leverage SecureWatch to enrich its geospatial foundation data holdings and derivative product portfolio that aid critical decision-making within The Netherlands Ministry of Defence (MoD).

Through SecureWatch, DGeo will have access to Maxar's 110-petabyte, high-resolution satellite imagery library, daily imagery collections, Vivid and Metro imagery mosaics, FirstLook service and synthetic aperture radar data from MDA's RADARSAT-2 satellite.

When the WorldView Legion constellation imagery is available after the first satellites launch in early 2021, DGeo will also access it via SecureWatch.

The abundance and variety of geospatial data available in SecureWatch will inform and support

the MoD's information-driven activities such as mission planning, disaster response and border security, among other purposes.

Tony Frazier, Maxar's Executive Vice President of Global Field Operations, said Maxar is delighted to bring DGeo and the Dutch MoD ecosystem into SecureWatch's ever-growing community of subscribers.

As one of the largest SecureWatch awards to date, this contract is the

culmination of a careful consultation process with DGeo, ensuring that Maxar's solution has the greatest impact on their work. SecureWatch, with its mission-centric design and depth of content, fits DGeo's requirements perfectly.

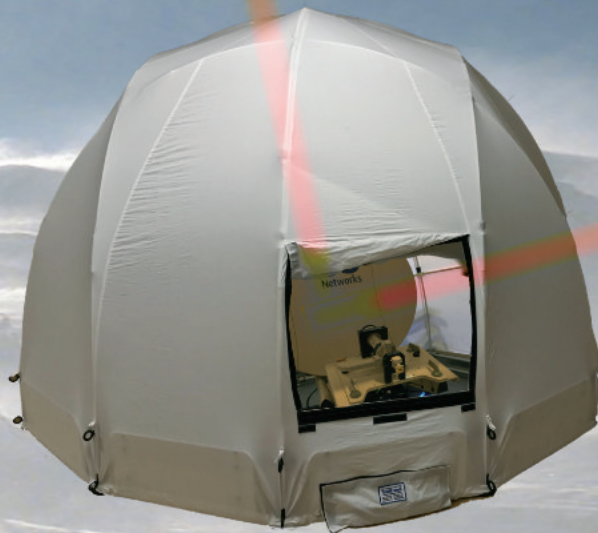
Lieutenant Colonel Rijk van Hunnik, DGeo's Commanding Officer, noted that SecureWatch will facilitate DGeo's ability to bring geospatial insights to a broader community within the Dutch MoD.

The Lieutenant Colonel added that secure, on-demand and easy access to very high-resolution imagery promises to be a game-changer for the organization's decision-making process and operations, allowing for the allocation of resources in the most effective way possible.

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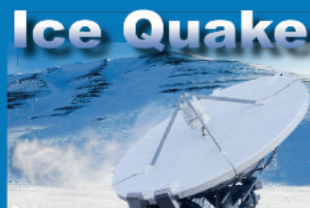
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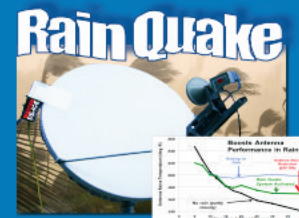
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DISPATCHES *Booz Allen Hamilton to modernize GPS*

The U.S. Navy's Naval Information Warfare Center (NIWC Pacific), in partnership with the U.S. Air Force Space and Missile Systems Center (SMC), has awarded Booz Allen Hamilton (NYSE: BAH) a \$178 million contract to provide technical engineering services toward the modernization of advanced Global Positioning System (GPS) systems.

The NIWC Pacific Positioning, Navigation, and Timing (PNT) Division is the Navy's principal research and development center for navigation sensors and systems. SMC is the center of technical

excellence for developing, acquiring, fielding, and sustaining resilient and affordable military space systems.

By executing this contract, Booz Allen Hamilton will continue to serve as a key mission partner for NIWC Pacific and SMC on the important endeavor of modernizing PNT systems for U.S. and Allied warfighters.

In order to execute this highly complex scope of work, Booz Allen will provide a range of essential services, including system definition, requirements synchronization, capability improvement,

cybersecurity engineering, platform integration and testing, and acquisition program management.

Specifically, Booz Allen's work will aid in the development and modernization of GPS systems through major programs such as Military GPS User Equipment, GPS III, and Next Generation Operational Control System.

Company VP, *Brian Zimmermann*, said the company's robust track record of work in both systems engineering and cybersecurity continues to inspire trust from the firm's clients. Booz Allen Hamilton's

deep bench of leaders and technical experts reassures clients that no project is too big or too complex. It is the firm's privilege to help the U.S. Navy and U.S. Air Force modernize GPS systems that are so vital to the security of the nation.

Booz | Allen | Hamilton*

DISPATCHES *Raytheon to modernize USAFs missile warning system*

Raytheon Company (NYSE: RTN) will help the U.S. Air Force (USAF) modernize its missile warning architecture with a new system that will collect and fuse data from an array of sensors to provide a comprehensive picture of launch activity under a 5-year, \$197 million contract.

To help with this mission, Raytheon Intelligence, Information and Services has developed a completely open framework — which the USAF calls the Future Operational Resilient Ground Evolution (FORGE) Mission Data Processing Application Framework (MDPAF) — that will be capable of processing Overhead Persistent

Infrared (OPIR) satellite data from both the U.S. Air Force's evolving Space Based Infrared System (SBIRS) satellite constellation and the future Next Gen OPIR constellation, as well as be capable of processing data from other civil and environmental sensors.

This is a significant departure from previous satellite ground control programs. Typically, companies would develop a system that collects and exploits data from specific types of satellites or sensors.

FORGE changes this model as it's able to collect data from nearly any type of satellite or sensor, and then helps operators make sense of that data quickly.

One of the key benefits of incorporating new applications is that the system can be used beyond its intended mission.

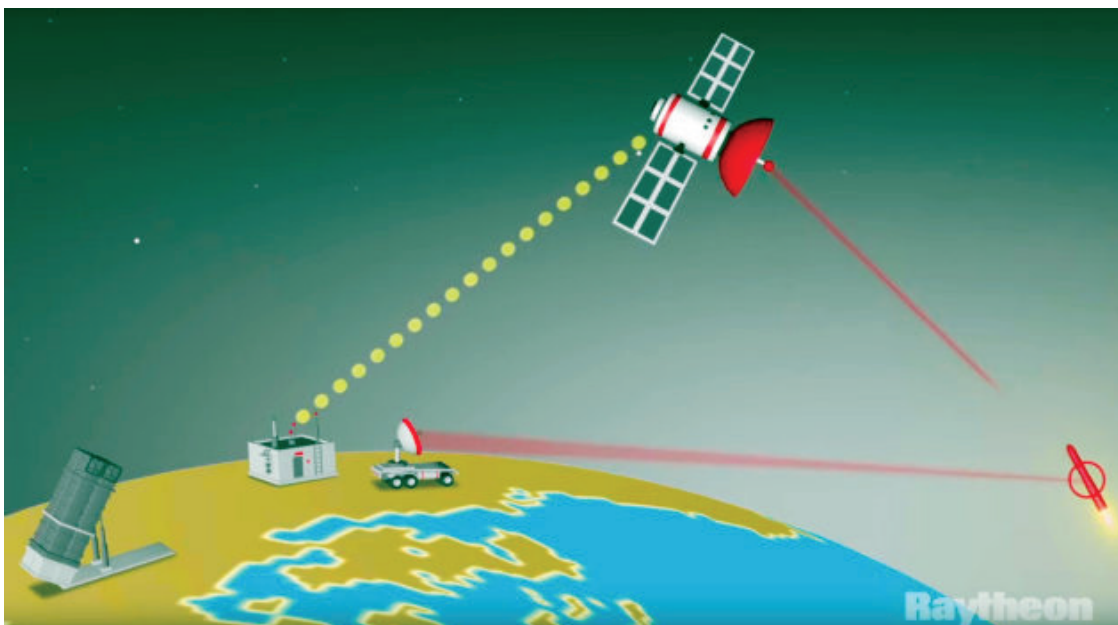
For example, an application could be built that would allow civil agencies to use the same satellite data to help detect forest fires, volcanic activity, agricultural changes, even surges in electric power consumption.

Further departing from the traditional ground control development model, Raytheon built the prototype system in less than a year and it's capable of processing real data today.

The company leveraged development work on several past programs, especially its Advanced

Weather Integrated Processing System, to design the framework. Raytheon also incorporated its deep experience developing applications using DevSecOps and Agile software development processes to dramatically speed development.

Raytheon will work with the USAF over the upcoming years to further evolve and prove the framework's capabilities.



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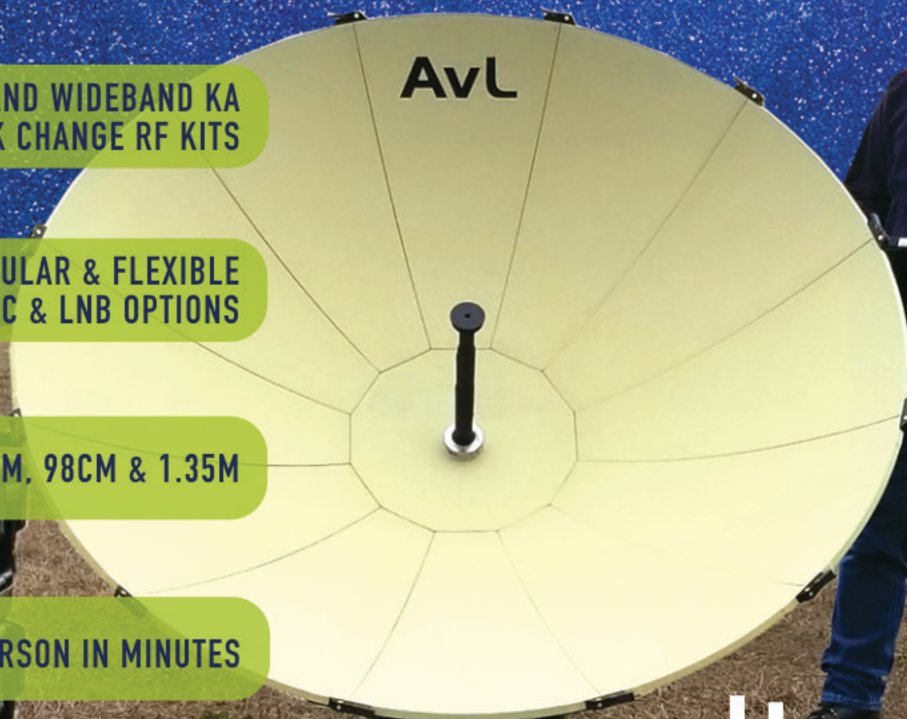
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DISPATCHES *A successful 2019 ensures space superiority*



All of the work put in by Team Schriever Airmen in 2019 paved the way for new advancements in the continuously evolving space and cyberspace warfighting domains.

To start off the year, three members of the 2nd Space Operations Squadron GPS Warfighter Collaboration Cell collaborated with USA Space and Missile Defense Command's Army Space Training Integration to build training smart books in January for Army Brigade Combat Teams prior to deployment.

The members met with an FA-40 from USASMDC to build a smart book with standardized GWCC products to include spike charts, which will be provided to the Army's three Combat Training Centers to be used in the preparation for deployment to combat zones.

"By providing these products for use in training the BCTs, we hope to make more warfighters aware of the support we can provide and the avenues to request our support," said 1st Lt. *Savanna Whitaker*, 2nd SOPS GWCC deputy director, one of the lead mission analysts for the GWCC.

In February, The 50th Space Wing sent 11 members from 4th SOPS and 50th Operations Support Squadron on a temporary duty assignment to the Wideband Satellite Operation Center at Fort Detrick, Maryland.

The Airmen spent two days at the WSOC talking to various operators from Alpha Co., 53rd Signals Battalion. 50th OSS's goal in the visit was to improve their processes in supporting Alpha Co. through intelligence product distribution and threat overviews.

"The impact was great for Alpha Co. to see and hear from 50th OSS Intel, give them a better understanding of the intelligence available to support and assist with their daily operations through intelligence product distribution and increase their knowledge on current and future threats to space operations," said Senior Airmen *Devin Vega*, 50th OSS intelligence analyst.

Milstar, formerly known as the Military Strategic and Tactical Relay, launched Feb. 7, 1994, reached 25 years of service in Feb. 2019. Milstar is responsible for providing the President, Secretary of Defense and the U.S. armed forces with reliable satellite communications, ensuring minimal interception or detection.

"From a 4th Space Operations Squadron perspective, we are amazed at the longevity of this satellite," said John Rogers, military satellite communications programs site manager. *"Milstar had a design life of ten years, the satellite has lasted two and a half times its design life - a truly impressive accomplishment."*

Also in February, Airmen from the 3rd Space Experimentation Squadron learned the newest space maneuvering techniques in the Advanced Rendezvous Proximity Operations course in Colorado Springs, Colorado. The course changes and expands the approach to achieving space situational awareness among satellites and builds on the knowledge 3rd SES Airmen learn during initial technical training.

In May, the 4th SOPS accepted control of a new satellite in their constellation, Advanced Extremely High Frequency-4 from the Space and Missile Systems Center and 14th Air Force in a satellite control authority ceremony here. During the ceremony, the SMC approved AEHF- 4 as being ready for operations, handing control to the 14th AF, who delegated control to the 50th Space Wing, then to the 50th Operations Group and finally to the 4th SOPS.

"The addition of this satellite to the protected communications constellation further promotes Schriever and America as being the masters of space," 1st Lt. *Scott Podlogar*, 4th SOPS satellite engineer, said.

During the summer, Gen. Jay Raymond, United States Space Command commander, hosted an all-call as part of the command's space warfighting road show July 29 at the base fitness center. Hundreds of 50th Space Wing personnel and mission partners, such as the

National Space Defense Center, participated in the discussion that highlighted the growing importance of the base's missions.

"Space is critical to everyday life," Raymond said. *"It's vital to our national security, and our adversaries know this. You are multi-domain leaders of the future. We need to compete, deter and win."*

On the same day as the all-call, Lockheed Martin presented the 2nd Space Operations Squadron with a GPS Block III model satellite to celebrate the successful on-orbit testing of the new GPS III satellite.

Capt. *Kaoru Elliot*, 2nd SOPS assistant director of operations, said, *"With the introduction of the GPS III, the advanced capabilities onboard the satellite will ensure we continue to provide the best for our civilian users and bring new capabilities to warfighters to operate through the contested environment. The 2nd SOPS and GPS are the global gold standard for all Global Navigation Systems."*

President *Donald J. Trump*, Vice President *Mike R. Pence*, Secretary of Defense *Dr. Mark T. Esper* and USAF Gen. *John W. Raymond* established the United States Space Command during a ceremony held August 30 at the White House.

At the direction of the President of the United States, the Department of Defense established U.S. Space Command as the 11th unified combatant command, with Raymond as its congressionally confirmed commander. Establishing USSPACECOM is a critical step that underscores the importance of the space domain and its strategic contributions to U.S. national security.

"The scope, scale and complexity of today's threat is real and it is concerning," Raymond said. *"The establishment of a combatant command solely focused on the space domain demonstrates the United States' commitment to protecting and defending its space assets against that threat."*

At the beginning of autumn, the 4th SOPS officially gained command of the Enhanced Polar System satellite. EPS adds two satellites to 4th SOPS, increasing the squadron's arsenal to 25 satellites.

"This is an amazing accomplishment and shows how our squadron has been able to adapt and overcome the many obstacles presented by space," said Lt. Col. *Timothy Ryan*, 4th Space Operations Squadron commander. *"Our operators work tirelessly around the clock to ensure the United States maintains space superiority."*

In October, the 2nd SOPS decommissioned Satellite Vehicle Number 38, after 22 years, design life of 7.5, to give way to the next generation of GPS III satellites.

In October, the Cyber Defense Correlation Cell for Space stood up here, and will operate at the enterprise level by detecting and responding to cyber threats against Air Force Space Command mission systems. The CDCC-S is the first of its kind in the Air Force and has more than 50 civilian and military personnel working alongside 30 contractors.

"Our cyber defenses must be better today than they were yesterday and better tomorrow than they are today, and that pattern must continue indefinitely," said Maj. Gen. *Stephen Whiting*, 14th Air Force commander. *"Our space systems will be safer, and in the end, the work you do here today will keep America and our allies safer as well."*

In November, the 50th Operations Support Squadron began its largest class to train 64 space operators. The course is expected to send Airmen to the 2nd SOPS and the 4th SOPS upon their graduation April 15, 2020. This is in response to the new officer undergraduate space training and enlisted space training courses being taught at Vandenberg Air Force Base, California.

"The new course will provide a base-level foundation for space operators," Master Sgt. *Carl White*, 50th Operations Support Squadron operations support flight chief said. *"The course is constantly evolving alongside our mission to ensure we can better meet the needs of the Air Force."*

All of these achievements will continue to pave the way for future advancements in space operations, ensuring the United States stays at the forefront of space and cyberspace warfighting realms.

Story By Airman Amanda Lovelace, 50th Space Wing Public Affairs

DISPATCHES *Momentum awarded SBIR contract by U.S. Air Force*



Momentum has been awarded of a U.S. Air Force Small Business Innovation Research (SBIR) Phase I contract to accelerate innovations for in-space transportation services and satellite upper stage technologies.

The Air Force Research Lab (AFRL) and AFWERX have partnered to streamline the SBIR process in an attempt to speed up the experience, broaden the pool of

potential applicants and decrease bureaucratic overhead.

Beginning in SBIR 18.2, and now in 19.3, the U.S. Air Force (USAF) has begun offering "Special" SBIR topics that are faster, leaner and open to a broader range of innovations.

A graduate of the prestigious Y Combinator program, and based in Santa Clara, California,

Momentum raised \$40M of equity funding, including a \$25.5M Series A in 2019.

Momentum has created new patent-pending and proprietary technologies, including a water plasma propulsion system that eliminates HAZMAT concerns and provides rapid, affordable, and revolutionary launch deployment technologies and in-space shuttle services.

A 16U demonstration mission, "El Camino Real", was launched and tested in 2019. Two demo missions of the Vigoride transfer vehicle will fly in 2020, paving the way for commercial mission beginning in 2021 onward

Mikhail Kokorich, CEO of Momentum, stated that the company is honored to have been selected by the U.S. Air Force for this SBIR 19.3 award. By partnering with the Air Force through the SBIR program.

He added that Momentum can bring unique in-space transportation solutions to the Air Force for faster deployment of new missions and new ways to improve space resiliency and space access. The company's Phase I study will identify Air Force missions where Momentum's space vehicles can be used to transport satellites to unique and/or more precise orbits.



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A YEAR OF SUCCESS FOR THE USAF'S SMC

By Dr. Paul LaTour, Lieutenant Colonel, United States Air Force (USAF)



Air Force delivers global satellite communications (SATCOM) capabilities that are foundational to joint warfighter operations across the range of military operations, and will only become more critical in preparation for the battlespace of the future.

With potential adversaries continually seeking to deny, degrade and destroy U.S. asymmetric advantages in space, the U.S. Air Force (USAF) is evolving SATCOM capabilities for the nation's warfighters and strategic allied partners.

The entire SATCOM enterprise (military, commercial, and international partners) is transitioning an integrated architecture that is more robust, resilient, flexible, and capable of fighting through a contested, degraded, and operationally-limited (CDO) environment.

Disaggregating for Resilience and Flexibility

A major step toward this new architecture is to implement a disaggregation strategy in the military satellite communications (MILSATCOM) space tier to improve resiliency while maintaining backward compatibility.

The Advanced Extremely High Frequency (AEHF) satellite constellation, in concert with its predecessor, the Milstar system, currently provides both protected tactical communications and strategic, nuclear-hardened communications for the President and other decision makers.

The next-generation of space systems disaggregates the AEHF strategic and tactical SATCOM missions into the Evolved Strategic SATCOM (ESS) and Protected Tactical SATCOM (PTS) programs, respectively.

SMC is embracing faster acquisition processes and faster command and control constructs to maintain the advantage in any conflict.

This disaggregation improves resilience by reducing inherent single-point-of-failure vulnerabilities associated with multi-mission satellites while also providing increased architectural flexibility via payload hosting opportunities.

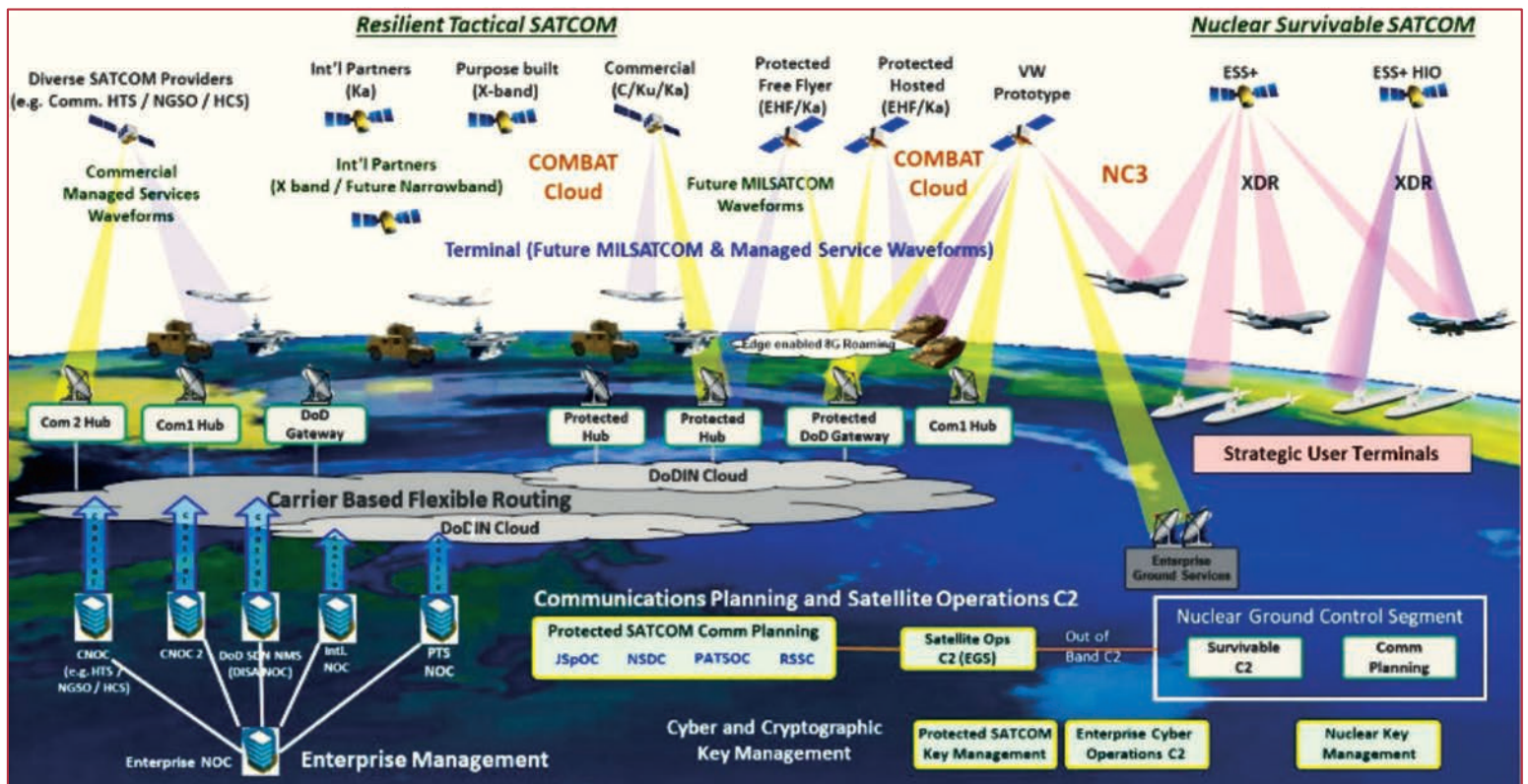
Dedicated "free-flyer" satellite solutions are also subject to fewer technical trade-offs that may marginalize mission-specific capability in order to accommodate a multi-mission satellite design.

Moving Toward an Integrated SATCOM Architecture

U.S. Air Force Space Command (AFSPC) Commander General John W. "Jay" Raymond's vision for SATCOM is that AFSPC provide an operationally effective, affordable, resilient, and secure satellite communications architecture that supports global mission priorities and is adaptable to rapidly changing requirements, technologies, and threats.

This architecture delivers enterprise SATCOM capabilities to the Commander, United States Space Command in order to support joint warfighters across the full spectrum of conflict, at the speed of relevance, and in CDO environments. AFSPC refers to this operational vision of the future as "Fighting SATCOM."

The key building blocks for achieving Fighting SATCOM are a management and control framework to coordinate assets/tasking, flexible terminals that can operate in military platforms/environments, flexible networks to rapidly restore network connections, and a



diverse pool of space assets to provide path redundancy and operational flexibility.

As the operational environment evolves, the flexible terminals can “roam” across multiple waveforms, bands and other elements of the architecture including commercial and international partner systems.

The USAF’s Space and Missile Systems Center is furthering the advancement of Fighting SATCOM by awarding development contracts for enterprise management and control prototypes to members of the Space Enterprise Consortium, a team of industry leaders, academic research institutions and innovative early-stage and start-up companies that are working together to develop next generation space technologies.

Prototype solutions will demonstrate key attributes required of the enterprise to include rapid, resilient, sustainable and global access to SATCOM capabilities; terminal, modem and network agility; cyber, link and operational security; and data interoperability with joint command and control systems.

This year’s prototyping efforts are focused on delivering situational awareness capabilities and providing a common operating picture that assists users in conducting enterprise SATCOM planning, brokering, and orchestration functions. These prototypes will be important steps toward defining the architecture, conducting risk reduction, and identifying early technologies and capabilities that can quickly be transitioned into operations.

Defining the enterprise architecture will allow future programs and capabilities to quickly and seamlessly integrate with legacy systems while bringing together the full spectrum of SATCOM service capabilities.

For SMC, 2019 was a critical year for the MILSATCOM portfolio. With the decade concluded, the roadmap for the next decade has come into clear focus. The existing global communication constellations are healthy and being fortified,

Simultaneously, the next generation of ground and space communication systems are getting into gear. The enterprise envisioned will maintain the strategic communications vital to defending American Sovereignty while meeting the growing demand for protected communications and increased bandwidth across the globe.

The Advanced Extremely High Frequency (AEHF) systems fourth satellite, AEHF-4, was the star of the show at the start of 2019 when the satellite successfully arrived on-orbit after its launch in October of 2018. This strategic communications satellite was the first in six years to join the existing Milstar and AEHF operational constellation designed to provide survivable, global, secure, protected, and jam-resistant communications for high-priority military ground, sea, and air assets.

Within four months of arrival on-orbit, the team completed a satellite checkout and successfully transferred AEHF-4 to 4th Space Operations Squadron (4 SOPS) for operational use by the warfighter. While AEHF-4 was wrapping up, the team immediately transferred focus to AEHF-5, holding multiple rehearsals in preparation for launch and early operations.

Their efforts were rewarded when AEHF-5 was successfully launched on August 8 in a beautiful, pre-dawn show. The satellite reached orbit in November and the teams worked during Thanksgiving and Christmas and they will have delivered two strategic communications satellites to America in one year.



The fifth Advanced Extremely High Frequency (AEHF-5) satellite from the U.S. Air Force Space and Missile Systems Center successfully lifts off at 6:13 a.m. EST from Launch Complex-41, Cape Canaveral Air Force Station, Florida, atop a United Launch Alliance Atlas V 551 rocket on Thursday, August 8, 2019. Photo is courtesy of the U.S. Air Force photo — Van De Ha)

The sixth and final planned AEHF satellite completed its final major test event in August and was shipped to Cape Canaveral in Florida before the close of 2019, meeting the final program milestone. The AEHF team has taken additional pride in knowing that an additional resiliency capability was added to the AEHF constellation throughout the production cycle while avoiding issues associated with requirements creep and schedule delays.

In 2019, the program added a 4th international partner in Australia to the existing list of highly-valued partners: Canada, the Netherlands and the United Kingdom. No doubt 2020 will be a bittersweet year for SMC as, after the completion of AEHF-6, the program transfers into sustainment.

The Enhanced Polar System (EPS) is the polar adjunct to the AEHF system that provides continuous protected communication (low probability of interception and detection) over the North Polar Region using two communication satellites in highly elliptical Molniya orbits.

In 2019, EPS completed a flawless 8-week, Multi-service Operational Test and Evaluation that followed more than 12 months of rigorous troubleshooting and testing with 17 joint organizations. The EPS test reports from U.S. Air Force Operational Test and Evaluation Center and Director, Operational Test and Evaluation, declared EPS operationally suitable and effective with no liens.

On September 19, EPS achieved U.S. Air Force Space Command Operational Acceptance and Initial/Full Operational Capability with no liens or deficiencies, a rare feat in delivering operational capability to warfighters.

The 4th SOPS at Schriever Air Force Base, Colorado officially took command of EPS following a ceremony during which the EPS materiel leader, Lt. Col. Kenny Smith, passed a ceremonial "Arctic" key to Lt. Col. Tim Ryan, the 4th SOPS commander.

EPS brings multiple capability enhancements over the legacy Interim Polar System, including larger capacity, higher data rates, and improved connectivity through the EPS Gateway at Clear Air Force Station, Alaska.

The EPS Recapitalization (EPS-R) program is a follow-on to EPS that prevents a coverage gap in protected polar satellite communications for warfighters in the North Polar Region (in both benign and contested environments) until the future Protected Tactical SATCOM and Evolved Strategic SATCOM polar variants are available in the 2030s.

The EPS-R payloads, built by Northrop Grumman Aerospace Systems, will fly in a three apogee orbit and will be a hosted payload on Space Norway-procured space vehicles.

During 2019, EPS-R solidified its partnership opportunity with Norway, an effort unprecedented in its ambition, delivering a rapid, 4-year launch schedule and at significant cost savings. The Arctic Memorandum of Agreement was signed between the United States Air Force and the Ministry of Defence of the Kingdom of Norway in May of 2019.

SMC advised and assisted Space Norway in solidifying its contracts with Northrop Grumman Innovation Systems as the space vehicle developer and with SpaceX as the commercial launch provider. SMC awarded a contract for the EPS-R Control and Planning Segment (CAPS) to Northrop Grumman Mission Systems in fewer than 40 days from receipt of the contractor's proposal.

The program office conducted several major technical reviews including EPS-R CAPS System Requirements Review and Preliminary Design Review as well as EPS-R Payload Critical Design Review. The program remains on track for a dual-launch of both EPS-R payloads in December of 2022.

The Evolved Strategic SATCOM (ESS) program continues the strategic SATCOM mission of the Advanced EHF (AEHF) program. The next-generation ESS will replace AEHF and EPS to provide the National Command Authority and Combatant Commanders with highly-reliable, secure MILSATCOM.

The ESS program leverages Middle Tier Acquisition authorities from the National Defense Authorization Act of 2016 to employ an innovative strategy for the space segment acquisition. This approach energizes how the Government develops and fields strategic SATCOM through rapid



The U.S. Air Force's 10th Wideband Global SATCOM communications satellite (WGS-10) atop a Delta IV rocket lifts off on from Space Launch Complex-37B at Cape Canaveral Air Force Station, Florida, March 15. Photo is courtesy of Van Ha.

prototyping, reducing higher risk technologies early, driving innovation and open systems architectures supporting future technology and resiliency enhancements, while shortening development timelines.

Since this strategy was approved in December 2018, the program office released its rapid prototyping Request for Proposals in August, has already received multiple proposals and is moving quickly to award rapid prototyping contracts in early 2020.

For the ESS ground segment, the program office released a Broad Area Announcement to industry in August of 2019 to explore Strategic Communication Mission Planning (SCMP) architectural design options, based on ESS requirements, and the feasibility of evolving the current AEHF mission planning architecture for open systems architectures, agile software development, ground system integration, and resiliency.

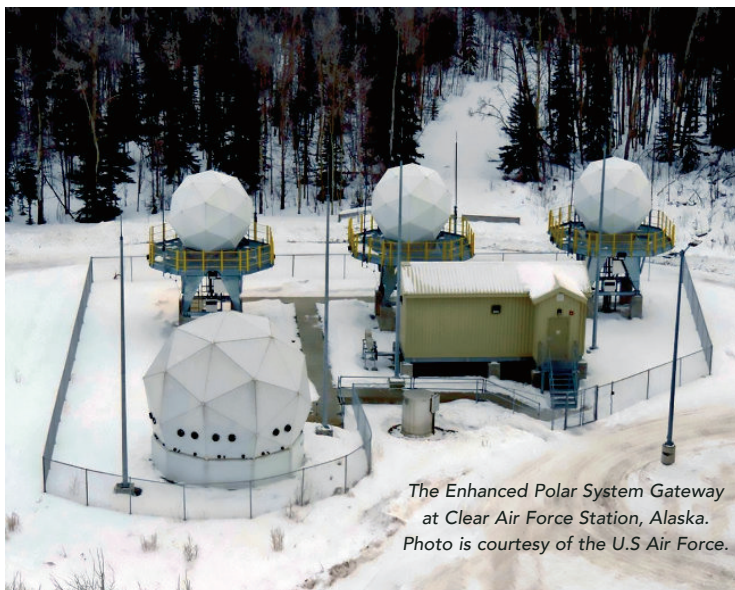
The ESS program office has received significant interest from industry. The program is on track to award study contracts by the end of this year to begin an effort that will inform the future SCMP. The ESS program is making tremendous strides and is on track to support the users' strategic need.

Wideband Global SATCOM (WGS) serves as the backbone of the U.S. military's global satellite communications, providing worldwide flexible, high-capacity, long-haul communications for marines, soldiers, sailors, airmen, the White House Communication Agency, the U.S. State Department, international partners and other special users. WGS provides essential communication services, allowing Combatant Commanders to exert command and control of their tactical forces, from peace time to military operations.

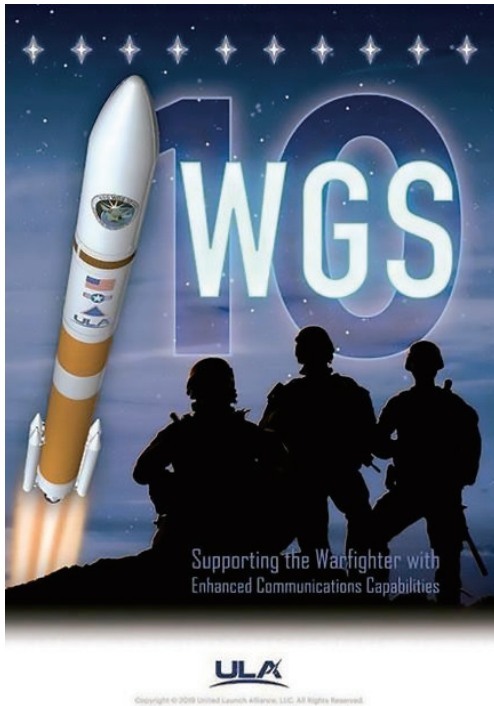
WGS-10 was launched on March 15 and concluded Payload Characterization Verification and Special Testing on September 5. During July and August, numerous activities helped optimize performance for the WGS-10 spacecraft and ground equipment. Additionally, the team demonstrated new and emerging capabilities that can be used with the WGS constellation.

WGS-10 is now in the process of operational acceptance by USSPACECOM, at which point all 10 WGS satellites will be in service as long as they remain mission capable.

In FY18, Congress appropriated \$600 million above the FY18 President's Budget to procure WGS-11 and WGS-12. SMC proposed to procure a single space vehicle with double the capacity of a legacy WGS satellite.



The Enhanced Polar System Gateway at Clear Air Force Station, Alaska. Photo is courtesy of the U.S Air Force.



An UnDefinitized Contract Action was awarded to Boeing on April 19 to build a single WGS satellite (WGS-11+) with double the operational capacity of a WGS Block II Follow-On (B2FO) Satellite. The program office continues to work closely with Boeing and our mission partners to ensure WGS-11+ meets warfighter requirements.

Several technical interchangemeetings and design trades are currently being navigated and the program passed its System Requirements Review on October 24. The SMC Production Corps is in the process

of definitizing the contract for the WGS-11+ satellite and associated ground enhancements.

This acquisition effort aligns with SMC's tenets of innovation, culture, and speed by rapidly implementing commercial technologies and respecting

Boeing's commercial model and practices. The WGS-11+ capabilities were briefed during panel discussions at the 2019 Wideband Working Group—its capabilities were well received by warfighters, operators, and planners across the Department of Defense. While WGS-11+ will add additional capacity to the existing constellation, the WGS Program Office is also exploring collaborative efforts to posture WGS-11+ as a viable government host platform for rapid prototyping efforts.

The Mitigation and Anti-Jam Enhancement (MAJE) program is a ground-based anti-jam upgrade that will use the existing capabilities of the WGS satellites to locate interference sources on the Earth and shape beams to mitigate the interference. MAJE is currently in software development and has successfully completed two test events in 2019 to keep it on track for operations by early 2021.

The Protected Anti-Jam Tactical SATCOM (PATS) family of programs was created to fill a capability gap between AEHF and WGS by increasing protection in contested environments with higher data rates than available on legacy systems. This capability centers on the Protected Tactical Waveform (PTW) — a frequency-agnostic, anti-jam waveform designed to mitigate the effects of advanced jamming in Anti-Access/Area Denial environments. The Department of Defense (DoD) plans to implement PTW to ensure delivery of protected tactical SATCOM to the joint and coalition warfighters in contested, degraded environments.

In August and September of 2019, SMC completed successful PTW demonstrations on contractor-built modems integrated with existing U.S. Army, U.S. Navy, and U.S. Air Force SATCOM terminals as part of the Protected Tactical Service Field Demonstration (PTSFD) program. These terminals were used to transmit PTW signals over both WGS satellites and Intelsat's EchoStar 9 satellite, proving the waveform can be operationalized for government and commercial use with a terminal modem upgrade.

The first phase of this operational capability will be provided by the Protected Tactical Enterprise Service (PTES), a software-intensive ground system awarded to Boeing in November 2018 providing satellite communications with enhanced Anti-Jam and Low Probability of Intercept capabilities to the nation's armed forces tactical warfighters in

contested environments. It is comprised of mission management, cryptographic key management, and joint hub communication systems. PTES will be the enabling Joint Ground System for future large-scale PTW operations and the PATS architecture and will include a future phase over commercial SATCOM systems.

As the DoD's first Middle Tier Acquisition rapid prototype program, PTES uses innovative and non-traditional acquisition approaches to deliver an operational prototype capability 18 months faster than a traditional acquisition, largely due to its application of Agile Product Management.

Since awarding a \$382 million development contract in November of 2018, PTES:

- *Stood up nine Agile Product Development teams*
- *Established a state-of-the-art DevSecOps pipeline*
- *Started writing and automatically testing secure code two years earlier than traditional DoD software programs.*

The program was invited to join the DoD's DevSecOps Initiative and became a pilot program for operational testing of Agile Software Programs.

The Protected Tactical SATCOM (PTS) program will build upon the PTW architecture in the next phase by delivering a space-based fully processed SATCOM payload.

PTS is the capstone capability of the PATS enterprise, which will provide resilient, worldwide, beyond line-of-sight, anti-jam communications to tactical warfighters. PTS will use new, on-orbit payloads with onboard PTW processing to enable single hop, direct user-to-user connectivity for secure, reliable, anti-jam satellite communications for tactical warfighter operations in close proximity to jammers.

The USAF plans to use an evolutionary approach to meet the full PTS system requirements for payload development, starting with a Rapid Prototyping Spiral. A Request for Prototype Proposal was released in May of this year and the DoD expects to award up to four Other Transaction Agreements for PTS payload design, build and on-orbit demonstration in the next few months.

During the Rapid Prototyping Spiral, each payload vendor will design a modular, scalable, hostable payload that demonstrates key PTS requirements. Understanding the challenge of requiring multiple vendors to individually develop and simultaneously achieve National Security Administration certification of the End Cryptographic Units (ECU) required to provide transmission security of information to and from the PTS satellites, the DoD decided to execute a separate acquisition for the Space Hub ECU. This effort was awarded to L3Harris in June of this year.

The U.S. Army Anti-Jam Modem (A3M) program capped off a busy 2019 for PATS when the DoD released a Request for Proposal in October. This joint U.S. Air Force/U.S. Army Indefinite-Delivery/Indefinite-Quantity (IDIQ) multi-award modem contract will build on the work done by the PTSFD program and operationalize PTW on the USAF Ground Multiband Terminal and U.S. Army Satellite Transportable Terminal, allowing for fielded capability in FY2023.

In summary, 2019 was a year of great successes for SMC in delivering capability and developing an integrated SATCOM enterprise architecture to meet the demands of the future. The USAF is accelerating delivery of this enterprise to ensure warfighters receive the operational benefits of SATCOM effects in CDO environments.

SMC is embracing faster acquisition processes and faster command and control constructs to maintain the advantage in any conflict. Delivering fighting satellite communications for our nation's warfighters will be a major step toward maintaining MILSATCOM dominance on the battlefield.

OFFSETTING THREATS AND CHALLENGES FROM SPACE

By Matt Langenbahn, Vice President of Product Engineering, Kratos Defense

As we enter a new decade, at least one item is clear: satellites and space-based capabilities are playing an indispensable role, from providing essential services such as GPS and communications, to imaging and surveillance.

The opposing reality is that adversaries are developing a variety of means to disrupt reliance on commercial and military satellites, heightening the importance and need to protect and defend these assets.

In this changing space environment, one the military has acknowledged is evolving into a warfighting domain, RF monitoring is being put to expanded new uses to address these challenges, and to help better understand, pre-empt and prevent threats to satellites.

For years, RF monitoring has provided value to support a wide range of space operations, from supplying ephemeris to track satellites on-orbit, to monitoring payload performance and usage, to detecting and geolocating interference.

The expanded use of RF to protect space-based capabilities now includes more comprehensive monitoring across military and commercial satellites, detecting new and evolving threats that can go unseen and supporting a more comprehensive concept of Space Domain Awareness required by the military and the newly created Space Force.

Monitoring RF across Military and Commercial Satellites

Historically, the most common threat to satellites has been from interference, with the vast majority of these instances caused inadvertently by misaligned antennas and transponders, configuration issues as well as human error.

However, in more recent years, adversaries have increasingly invested in means to disrupt satellites through electronic jamming and other techniques, actions that would challenge our capabilities and potentially upend the diplomatic use of space.

The U.S. military monitors many of its own satellite systems, such as the Wideband Global SATCOM (WGS), a high capacity satellite communications system. But as it increasingly relies on the commercial sector, leasing capacity from operators launching new satellites, it is also turning to commercial innovation and partners to augment its RF monitoring in an evolving threat environment.

A recent Department of Defense (DoD) contract illustrates an approach to monitoring that will protect its more diverse fleet of leased and owned capacity from commercial and military satellites. Kratos, which has monitored satellites for commercial and government organizations for years, will provide the DoD with continuous RF monitoring for government leased bandwidth on commercial satellites, bandwidth on military satellite communications and bandwidth identified by the Combined Space Operations Center (formerly the Joint Space Operations Center).

Kratos, which operates a global RF network of more than 80 antennas and sensors across 20 worldwide sites, has tuned its infrastructure to support the shift from a more neutral space environment to a more congested and adversarial one.

Featuring enhanced software and sensors, high speed data collection and processing and refined accuracy, these spectral services identify, isolate and geolocate interference of all types, inadvertent or intentional.

These RF techniques can characterize and identify interfering activities, whether due to the proliferation of VSAT terminals, intruding signals from adjacent satellites, or the friendly 'blue' interference that can occur in naval fleets or on the battlefield.

These RF services will help the military resolve interference through geolocation activities to ensure that critical satellite communication links stay operational and to support new mitigation strategies.

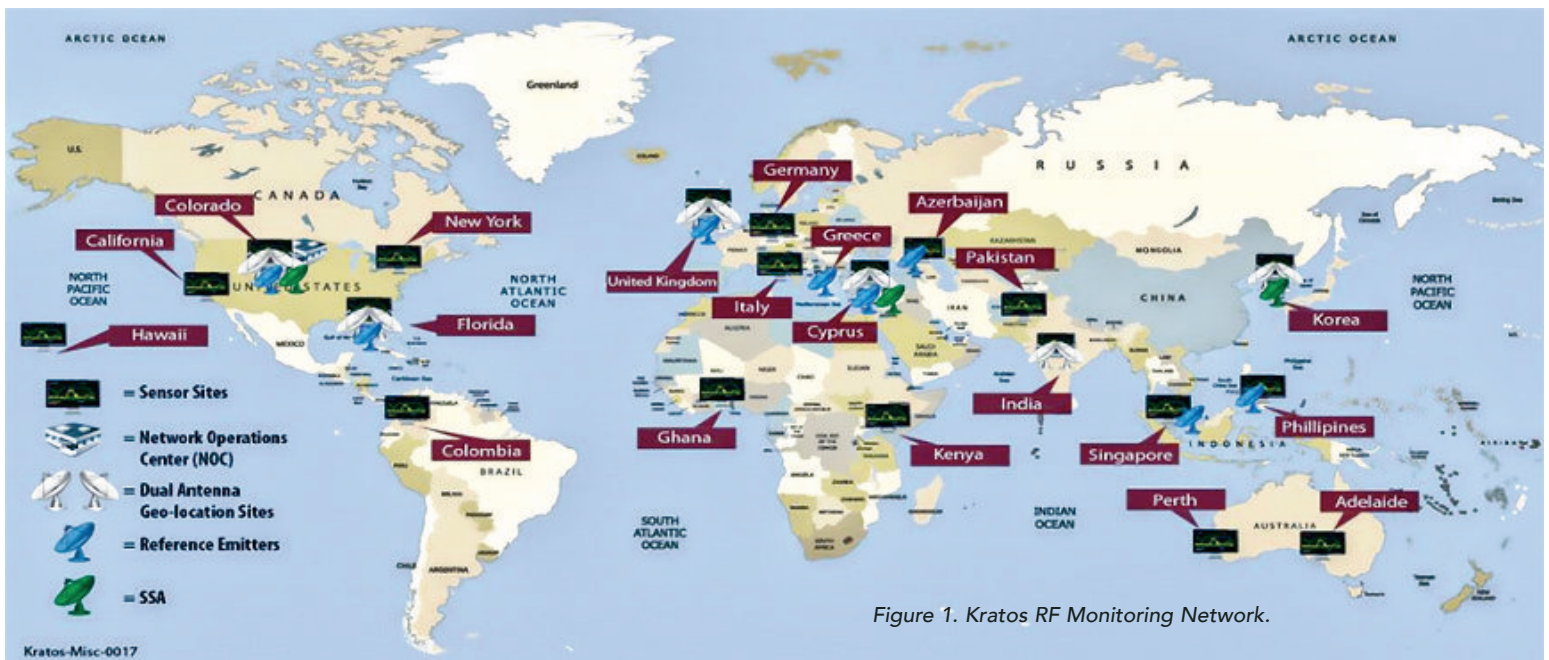


Figure 1. Kratos RF Monitoring Network.



Kratos RF Monitoring Network

The Growing Threat-scape

There are other threats to satellites beyond interference. As space grows more crowded and contested, with thousands more satellites planned for launch in the coming years, the risk of collisions and other events also rises.

The remoteness of space is no longer an assurance of security. Here, too, RF monitoring is playing a crucial role.

Traditionally, Space Situational Awareness, or SSA, has focused on tracking thousands of objects in orbit to avert and prevent orbital conjunctions or collisions.

SSA has relied mostly on sensors such as electro-optical telescopes and radar to observe satellite positions. However, these sensors also have limitations.

Telescopes are unable to track satellites in the bright light of day or when obscured by cloud cover or other adverse conditions; most ground-based radars do not extend beyond LEO to the geostationary arc.

Such blind spots could be used to shield maneuvers and potentially threaten nearby satellites. For example, when a satellite unexpectedly moved within mere kilometers of U.S. and allied satellites several years ago, it alarmed the international community and sparked concern about its undisclosed intention and the reality of such dangers.

In contrast, the RF signals used by satellites to communicate can be monitored day or night, in all weather conditions and offer a wealth of information that is either absent from, or to augment, other sensors.

This RF data can be used to locate satellites, detect their maneuvers, even spot unusual or anomalous behaviors in real-time to alert operators when a satellite is deviating from its normal expected patterns of life.

Further, RF data can characterize specific satellite behaviors and determine, for example, if an unexpected maneuver represents the drift resulting from an onboard system malfunction or that of an adversarial intent.

In theory, this RF data always held significant value, but in practice wasn't available at scale due to limited sensor coverage and incomplete infrastructure.

Now, with commercial global monitoring available, RF data can be collected for the complete geostationary arc at all times, providing unique insights that escape detection or characterization by traditional sensors.

Supporting the Shift from SSA to SDA

In 2019, the U.S. Air Force Space Command called for a shift in focus from the basic tracking of space objects, or Space Situational Awareness, to what it now calls Space Domain Awareness, or SDA.

This pivot from SSA to more comprehensive SDA reflects the need to know where satellites are in orbit as well as what capabilities adversaries can institute and how their activities could affect U.S. satellites and the nation's use of space.

RF data, pulled from the same network that Kratos uses to monitor interference around the globe, can help military and commercial operators better understand how the entire RF domain is used by the U.S., its allies and its adversaries, and how an adversary may be impacting MILSATCOM capabilities.

The unique signatures of RF waveforms can be used to attribute a satellite's origin or ownership, its payload type and operations and even infer its capabilities and intent. When combined with data from other sensors, the RF dimension helps provide a more insightful and complete picture of the space domain, while eliminating conventional blind spots.

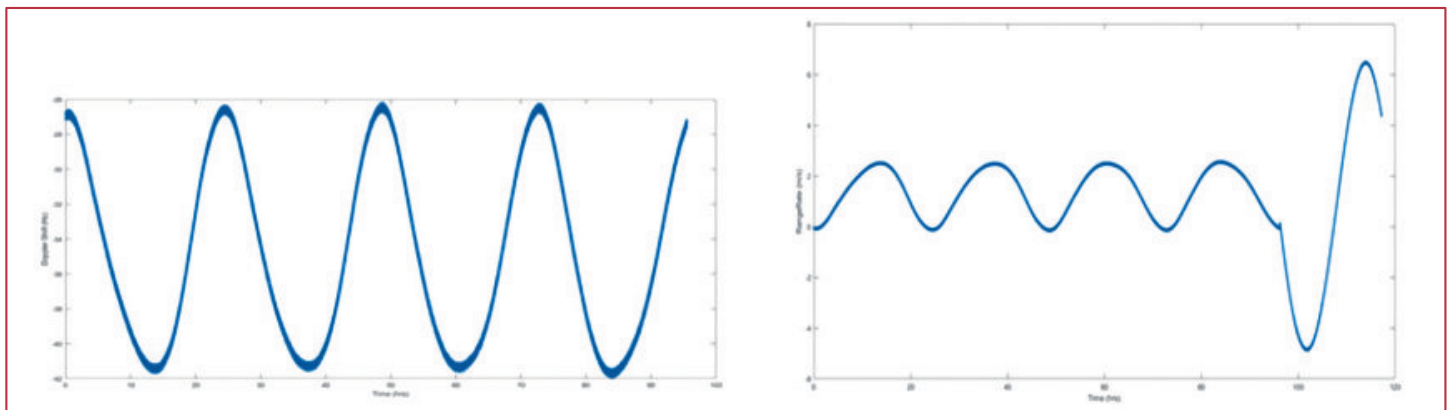


Figure 2 and Figure 3. RF to Detect Maneuvers: One method is to observe Doppler shifts of a satellite. When in natural motion in geosynchronous orbit, a satellite projects a Doppler shift similar to the image above left. When it unexpectedly maneuvers or accelerates, a discontinuity can be observed in the Doppler shift motion shown in far right image.

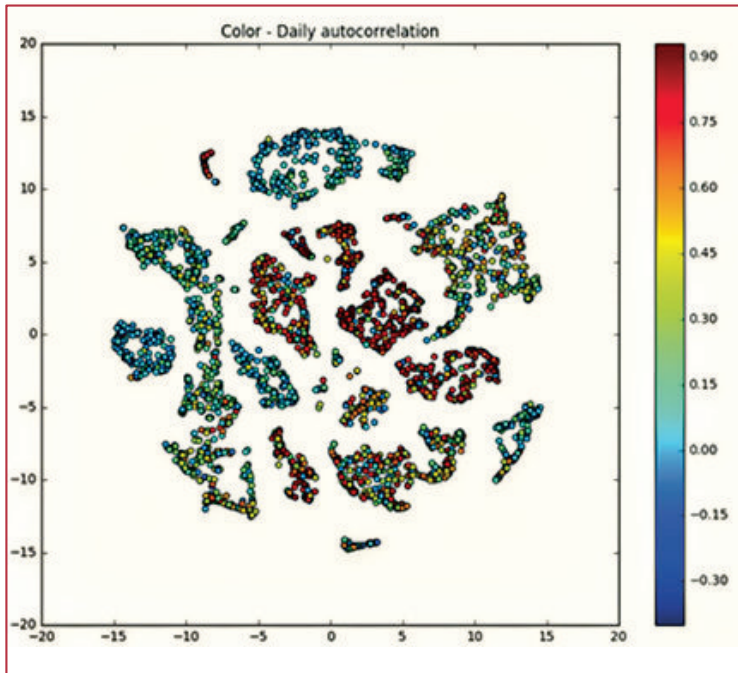


Figure 4. RF Data to understand satellite behavior and capabilities. The clustering algorithms, above, classify the types of RF traffic from a satellite. The color-coded bubbles represent the numerous channels and types of traffic being carried.

Reorientation to Space

Recognizing changes in space, the government has also adapted to such needs, in part, through reorganization.

In 2019, it authorized the creation of the Space Force, a new sixth, formal arm of the military. This dedicated entity will have a heightened focus on awareness of space as a warfighting domain, just as it does for land, sea and air operations.

RF and other sensor data will help these forces to determine, for example, whether a glitch in a satellite is due to an electronic attack, inadvertent cause or if a satellite is moving too close as well as when such scenarios occur, what actions should come next.

As the military prepares for new war footing in space, it will transition and offload more traditional space traffic management (and SSA) from within the U.S. Air Force to a more civilian function under the Department of Commerce.

Commercial RF data can augment the government's existing sensors and resources to gain a more complete and accurate real-time tracking of space and satellite activity for collision avoidance.

Supporting New Mitigation Strategies and Resilient Space Enterprise

While RF monitoring helps detect threats and enhance space domain awareness, it is also being leveraged as a key mitigation strategy to maintain MILSATCOM for soldiers and their missions.

In an innovative new approach to resilient MILSATCOM, Kratos, along with the company's partners as well as the U.S. Air Force, are developing a new enterprise ground architecture that will detect disruptions and automatically switch users to alternative satellites or networks for mitigation.

The Enterprise Management & Control system, or EM&C, will enable roaming across military and commercial satellites and networks in much the same way that commercial cell phone networks roam to ensure users remain connected.

The RF monitoring component that is part of the EM&C architecture provides an enterprise-wide view or common operating picture (COP) of the health, status and availability all satellites, gateways, and terminals.

If the system detects jamming or other threat, it will identify the most suitable available satcom resource or service. EM&C's software-defined architecture will then re-provision users in seconds or minutes, bypassing the interference or threat to maintain connectivity.

EM&C's innovative approach will more fully integrate threat detection and mitigation for assured satellite communications, unifying many functions that are currently separate in existing stove-piped systems.

As the DoD looks to a more combined concept of operations, merging military and commercial space capabilities, such flexible new architectures featuring an RF common operating picture will support a more resilient and robust space enterprise.

Maintaining uninterrupted satellite operations will be necessary as the military pursues multi-domain operations, where it seeks to integrate space capabilities more closely with terrestrial forces.

In 2019, the Combined Force Space Component Command (CFSCC) was established to lead USSPACECOM's efforts to bring satellite communications, space awareness, surveillance and command and control capabilities into the combined, multi-domain operations of land, sea, and air forces.

In addition to protecting SATCOM, RF systems are also being developed (by Kratos) to monitor and protect the command and control (C2) links that fly Earth Observation (EO) satellites and other systems for more resilient operations.

The Increasing Value of RF Monitoring

With the increasing dependence on space, and a growing array of threats, RF monitoring is playing a more crucial role in protecting satellite systems.

This includes detecting interference and other threats across military and commercial systems, supporting a more complete concept of space domain awareness, and enabling a more defensible, robust, and resilient space enterprise.

Kratos' global RF network and spectral services augment the U.S. government satellite communications with detection for interference, anomalies, and maneuvers. The company's mission partner approach helps the government and satellite operators understand more about the health, location, attribution, performance, and other behavioral factors of satellites for greater domain awareness, security, and assurance in space.

Mr. Matt Langenbahn is Vice President of Product Engineering for Kratos Defense. Mr. Langenbahn has supported dozens of satellite programs, including commercial, civil, DoD, and classified systems. He holds a B.S. in Electrical Engineering from the University of Idaho, and an M.B.A. from the University of Colorado.



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HOW THE USG LEVERAGES COMMERCIAL INNOVATION

By Tony Frazier, Executive Vice President of Global Field Operations, Maxar Technologies

In the last decade, the U.S. commercial space industry has pushed the limits of innovation to entirely new heights. The industry is developing novel space-based solutions that support a wide range of missions and pioneering the development of technologies that will improve lives on Earth and explore and advance the use of space.

Capabilities such as artificial intelligence and machine learning (AI/ML) are increasing the speed at which analysts are able to solve critical problems from space; companies are coming up with disruptive new ideas that promise to increase access to what once was a frontier only available to national governments; and satellite imagery is becoming more persistent and more valuable.

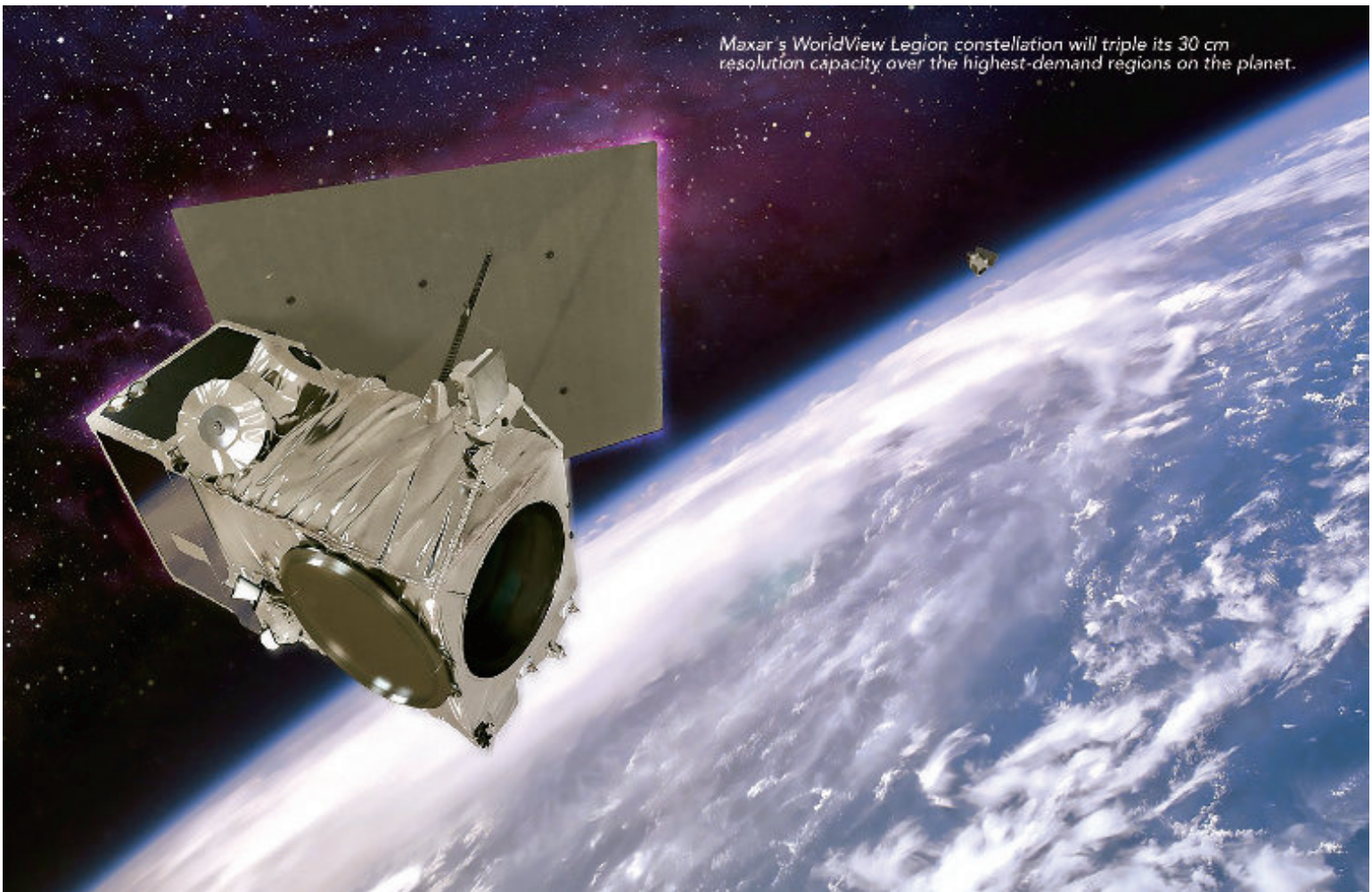
This swell of innovation has not gone unnoticed by the U.S. government, which in recent years has placed an increasingly high value on the use of commercial services, hardware and imagery.

As reported by CNBC, this year's NASA budget request mentions the word "commercial" almost twice as much as last year's request. In a similar vein, the DoD and Intelligence communities have been focused reforming acquisition to enable the rapid procurement of commercial technologies for years.

A new and exciting era is now being entered wherein commercial providers are creating revolutionary capabilities and disruptive ideas for space.

For example, earlier this summer, the U.S. National Reconnaissance Office (NRO) selected Maxar to help them understand the satellite imaging capabilities that will be available in the years ahead.

As a trusted partner to the U.S. government for decades, Maxar plays a crucial role in delivering innovative Earth Intelligence and Space Infrastructure solutions for critical missions. In my role, I am responsible for all sales, business development, account management and service delivery across our combined national security and commercial customer base. This position provides me with a unique vantage point into the U.S. government's increasing use of commercial capabilities have been focused on reforming acquisition to enable the rapid procurement of commercial technologies for years. For example, earlier this summer, the U.S. National Reconnaissance Office (NRO) selected Maxar to help them understand the satellite imaging capabilities that will be available in the years ahead.





Maxar is building the Power and Propulsion Element of the NASA-led Gateway.

What I see in the Earth Intelligence realm is an insatiable appetite for more persistence and actionable intelligence—not just pixels. Persistence is the ability to stay on target and not lose track of objects of interest, whether located in space or on Earth.

At Maxar, we're amping up the delivery of persistence with our forthcoming WorldView Legion constellation, which will triple our 30 cm. Resolution capacity over the highest-demand regions on the planet and allow us to image the Earth from sunrise to sunset.

We're also leveraging our deep mission expertise and 1,500 cleared experts to continue delivering the highest resolution and most accurate commercial satellite imagery to the NRO through the EnhancedView contract and mission-ready satellite imagery in multiple classification levels through the Global EGD program, which was recently extended four years by the National Geospatial-Intelligence Agency.

Maxar's WorldView Legion constellation will triple its 30 cm. Resolution capacity over the highest-demand regions on the planet.

Industry-leading imagery is not just the end product but a vital raw material for the answers and actionable insights we provide to various U.S. Defense and intelligence agencies.

Using our extensive expertise in AI/ML, data science, big data integration and domain-specific analytics, we gather content from many sources, sensors and providers, and then combine that content with powerful geospatial analytics to help customers be more predictive in their critical decisions and more productive in their daily operations.

This effort is highlighted in our recent work with the U.S. Air Force and U.S. Special Operations Command to help automate intelligence production cycles and integrate machine learning and computer vision capabilities into operations—evolving the mission from mapping to automated intelligence using machines. Maxar uses AI/ML to deliver actionable insights for U.S. government customers.

On the Space Infrastructure side, we're seeing revolutionary capabilities brought to bear by the commercial industry. As demand for persistence grows along with humanity's desire to explore the universe and need for 24/7 global internet access, the necessity for more sophisticated technologies and greater access to space has become paramount. To address these requirements, entirely new approaches are being developed to enhance our understanding and use of space.

Similar to Earth Intelligence, Maxar is a leader in this arena. A few months ago, we were selected to build and fly the first element of the NASA-led Gateway, an essential component to [NASA's Artemis program](#) to land American astronauts on the surface of the Moon by 2024 and enable future crewed missions to Mars.

In August, NASA asked Maxar to leverage its experience as the proud space robotics partner for all six of the agency's Mars landers and rovers to deliver a robotic arm for use on the Moon.

Maxar is integrating some of this robotic technology on the spacecraft it is building for [NASA's Restore-L](#), which will refuel a satellite in low Earth orbit. Maxar is building the Power and Propulsion Element of the NASA-led Gateway.



Maxar uses artificial intelligence and machine learning to deliver actionable insights for U.S. government customers.

Increasing access to space—the lifeblood of the space industry—is something that we’re working on from multiple angles. Using robotics, we’re developing **SPIDER**, a dexterous system that will enable the on-orbit assembly of satellites, telescopes and other systems that might not fit into a standard rocket fairing when fully assembled.

With our highly flexible 1300-class satellite platform, we’re able to offer rides to space for free-flying satellites and hosted payloads, including **NASA’s TEMPO** pollution-monitoring instrument.

A new and exciting era is now being entered wherein commercial providers are creating revolutionary capabilities and disruptive ideas for space. This swell of innovation is transforming the way U.S. government agencies approach the development of new technologies.

As a trusted partner in Earth Intelligence and Space Infrastructure, Maxar is working at the leading edge of innovation to deliver disruptive, cost-effective and powerful solutions that build a better world and help our U.S. government customers solve their most complex problems.

Tony Frazier joined Maxar in 2017 after its acquisition of DigitalGlobe and serves as our EVP of Global Field Operations. In this role he leads all sales, business development, and services delivery activities for the company outside of the Canadian market.

Prior to this role Mr. Frazier served as President of Radiant Solutions. Mr. Frazier served as Senior Vice President, General Manager of DigitalGlobe’s Services business from 2013 and led GeoEye’s Marketing and Communications team since 2010, prior to its acquisition by DigitalGlobe in 2013. Prior to GeoEye, Mr. Frazier served as Senior Director of Product Management at Cisco Systems, where he brought to market emerging technologies core to Cisco’s video and collaboration strategy.

Prior to Cisco, Mr. Frazier held senior marketing roles at Infor, iPhrase Technologies, an MIT start-up acquired by IBM, and pcOrder.com. Mr. Frazier began his career in strategic consulting at Bain & Company. Mr. Frazier holds a Bachelors of Systems Engineering from the University of Pennsylvania and an MBA with distinction from Harvard University.



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HOW HACKERS TARGET YOUR SATELLITE COMPANY

By Robert Bell, Executive Director, World Teleport Association

Every discussion of cybersecurity descends, sooner or later, into a fog of words that only people who are cybersecurity experts understand. They can talk all day about cross-site scripting, SQL injection and buffer overflow vulnerabilities—and decision-makers will be none the wiser.

What's missing is a shared understanding of—not what the bad guys are doing—but how they go about their work. When you understand how hackers work, decisions about what to defend and how best to defend it, the realization is easier to understand.

Some of the hacker's work is highly automated. Cybercriminals use tools such as Shodan—a search engine for web-connected devices—to scan the web and generate an extensive overview of everything from web servers to security cameras, webcams and printers.

For a 2018 study, security firm Cybereason set up a fake server known as a “honeypot” to log everything done to it by digital intruders. They created a company name, generated staff identities and simulated network traffic. It only required two hours from the moment the server went online for it to be discovered by an automated “bot” that set about taking the website over.

Fifteen minutes later, the bot used several known vulnerabilities to scan the simulated network, steal and dump credentials for other vulnerable (if

fake) machines connected to the network and to create new user accounts that would have provided complete access to the real thing.

This is a scary picture of automated combat. However, as any cybersecurity expert will tell you, the biggest risks all face comes not from robotic attack but from people who have painstakingly honed the skills needed to break into a digital domain and find the “valuables.” Here are three of the most common approaches that hackers take to identify a target, find the target's vulnerable points and to then launch an attack.

Phishing

We have all had personal experience of phishing scams: the Nigerian prince or non-existent relative who offers you an absurd amount of money if only you will turn over your credit card information. Most are not very sophisticated, but they rely on volume to make up what they lack in originality. Let's say a phishing email goes to one million recipients, which is not difficult with the correct technology. If just one-tenth of one percent of people fall for the email and are duped out of an average of US\$1,000 each, that's a \$100,000 windfall.

Hackers targeting a company are just as relentless but put far more effort into their work, whether they are getting paid to break into the network, plan to sell assets they discover there or to hold up the company for ransom to get their files returned. A



motivated hacker may spend months researching a target and preparing an approach before striking.

Hackers start by researching companies online, based on an article they read, a website they visited or even a sign on a building. From Google, LinkedIn, Facebook and other sources, it is relatively easy to identify people in the company and learn how they are related.

Let's say a hacker is targeting a mid-size company called Teleports International. From online research, the hacker identifies a technician there named Arnold Smith. Arnold's LinkedIn profile confirms that he works for Teleports International and a Facebook post makes it clear that he will shortly be going on holiday.

Additional LinkedIn searching finds other people at the company, including the operations director, Madeline Bond. The hacker now has everything needed to go phishing. They create a Gmail account, *madeline.bond@gmail.com* and write an email, such as the example that follows:

From: *madeline.bond@gmail.com*

Arnold,
My corporate email isn't working on my phone, so I'm sending this from my personal email. Your annual leave should be approved, but we need a few more details. Please fill out this form for me.

www.leave-request.teleportsint.staff-organizer.com

Thanks,
Madeline

The important part of this message is the link. The first part looks legitimate, but the next part is where the danger lies. The hacker has bought the domain *staff-organizer.com* and created a web page that clones Teleport International's internal portal. When Arnold clicks the link and logs in, the system sends his user name and password to the hacker. Once the hacker has Arnold's login, it is little trouble to invade the system and really get to work on the data acquisition.

Re-Used and Weak Passwords

We are always being told not to re-use our passwords and to have strong ones with hard-to-remember strings of letters, numbers and symbols. But we are seldom told why.

Start by imagining that Evil B. Hacker has been hired to gain access to the email inbox of the CEO of a satellite antenna manufacturer, BigDish, without anyone knowing. The first step of the campaign is research. Searching the web for CEO Matt Longview, he finds social media profiles showing him to be an avid enthusiast for classic sports cars and that he posts often on a site called *classycars.com*. He even has a profile on that site, and it reveals his personal email address, *matt.longview@yahoo.com*.

Because Evil is a professional, he has copies of the immense data files that other hackers have stolen and dumped onto the internet in recent years. Unfortunately for Matt, he uses Dropbox to share photographs and videos of cars he loves, and Dropbox suffered just such a hack some time ago.

A search for Matt's personal email address in one of Evil's data dumps turns up a record with his Dropbox password, which is "*favcars2012*." Now Evil is getting somewhere. He goes to Matt's favorite website and logs in as *matt.longview@yahoo.com*, with an updated version of the password: "*favcars2019*." And it works on his first attempt: Evil is in Matt's record and can view private messages going back years.

Having found a password that works, Evil does one last bit of research. He searches Google for "*intext:@bigdish.com*" and it turns up records of employees with their email addresses visible. All seem to have the same format:

FirstName.LastName@big.dish.com. So he tries logging into Big Dish's corporate email system using *matt.longview@bigdish.com* and the password "*favcars2019*."

It works—because Matt made the critical error of re-using his password. Evil sends a copy of Matt's most sensitive emails to his client on the dark web and gets a fat paycheck in return.

Does this series of events seem unlikely? Perhaps—but but people who steal for a living work just as hard as those who don't and can afford to dig deep on the web to find what they need.

Social Engineering

Social engineering is the cyber-term for using basic deception techniques to con people into providing access to your systems. It is distressingly easy for a social engineer with the correct tools to penetrate your organization. What are those tools?

- A professional, charming nature
- Business attire
- A fluorescent vest, clipboard or tablet, and lanyard with fake ID
- A fake email from the CEO giving permission to be there

If a stranger turns up in your lobby and asks to look around the place, the receptionist is sure to say no. However, if the same person walks off the street in this year, saying "I'm here for the safety audit of your data center," the same receptionist may say yes. This is not because she is dim-witted, but because she is human. This is only one of many guises in which an attacker can approach and penetrate your physical defenses. They are limited only by imagination and our preference for trusting others.

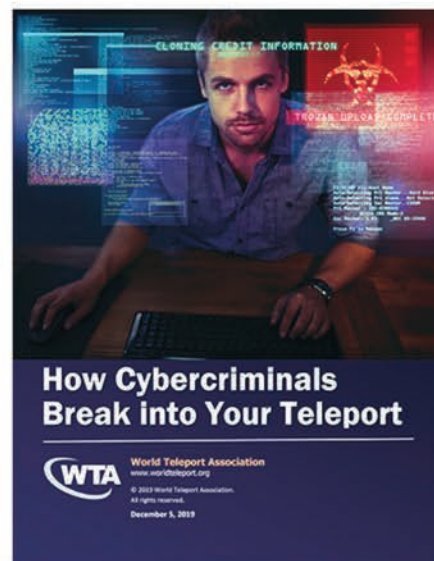
Human beings are the biggest threat to the security of your enterprise network. Ironically, they are also its most vital defense. Technology will always play a role in cybersecurity, but the biggest contributor is a strong security culture within the company, built through required training that is regularly refreshed and a supportive and responsive IT department.

An important element of that training is to make certain employees know what to do after they have made a mistake and don't fear that they will be punished for this error. A call to a manager or tech support directly after that mistake can make all the difference between a major incident and a quick fix.

This article is adapted from "*How Cybercriminals Break into Your Teleport*," published by WTA for the benefit of its members.

[More information is available at this direct link...](#)

Robert Bell is the executive director of the World Teleport Association.



SMALLSAT LAUNCHES CONTINUE TO INCREASE

By Andrew de Naray, Space Foundation

Just as the developed world has evolved to depend on space for everyday communications and data collection, so have defense operations. Larger satellites have been used for military purposes since the dawn of the Space Age, but there has been a growing interest in the feasibility of using various forms of small satellites (SmallSats) to support tactical operations.

Although there is no universally accepted definition of a smallsat, and numerous subcategories exist, they are commonly defined as satellites that weigh 500 kg. or less. More companies are deploying smallsats each year for myriad purposes, and the small launch vehicle market and launch providers are responding by expanding to support those satellite operators' needs.

According to research from the Space Foundation, in the last five years, the number of SmallSats in space has increased 175.6 percent, while the number of smallsat operators has more than doubled.

For decades, the use of satellites was economically and legislatively restricted to providing civil and defense communications primarily for voice transmission and television as well as Earth observation for meteorology needs. Building satellites required expensive, high-tech capabilities, and development of launch vehicles was also costly, making space accessible only to wealthy and technologically advanced nations.

This dynamic began to shift at the beginning of the 21st century with the evolution of advanced microelectronics, enabling the fabrication of smaller satellites built in modest facilities and launched in vehicles that had room to spare for secondary payloads. Over the last decade, smallsats have increasingly demonstrated their ability to support a range of missions, effectively contributing to commercial, institutional and educational efforts at a lower cost for technologically developing nations and new space players.

Subsequently, there has also been an increasing willingness to adopt smallsat technology in the military and defense intelligence communities. The U.S. Army is currently testing three different smallsat-based programs with the objective of providing direct support (via communications, navigation, reconnaissance and more) from Low Earth orbit (LEO) to tactical units on the ground. The Army's longstanding interest in building an orbital presence in LEO to track missile threats—particularly fast, unpredictable hypersonic weapons—has become one of the Department of Defense's top priorities, and smallsats are expected to play a role.

The greatest hindrance to faster growth in the smallsat sector has been the cost and availability of launch vehicles and services. That need has not only led to development of lower-cost launch vehicles... it has kick-started a spaceport building boom, concurrently creating a surge in small launcher developments from both national agencies and the private sector. To date, about 50 new small launch vehicles are in various stages of development.

Likewise, spaceport upgrades and new spaceport development are at an all-time high, with 40 active launch sites on five different continents around the globe.

Adding to this current capacity, 10 more spaceports are in development in the U.S., Sweden, Australia and Canada, with another 13 more proposed in eight countries, according to "The Space Report 2019, Q4."

In the United States, through the development of a second small vehicle launch location at Wallops Island on the Eastern Shore of Virginia, the U.S.-based startup Rocket Lab is poised to capture an even larger share of U.S. defense revenues. As reported on the company's website, their newest spaceport "Tailored specifically for U.S. government small satellite missions, Launch Complex 2 can support up to 12 missions per year."

Over the last decade, smallsats have increasingly demonstrated their ability to support a range of missions.

Likewise, the Pacific Spaceport Complex-Alaska (PSCA), operated by Alaska Aerospace, is positioning its facilities to support increased commercial operations for smallsat operators in the coming years.

Additional launch providers accommodating smallsat payload launches in the U.S. include: Spaceport Camden in Camden County, Georgia; Spaceport America in Sierra County, New Mexico; and Space Exploration Technologies Corp. in Cameron County, Texas.

In Australia, three spaceports are being developed to support smallsat deployments using small launch vehicles. Arnhem Space Center is located in the far northern region of Nhulunbuy. Equatorial Launch Australia (ELA) will be working with NASA to develop Arnhem into a sounding rocket launch site and orbital launch site.

On the southern Australian coast, Southern Launch is developing the Whalers Way Orbital Launch Complex into a polar orbital launch site for SmallSats. Gilmour Space Technologies is planning mobile small vehicle launches near Bowen, Australia.

The U.K.'s Virgin Orbit, an aspiring smallsat launch company backed by billionaire *Richard Branson*, has signed an initial agreement to develop smallsat launch capabilities for the U.K.'s Royal Air Force.

Virgin Orbit's method for launching employs smaller rockets that attach to the wing of a modified Boeing 747, which then separate at a high altitude, traveling the rest of the way to LEO carrying light payloads.

British-based OneWeb and Starlink from SpaceX have begun on-orbit testing of constellations of smallsats. OneWeb expects to launch 900 SmallSats, while SpaceX plans to launch 40,000, with each individual satellite weighing under 500 lbs. (~227 kg).

If the Bureau of Labor Statistics occupational outlook is any indicator, this growth will likely continue to create even more demand for skilled STEM talent. The BLS estimates that by 2028, employment of aerospace engineers will increase by 2 percent and employment of aerospace engineering and operations technicians will increase by 4 percent. In both cases, the Bureau cites new developments in SmallSats and advances of the commercial space sector as drivers of this growth.

With that growth comes new opportunities for the smallsat community to prove its abilities to satisfy client demands and also to evolve and provide more capabilities not yet imagined. This will be growth worth tracking.

Andrew de Marry is a research writer and editor with [The Space Report](#) from [Space Foundation](#). The 36th Space Symposium is presented by the Space Foundation and will take place from March 30 to April 2, 2020, at The Broadmoor in Colorado Springs, Colorado, USA. This event brings together thousands of space professionals from the world's leading spacefaring countries to discuss and plan the future of space. See the agenda and registration information at www.spacesymposium.org.