SATCOM for Net-Centric Warfare

MilsatMagazine

2020

December 2019 issue

2019 YEAR IN REVIEW

WALTON DE-ICE

Portable Radome

Protect antennas in extreme conditions

New LEO/MEO design
Call for details!

PUBLISHING OPERATIONS

Silvano Payne, Publisher + Executive Writer
Simon Payne, Chief Technical Officer
Hartley G. Lesser, Editorial Director
Pattie Lesser, Executive Editor
Donald McGee, Production Manager
Andy Bernard, Sales Director
Teresa Sanderson, Operations Director
Sean Payne, Business Development Director
Dan Makinster, Technical Advisor
Wendy Lewis, Contributing Editor
Paul Sims, Contributing Editor

SENIOR COLUMNISTS

Richard Dutchik, Dutchik Communications
Chris Forrester, Broadgate Publications
Karl Fuchs, iDirect Government Services
Bob Gough, Goonhilly Earth Station
Rebecca M. Cowen-Hirsch, Inmarsat
Ken Peterman, Viasat
Giles Peeters, Track24 Defence
Koen Willems, Newtec

THIS ISSUE'S AUTHORS

Ken Chadder
Krystal Dredge
Joakim Espeland
David Helfgott
Obi Johnson
C. Todd Lopez
Tony Radford
John Ratigan
Tony Russell
Ulf Sandberg
David Walton

SatMagazine is published 11 times a year by Satnews Publishers, 800 Siesta Way, Sonoma, CA, 95476 — USA.
Phone: (707) 939-9306 / Fax: (707) 939-9235

© 2019 Satnews Publishers

We reserve the right to edit all submitted materials to meet publication content guidelines, as well as for grammar and spelling errors, or to move articles to an alternative issue to accommodate publication space requirements, or remove content due to space restrictions or unacceptable content. Submission of articles does not constitute acceptance of said material by Satnews Publishers. Edited materials may, or may not, be returned to author and/or company for review prior to publication. The views expressed in Satnews Publishers' various publications do not necessarily reflect the views or opinions of Satnews Publishers. All rights reserved. All included imagery is courtesy of, and copyright to, the respective companies and/or named individuals.

FEATURES

Dispatches ..... **4 to 13**

Command Center: Frank Backes, Kratos Defense and Security **16**

Year in Review
Advantech Wireless Technology **18**
AvL Technologies **20**
Centauri **22**
CPI Antenna Systems Division **24**
iDirect Government **26**
Paradigm **28**
Phasor **30**
QuadSAT **32**
W.B. Walton Enterprises, Inc. **34**

Command Center: Rick Lober, Hughes Network Systems **36**

How to Overcome the Biggest Challenges of Connected Ops **40**
by Obie Johnson

Managing the High Volume of Mission-Critical Data for Defense Ops **42**
by Ken Chadder

Command Center: Ron Lopez, Astroscale US **44**

Space Report 2019: Q3 — A Guide to Global Space Activity **46**
by Space Foundation

ADVERTISER INDEX

2020 SmallSat Symposium **37**
Advantech Wireless Technologies **15**
AQYR (A Windmill Company) **11**
AvL Technologies **5**
CPI Satcom Products **13**
iDirect Government **9**
Spacebridge **3**
Space Foundation — 36th Space Symposium **39**
W.B. Walton Enterprises, Inc. ..... **Cover + 7**

SPACEBRIDGE

BRINGING SATCOM TO THE CLOUD

ZERO OVERHEAD, FULLY MANAGED CLOUD-BASED SATCOM SERVICE

SpaceBridge delivers high quality dynamic SCPC BoD (Bandwidth on Demand) satellite connectivity as a fully managed cloud-based service – no hub or even teleport required!

Simply partner up with **SpaceBridge**, sign up for the period of time and amount of bandwidth desired, and you're all set. We'll provision your very own slice of our satellite infrastructure - equipment and optional bandwidth - CAPEX-free, with 24/7 management and technical support, maintenance; full visibility and control included.

Best of all, **SpaceBridge**'s pay-as-you-grow scalability will allow you to cost-effectively expand your satellite communication assets as you go.

Sign up today, and enjoy SpaceBridge's cost-effective, efficient and scalable satellite connectivity-as-a service!

- **High quality dynamic SCPC BoD satellite connectivity**
- **A fully managed, 24/7 cloud-based service**
- **OPEX only subscription engagement basis**
- **Optional teleport services**

SPACEBRIDGE
ALL THINGS CONNECTED

www.spacebridge.com

The mission from the United States Air Force (USAF) and the challenge to Aerospace Corporation was to build and launch a pair of cube satellites on a tight budget and even tighter timeline of only 18 months.

In a world where the threats facing orbiting satellites proliferate with each passing year, the ability to field an agile response and quickly restore lost functionality is a critical, but still developing, capability.

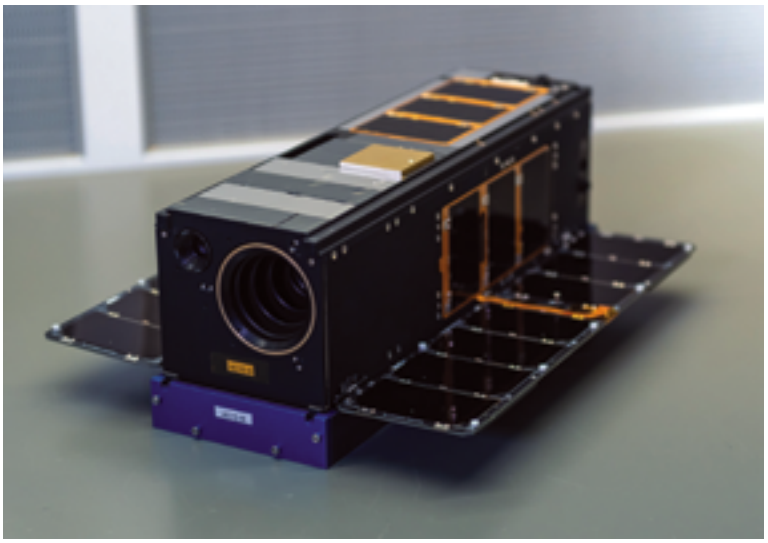
Aerospace's technical expertise put it in an unmatched position to chart a path forward, with staff using Commercial Off-The-Shelf (COTS) parts in their race against the clock.

On November 2, the team crossed the finish line with the successful launch of AeroCube-15, also known as the Aerospace Rogue Alpha/Beta CubeSats, launching aboard the Northrop Grumman Antares rocket.

"*One of the keys to rapid reconstitution was to not stretch the technology limits too far with this one*," said Dr. ***Jeff Emdee***, General Manager in the Space Development Division. "*It really wasn't about testing unknown capabilities. It was about integrating off-the-shelf capabilities, testing it and assembling it in time for the launch date.*"

The accelerated development timeline positioned the Aerospace CubeSats as pathfinders for studying rapid reconstitution, a key component of Agile Mission Assurance, which seeks to ensure mission capabilities even if on-orbit satellites are compromised.

The Aerospace Rogue Alpha/Beta CubeSats consist of a pair of identical, 3-unit CubeSats designed, built and operated by Aerospace for the USAF's Space and Missile Systems Center.



They will be stored onboard the Cygnus vehicle at the International Space Station for several months, with a planned deployment to Low Earth Orbit (LEO) in early 2020.

The Aerospace CubeSats are planned for a 12-month mission. The mission experiment will consist of observing cloud backgrounds and ground targets to research the capabilities of commercially derived technology for space mission applications.

Developing the cubesats on such a tight timeline — a typical satellite takes several years or more to design, build and launch — required Aerospace employees to work collaboratively to reshape their approach in pursuit of maximum efficiency and reduced complexity.

"*The great thing about The Aerospace Corporation is we have world class experts in every aspect of satellite and sensor design. It's really amazing what you can do when you put all that expertise together*," said Dr. ***Dee Pack***, Principal Investigator and Chief Scientist for the Aerospace Rogue Alpha/Beta CubeSats mission. "*The challenge was the project management discipline to pull experts from every part of the company and marshal them in an organized manner, so you don't break the bank.*"

Their work started with proven technologies developed by Aerospace, including the spacecraft bus and laser communications system, and the expertise developed at xLab through prior AeroCube builds.

Perhaps most challenging aspect was the shift in mindset required at a company that since its inception has focused on mission assurance and the highest level of reliability.

A focus was placed on using as many COTS parts as possible, yielding valuable lessons about the parts' reliability and how long it takes to procure them.

For instance, obtaining a focal plane array of the desired size would take at least a year, forcing Aerospace engineers to alter the design in favor of a smaller array.

In other cases, Aerospace had to further modify commercial parts or design their own when off-the-shelf parts, like a commercial infrared lens, didn't meet performance needs.

The various components then had to be tested and calibrated to meet the compressed timeline.

Perhaps most challenging aspect was the shift in mindset required at a company that, since its inception, has focused on mission assurance and the highest level of reliability.

"*We had to make sure we stayed focused on the requirements that were important to the system*," said Dr. ***Sara Lampen***, Engineering Specialist in the Visible and Infrared Systems Department and payload lead for the mission. "*Making sure things are small, that they would be quick to manufacture — those all factored in to our decisions.*"

The successful launch of AeroCube-15, along with the concurrent launch on November 2 of AeroCube-14, will bring the total number of Aerospace CubeSats on orbit to 25.

Aerospace was an early pioneer in the development of small satellites and continues to conduct pathfinding research in the field as one of the world's leading private constellation operators.

AEROSPACE

25 YEARS
AvL TECHNOLOGIES
1994-2019

CONNECTING THE WORLD FOR 25 YEARS

NEW 2.2M ULTRALIGHT ANTENNA

- The most compact 2m class antenna on the market
- Comparable performance to competing 2.4m antennas with small pack-up
- High-stiffness ultra-lightweight carbon fiber reflector and positioner base
- Quad-band: Ku, Ka, X and C
- Intuitive coarse/fine Az/El positioning
- Simple feed polarization positioning
- Can be assembled and on-network in less than 25 minutes
- Packs into two checkable transit cases with each weighing less than 100 lbs.

AvL TECHNOLOGIES

avltech.com

Visit AvL at SmallSat Symposium in Mountain View, CA

Space Fence nearing operational acceptance by U.S. Air Force

When the U.S. Air Force declares operational acceptance of the Space Fence radar located on Kwajalein Atoll, it will play a critical role in providing a tactical advantage to the nation's warfighters in the space domain.

Space Fence will use its flexibility, coverage, and sensitivity to detect and accurately track significantly more objects than the current-day catalog.

This crucial capability is now one step closer to providing unprecedented space situational awareness with the system completing its developmental and operational testing phases and has entered a trial period - one of the last steps before achieving operational acceptance.

Beyond cataloging objects, Space Fence will detect closely-spaced objects, breakups, maneuvers, launches and conjunction assessments from LEO through GEO.

Frequent collisions and deterioration of assets, such as defunct satellites and rocket boosters, have increased the amount of space debris and raised the risk of future collisions in space.

According to NASA's most recent Orbital Debris Quarterly News, NASA calculates about 17.6 million pounds of objects are in earth orbit.

Space Fence Operations Center. Image is courtesy of Lockheed Martin.

That number will only grow as more commercial space projects launch massive constellations with thousands of smallsats, presenting a huge problem for both U.S. government and commercial organizations.

That's where the U.S. Air Force's Space Fence will play a crucial role.

The radar system will also play a crucial role in the everyday lives of Americans who are becoming more dependent on space-based technologies for everything from weather forecasting, banking, global communications to GPS navigation.

Today, these critical services are being threatened by hundreds of thousands of objects and space debris orbiting the Earth.

Space Fence has already begun to prove its unmatched capabilities. During testing of the system in March, it detected the debris field from an anti-satellite test conducted by India. Space Fence observed a significant amount of debris tracks surrounding the time of the event, and the system proved its ability to automatically predict and correlate their next crossing times.

Space Fence uses advanced solid-state S-band radar technology. The technology includes element level digital beamforming, Gallium Nitride-based, software defined programmability that can be adapted over time to address emerging needs of the warfighter.

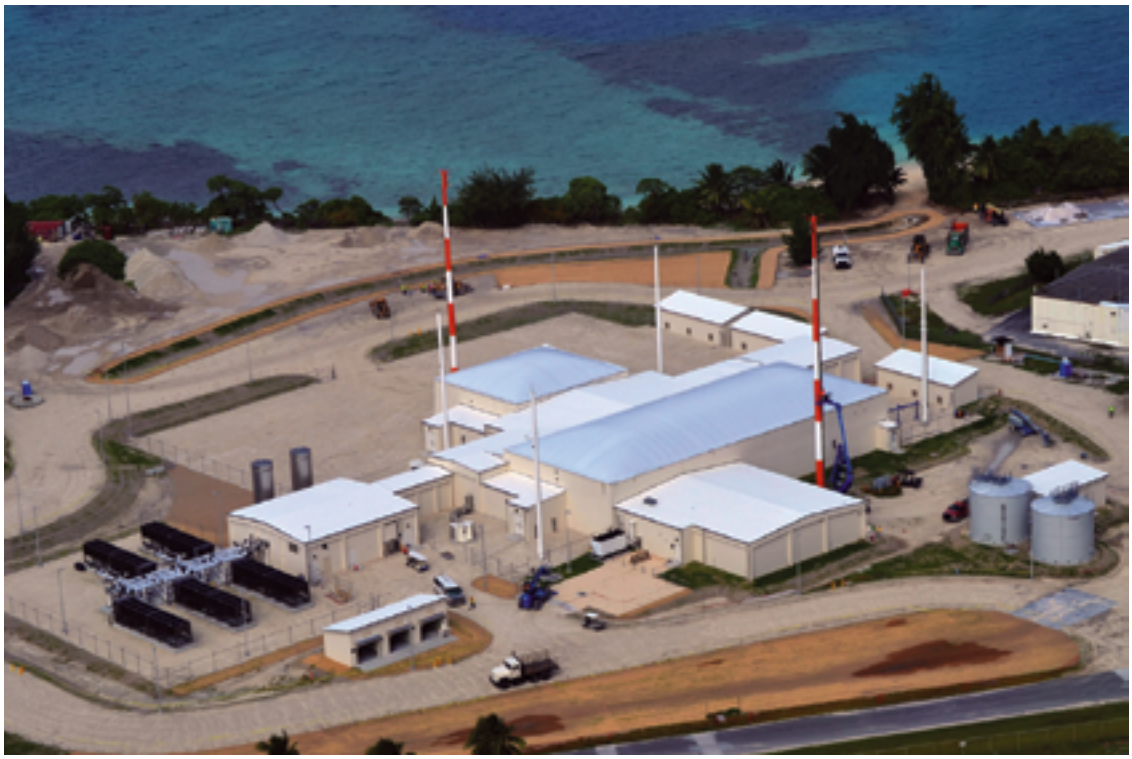
Dr. ***Rob Smith***, VP and GM of Lockheed Martin's Radar and Sensor Systems, said Space Fence will revolutionize the way objects that threaten both manned and unmanned military and commercial space assets are tracked and classified, critical to the national defense and economy.

The Air Force Space Surveillance Network currently tracks about 25,000 objects.

When Space Fence comes online, the catalog will experience significant growth and when fully operational, Space Fence will be the world's largest and most advanced radar system, providing unprecedented space situational awareness.

In a 2019 interview with Breaking Defense, Gen. ***John Hyten***, U.S Strategic Command commander, said of the Space Fence radar system, "*I've been out there and the data is eye watering. It's better than we even thought it would be.*"

Once the Trial Period is successfully completed, operational acceptance of the radar will be declared by the U.S. Air Force.



An aerial view of the Space Fence facility located on Kwajalein Atoll. Image is courtesy of Lockheed Martin.

WALTON DE-ICE

Portable Radome

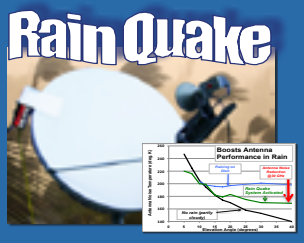
New LEO / MEO Design

The **Portable Radome** makes satellite networks more survivable and deployable into extreme and harsh environments. Protect transportable antennas and equipment from, snow, ice, burning sun, sandstorms, torrential rains, up to 85 mile-per-hour winds, and more.

- Single-person setup in less than an hour — conventional radomes can take days.
- New LEO/MEO design for full-arc / elevation angle performance. L, C, Ku, X, & Ka.Bands.

The industy's most powerful, cost-effective De-Icing. For antennas from 3.7 to 32 meters.

Sheds off snow before ice forms. Huge — up to 100 X — energy savings compared to conventional systems. 0.6 to 6.3 meters.



Minimize Signal Loss due to Rain Fade. Reduce data loss — by 20X or more.

+1 (951) 683-0930 I sales@de-ice.com I www.De-Ice.com
WB Walton Enterprises, Inc. P.O. Box 9010 San Bernardino, CA 92427, USA

Making a difference fuels retention in Space, Cyber Commands

Soldiers, airmen and industry partners conduct network surveillance during Cyber Shield 19 training week at Camp Atterbury, Indiana, earlier this year. Photo by U.S. Army Staff Sgt. George B. Davis.

More than anything, making a difference and staying on mission are the keys to retention in U.S. Space Command and U.S. Cyber Command, the senior enlisted leaders for those two organizations said.

"*Retention is a challenge that we face in Cyber Command and with our cyber workforce*," U.S. Marine Corps Master Gunnery Sgt. ***Scott H. Stalker***, the senior enlisted leader for Cybercom, said during a briefing at the Pentagon. "*What we've found is there are a lot of factors to keeping that talent in and keeping them on the mission.*"

One way Cybercom retains talent is that the military services offer certain bonuses, up to $90,000 in some cases, to those qualified, Stalker said.

Some offer special duty assignment pay as well, up to $1,500 a month in some cases, he added.

"*But what we found is, with all of that, you are going to keep in manpower, but not necessarily talent*," he said. "*So we have go to look at our high-end talent, our top 25%. What are the things that keep them in? And more often when I talk to them, they want to have stability. They want to do something that is important and hard.*"

Stalker said there's no shortage of hard, challenging work at Cybercom and the National Security Agency, both at Fort Meade, Maryland.

"*So we really focus on the job that they have to do — not so much 'Here's more money, we'll keep you in,'*" he said. "*We want them to know that what they are doing is relevant. ... When it comes to targets like China, Russia, Iran, North Korea and violent extremist organizations, on a daily basis they are employed. They are working hard. That's what they want to be doing. They want to be on mission doing their job. I'd say that's probably the same in most domains. They want to do the job they came in for.*"

U.S. Air Force Chief Master Sgt. ***Roger A. Towberman***, the senior enlisted leader for Spacecom, said the command's work is so exciting that he's not really concerned about retention of the force — or even about recruitment.

"*From a space perspective, there's never been a better time to be in this business,*" *he said. "Getting people excited about space isn't one of our current challenges. People are really excited. They are asking all the time. They want in. They want to be a part of it. And so I am not too concerned with retention, certainly not in the short term.*"

He continued, "*There is just so much work to do, and it's such an exciting business to be in right now. We've got lots of folks ready to step up and help us out.*"

Towberman said he sees first hand the new talent that's coming through the door — and he's impressed with what America has to offer.

"*What's really interesting is [that] the raw material we're getting from America has never been more incredible*," he said. "*The digital natives that are coming into the military today are exactly the warfighters we need for the future. And it's more about figuring out how to unleash the talent and capability that's within them than it is kind of teaching them things.*"

Army Command Sgt. Maj. ***John W. Troxell***, the senior enlisted advisor to the chairman of the Joint Chiefs of Staff, said the young Americans coming into careers in space and cyber have other options, but the military provides something else that keeps them interested.

"*I will tell you most of these high-end warriors like cyber and space, ... they want to make sure that what they are doing is having an impact*," he said. "*That they belong to a team that is cohesive, and they know that they are valued members of that team, and finally that their families are being taken care of. They are at a place they want to serve, and they are comfortable doing it.*"

"*So, more and more*," he continued, "*as we move forward and we look at these critical skills we have to be in the talent management business, as opposed to potentially a personnel management business.*"

Story by C. Todd Lopez

A long-exposure photograph of a night launch of a missile, which leaves a trail of light.

L3Harris receives $50 million order for HF radios from the USMC

A sizable order worth $50 million for Falcon III AN/PRC-160 HF radios has been awarded to L3Harris Technologies (NYSE:LHX) as a follow-on delivery order for Falcon III AN/PRC-160 HF radios and related equipment from the U.S. Marine Corps as part of its High Frequency Radio II modernization program.

The order is part of the Navy Portable Radio Program five-year IDIQ contract received in 2017.

As part of the modernization program the Marine Corps selected the AN/PRC-160 to replace legacy L3Harris HF radios as it is a modern solution for Beyond-Line-of-Sight (BLOS) communications in a satellite-denied environment.

Additionally, the AN/PRC-160 is the smallest, lightest and fastest wideband HF manpack available that provides 10X throughput over legacy systems.

According to the company, this is the only HF manpack that meets new NSA crypto-modernization standards.

The system's software-defined architecture allows encryption updates, ensuring mission-critical information stays secure.

It also enables command and control in a degraded environment and long-range voice and data with interoperability across U.S. and Coalition forces.

Dana Mehnert, President, Communication Systems, L3Harris stated that the AN/PRC-160 delivers the security and resilience the Marine Corps needs for its tactical radio modernization programs, while providing unmatched capability for Marines on the battlefield.

Dana continued by saying these radios provide high-speed, long-range HF communications that meet the Marine Corps' demanding program of record requirements.

L3HARRIS™
FAST. FORWARD.

Enhanced Polar Systems recapitalization payload program passes CDR

The Enhanced Polar System Recapitalization (EPS-R) Payload program reached a major program milestone completing a successful Delta Critical Design Review (CDR) on October 9.

Northrop Grumman Aerospace Systems (NGAS) is the EPS-R Payload developer via an approximately $410 million contract awarded in February of 2018 that runs through December 2023.

The CDR was the culmination of more than two months of review by the government and contractor team assessing the maturity of the payload design, which allows the program to transition to the manufacturing phase.

It focused on changes from the original EPS design to accommodate a new host space vehicle and was successfully completed with no significant issues or concerns.

As an EPS follow-on, EPS-R will include two eXtended Data Rate (XDR) payloads and will fill a Protected SATCOM coverage gap in the North Polar Region until the Protected Tactical SATCOM and Evolved Strategic SATCOM polar variants are available in the 2030's.

Partnerships, innovation and speed are key tenets of the Space and Missile Systems Center (SMC) 2.0 vision to accelerate fielding new capabilities to the warfighter.

SMC's Production Corps EPS program is strengthening international partnerships by collaborating with the Norwegian Ministry of Defence and Space Norway to integrate the EPS-R payloads onto two separate Space Norway-procured satellites (developed by Northrop Grumman Innovation Systems) scheduled to launch in December 2022 aboard a SpaceX Falcon 9 commercial launch.

Space Norway is procuring the Arctic Satellite Broadband Mission in order to deliver broadband coverage to civilian and military users in the Arctic.

The EPS program office used innovative and rapid solutions to award the EPS-R Payload contract to NGAS in less than six months using a sole-source undefined contract.

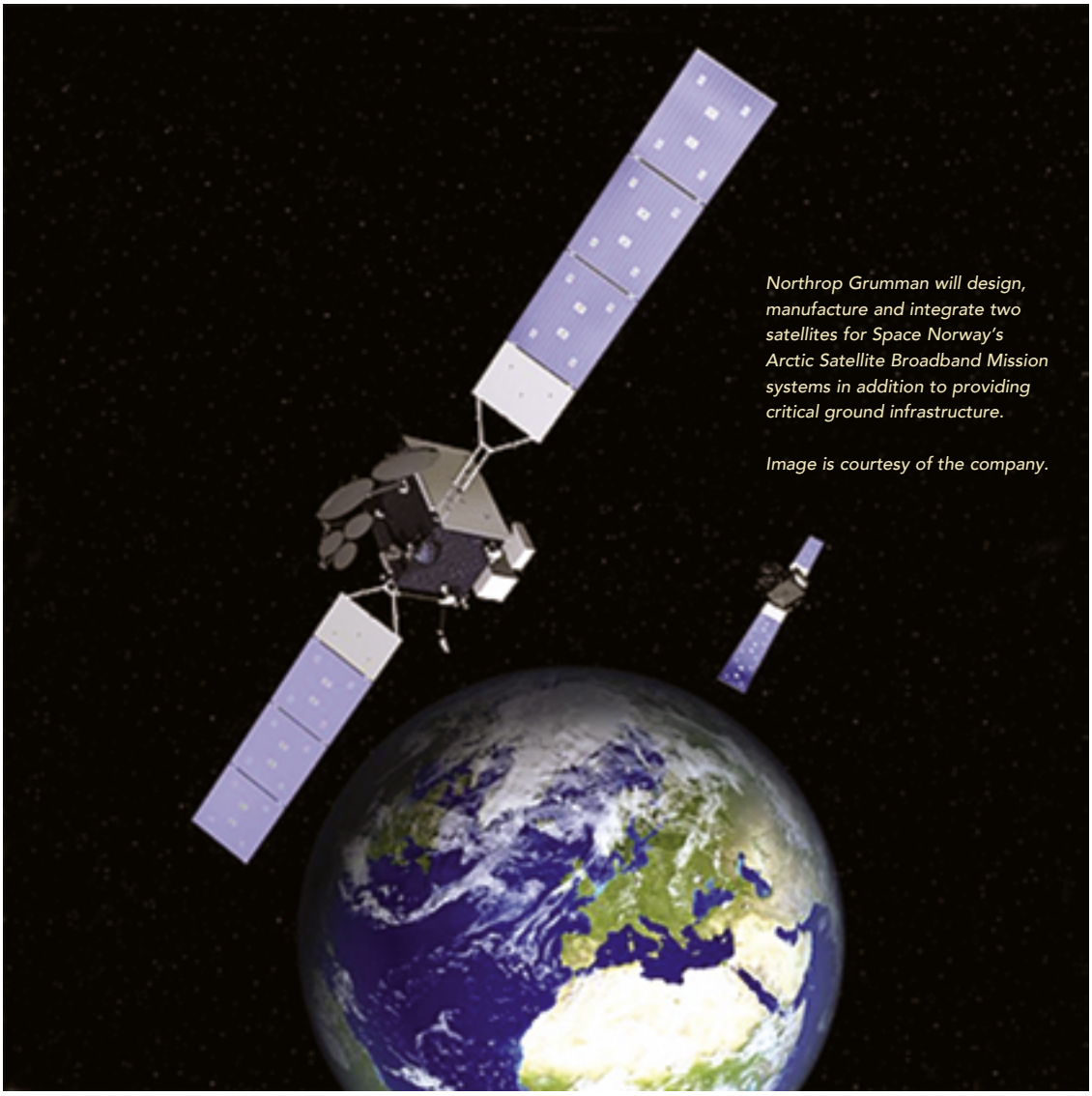
Additionally, the team awarded the EPS-R Control and Planning Segment ground contract less than 40 days after receiving a proposal from Northrop Grumman Mission Systems.

These efforts enabled the program to leverage the hosting opportunity with Space Norway and placed it on track to deliver its capabilities three years ahead of schedule with the potential savings of up to $900 million.

Major *John Gomez*, EPS-R Payload Program Manager, said the EPS-R program's unprecedented approach leverages best practices of the organization's commercial space vehicle and commercial launch vehicle provider,s while collaborating with Norwegian partners, and will prevent a protected communication coverage gap for warfighters in the Arctic region until future systems are available.

The U.S. Air Force Space Command's Space and Missile Systems Center, located at Los Angeles Air Force Base in El Segundo, California, is the U.S. Air Force's Center of Excellence for acquiring and developing military space systems.

SMC's portfolio includes the Global Positioning System, military satellite communications, defense meteorological satellites, space launch, range systems, satellite control networks, space-based infrared systems and space situational awareness capabilities.



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

Image is courtesy of the company.

DISPATCHES

Kratos gleans a $39 million geolocation global support services contract

Kratos Defense & Security Solutions, Inc. (Nasdaq: KTOS) has been awarded a $39 million sole-source contract for Geolocation Global Support Services — the award is a five year contract that includes a base year and four one-year options, for a total value of up to $39 million — work on the initial $7.7 million base year contract began on December 1, 2019.

Kratos will provide continuous RF monitoring services for government leased bandwidth on commercial satellites and bandwidth on military satellite communications; including bandwidth identified by the Combined Space Operations Center, or CSpOC. Kratos will also support resolving interference events through employment of mitigation strategies and geolocation activities.

These services use Kratos products including Monics® and satID® to identify, isolate and geolocate interfering signals.

Monitoring services will provide the U.S. Government the ability to efficiently use leased bandwidth, saving money and resources while ensuring that critical satellite communication links stay operational.

Kratos offers RF monitoring services, also referred to as spectral services, with a global network of antennas and sensors necessary to provide constant (24 hours per day, 7 days per week) bandwidth monitoring, detection and geolocation interference in the C- and Ku- bands specified by the Combined Force Space Component Command (CFSCC).

Kratos' sensor network currently consists of 20 worldwide sites hosting more than 80 fixed and steerable sensors and antennas in C-, Ku-, X- and S-bands.

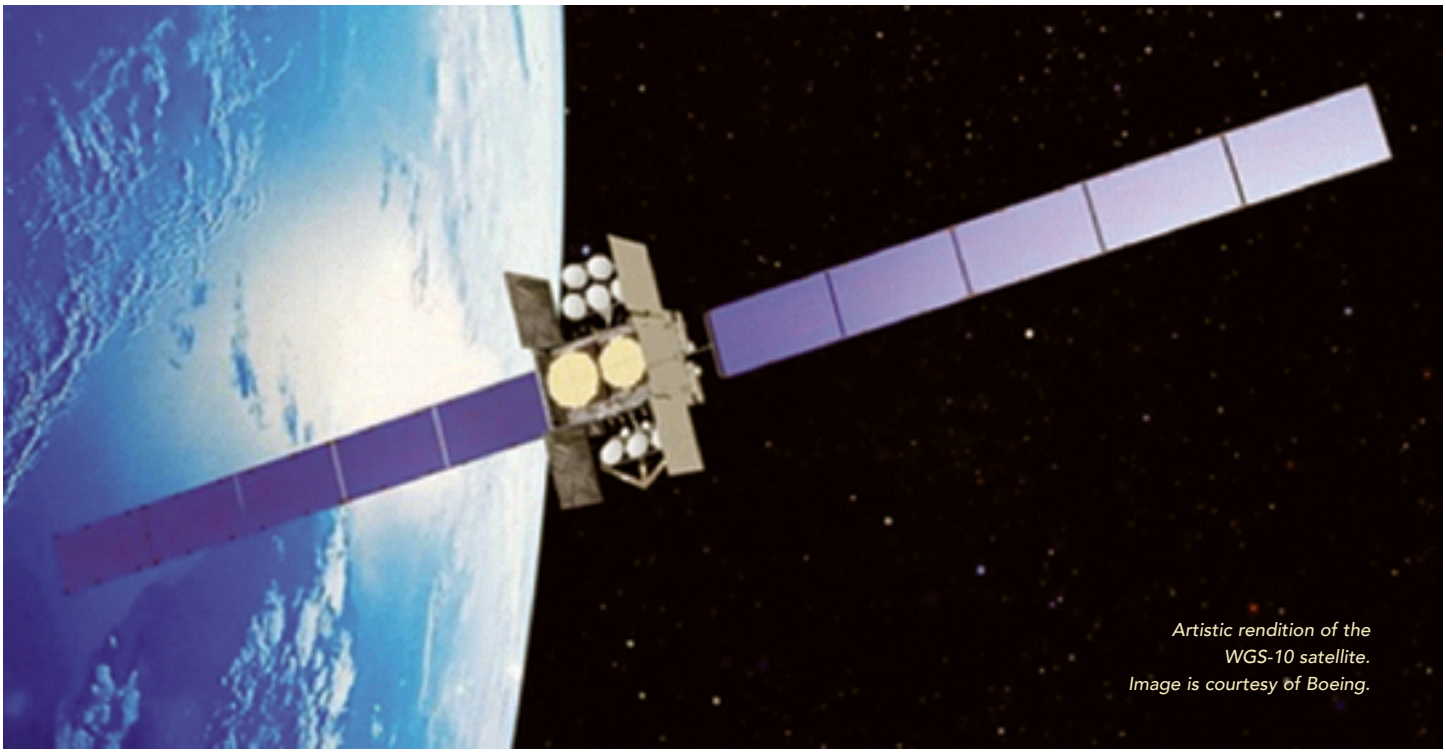
Kratos spectral services are part of a portfolio of RF services offered to government and commercial customers including end-to-end satellite RF monitoring, interference detection, geolocation and mitigation.
RF data analytics services including bandwidth use reports and advanced correlative and predictive analytics are available as a subscription or on demand. Kratos RF space domain awareness services provide RF data insights, including: detecting payload and other operational changes or anomalies, their origin or cause and ephemeris generation.

Matt Langenbahn, VP of RF Sensing Systems for Kratos, said that the company's commercially owned and operated global RF space domain awareness network uses proprietary sensors and software to collect and deliver persistent, day or night real-time data. The global network augments U.S. government satellite communication with detection services for anomalies, maneuvers and interference. Kratos' Mission Partner approach helps the government and satellite operators understand more about the health, location, attribution, performance and other behavioral factors about satellites in space.

Phil Carrai, President of Kratos Space, Training and Cybersecurity Division, added that the company's technology assures that U.S. multi-domain operations continue unabated. This service is just one of the many ways Kratos is aligning commercial capabilities with U.S. government strategies by ensuring satellite communication links in support of national defense.

KRATOS
DEFENSE & SECURITY SOLUTIONS

WGS-10 accepted by U.S. Space Command



Artistic rendition of the WGS-10 satellite. Image is courtesy of Boeing.

On November 19, U.S. Space Command accepted Wideband Global SATCOM (WGS)-10 into the operational constellation and will be transitioning users to use the bandwidth provided by this new satellite.

Boeing completed verification of the satellite's performance and handed control authority to the U.S. Air Force on July 10.

Following handover, Space and Missile Systems Center's WGS program office, in collaboration with the U.S. Army and U.S. Navy, completed on-orbit testing of WGS-10 and then recommended the satellite for acceptance into the operational constellation.

The joint team conducted numerous payload characterization and verification activities to optimize the end-to-end system's performance.

Additionally, the wideband community took advantage of an extensive special testing period to validate new and emerging anti-jam capabilities as well as resilient techniques and procedures that will be incorporated into the entire WGS constellation.

The WGS mission demonstrates the U.S. Air Force's and U.S.Army's continued commitment to jointly deliver secure and reliable satellite communications around the globe to US and Allied forces.

WGS delivers critical capacity, connectivity and interoperability to the Air Force, Navy, Army, Marines and International Partners. Each WGS satellite is fully backwards compatible with more than 15,000 joint terminals across the wideband enterprise.

Culture and partnerships are key tenets of the SMC vision to accelerate capabilities to the warfighter.

The WGS program office has established a strong working relationship with Boeing by having a lean and empowered government team embedded in the prime contractor's facilities, leveraging commercial processes, practices and technology.

The acceptance by U.S. Space Command of the WGS-10 satellite is a testament to the dedication of the U.S. Air Force-Boeing team that helped ensure military's communications capability anytime and anywhere in the world.

In order to accelerate the production of game-changing capabilities to meet an evolving threat environment, the WGS program office has been part of an SMC culture change from risk aversion toward innovation, and has utilized a "speed through empowerment" operating model.

With WGS-10 transferring to operations, the WGS program office will shift its focus solely to executing its Mitigation and Anti-jam Enhancement upgrade and the development and fielding of its next generation WGS-11+ satellite system.

With WGS-11+, the government is using its commercial best practices and is incorporating the same technologies offered to commercial communication satellite customers to deliver enhanced mission utility through contested environments.

The SMC Production Corps is leveraging partnerships and exploring collaborative efforts to posture WGS-11+ as a viable government host platform for rapid prototyping efforts.

Additionally, WGS-11+ will continue and expand upon the already strong international partner support associated with the WGS program.

Lt. *Connor MacMillan*, WGS test lead, stated that by verifying system performance and testing new resilient capabilities, SMC is able to put the warfighter first — maintaining a robust satellite constellation with proven MILSATCOM capabilities.

Dr. *Kurt Fiscko*, technical director of the Navy's Communications and Global Positioning System Navigation Program Office, noted that the WGS system now provides U.S. Navy ships worldwide 20 times the data throughput that ships received before the advent of the system. Computer applications that previously could not operate over wideband SATCOM are now enhancing warfighting capability on a daily basis, creating a Navy today that is digitally connected.

DISPATCHES

Envistacom's $47.8 million SATCOM contract

Envistacom has received a $47.8 million, three-year award to support the Deployable Ku Band Earth Terminal (DKET) program managed by the U.S. Army's Product Manager Satellite Communications (PdM SATCOM).

The task order was awarded under the Deployable Adaptive Global Responder Support (DAGRS) indefinite delivery, indefinite quantity (IDIQ) contract worth up to $480 million over five years.

Envistacom will provide installation, training, relocation, integration, and upgrades for new, legacy and existing DKETs, DKET LT ("Lite" version) and mobile DKET (MKET).

PdM SATCOM is responsible for the Army's tactical multi-channel satellite ground and commercial terminal programs and Envistacom will help upgrade existing terminals, as well as spares, new terminals, installation, relocations and necessary interface equipment and services.

Additionally, the new deployable SATCOM terminal antennas provided by Envistacom will be multi-band capable, operating in Ku, Ka and X-Band frequencies.

The DKET is the backbone of long-haul transmissions for the U.S. African Command (AFRICOM) and U.S. Central Command (CENTCOM), with more than 80 DKETs deployed to support multiple areas of operation (AOs).

DKET provides intra-country communications within and between regional commands globally, and inter-theater communications with reach back capabilities to other countries and continents.

Nelson Santini, SVP of Sales at Envistacom, said the company will help support the Army's PdM SATCOM achieve its modernization goals through the implementation of virtualization, and other new technologies. The firm has built a strong rapport with the Army and is pleased to be selected for such an important program providing satellite transmission capability within the Department of Defense global network for almost 20 years.

ENVISTACOM

GaN BUCs
for your mission-critical applications

The last word in GaN BUCs from the first name in HPAs.

- Ka-band 40 – 160 Watts
- Ku-band 25 – 80 Watts
- C-band 10 – 100 Watts
- X-band 50 – 100 Watts

10 W Transceiver | High Power BUC | 160 W Ka-band BUC

Download our app!
Search: CPI Satcom

App Store | Google Play

CPI Communications & Power Industries
satcom products

CPI SMP Division | **www.cpii.com** | +1 (669) 275-2744

DISPATCHES

Gilat's Wavestream receives $6 million DoD order

The U.S. Department of Defense (DoD) has enlisted the expertise of Gilat Satellite Networks Ltd.'s (NASDAQ, TASE: GILT) Wavestream subsidiary.

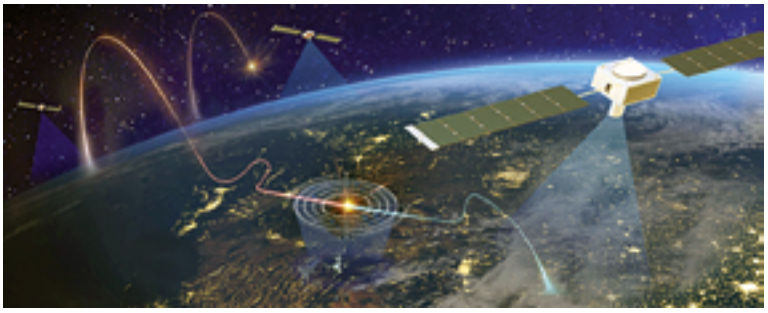
The company has received orders for more than $6 million from the U.S. Department of Defense (DoD) for their state-of-the-art GaN BUCs.

Bob Huffman, Wavestream's General Manager stated that Wavestream has delivered thousands of SSPAs to the U.S. Armed Forces for over a decade, This venture is the first award for Gilat of a five-year base-period of potentially over $10 million worth of deliveries to the U.S. DoD.

and they take pride in continuing to provide the best solutions to support the U.S. forces world-wide with field proven, highly reliable telecommunications solutions.

DISPATCHES

Hypersonic and Ballistic Space Sensor Tracking Phase IIa contract for Northrop Grumman

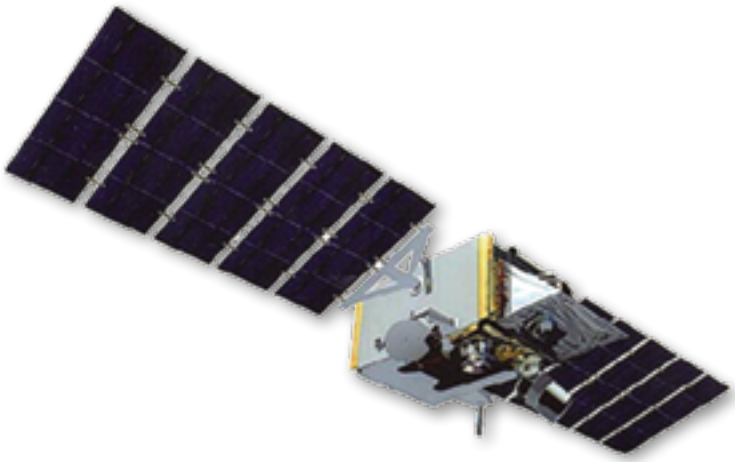


The company's concept advances under the HBTSS Phase IIa program
Image is courtesy of Northrop Grumman.

Northrop Grumman Corporation (NYSE: NOC) has been selected as one of four Other Transaction Authority awards for the Phase IIa Prototype Payload Design and Signal-chain Processing Demonstration of the Missile Defense Agency's (MDA) Hypersonic and Ballistic Tracking Space Sensor (HBTSS) program.

Northrop Grumman is developing a highly capable, affordable, survivable and extensible space-based sensing solution for hypersonic and ballistic missile defense.

The 12-month HBTSS Phase IIa will demonstrate the payload design for a proposed satellite constellation to detect and track hypersonic and advanced missile threats.



Artistic rendition of an MDA STSS satellite.

Phase IIa retires technical risk through the demonstration of critical technologies required to track advanced weapons like hypersonic missiles from space.

The award continues Northrop Grumman's longstanding partnership with the Missile Defense Agency and broader space and missile defense community on solving critical national security challenges.

Northrop Grumman will demonstrate its agile and affordable approach to producing space-based sensors in large quantities for proliferated, global operations.

Northrop Grumman is building Phase IIa upon the concepts developed in Phase I. Work will be performed at various company locations in the United States.

Northrop Grumman's end-to-end, multi-domain approach to hypersonic and ballistic missile defense spans technologies in multiple warfighting domains from sea to space, as well as the electromagnetic and cyber environments.

Kenneth Todorov, VP, Missile Defense Solutions, Northrop Grumman, said that HBTSS is an important undertaking that allows advanced threats, such as hypersonic missiles, to be seen in ways not previously possible. He added that if threats can be seen, they can be taken out.

The Missile Defense Agency (MDA) operates the Space Tracking and Surveillance System (STSS), which consists of two satellites orbiting at 1350 km., 58 degree inclination, with 120 minute orbital period. STSS uses sensors capable of detecting visible and infrared light and serves as an experimental space tracker for the Ballistic Missile Defense System (BMDS).

On September 25, 2009, MDA, NASA, and the U.S. Air Force teamed to successfully launch two satellites into LEO on a Delta II launch vehicle from Cape Canaveral, Florida.

Both satellites are operating nominally on-orbit at the Missile Defense Integration & Operations Center, Schriever AFB, Colorado.

STSS is participating in integrated BMDS testing and providing risk reduction in support of a future missile defense space tracker.

Advantech Wireless **Technologies**

25W to 50W

PAMIR

80W to 125W

DENALI

150W to 250W

CASCADE

300W to 500W

TAURUS

800W to 1kW

SUMMIT

1kW to 10kW

New line of
Solid State Power Amplifiers & BUCs

Ku, C and **X Bands – GaN** and **GaAs** configurations

ADVANTECH
Wireless Technologies

advantechwireless.com

COMMAND CENTER: FRANK BACKES, SENIOR VICE PRESIDENT, FEDERAL SATELLITE SOLUTIONS, KRATOS DEFENSE AND SECURITY

The nation's superior defense and intelligence capabilities are dependent on space and satellites and adversaries are showing that they intend to eliminate this advantage. What is Kratos doing to help keep the U.S. and Allies maintain the upper hand?

Frank Backes (FB)

When you look at space capabilities, Earth Observation (EO), GPS/PNT, and communications, and consider what an adversary might do to deny or disrupt them, there's a need to understand the space domain and anything that can impact those capabilities.

With Space Situational Awareness (SSA) the focus has been on tracking where objects are in space. However, with the new threat environment, there has been a pivot to Space Domain Awareness (SDA) because the concern isn't just where objects are, but also what adversaries are capable of doing in that area. The U.S. needs to know how those activities could affect our assets and how we use space.

Kratos is supporting many of the programs and initiatives being developed for Space Domain Awareness and to meet the DoD's requirement for more resilient and robust ground satellite communications. We are building tools that are modular in design and make up the basis of an enterprise management architecture for the satellite ground segment.

In terms of those threats, what types of programs and initiatives is Kratos supporting?

FB

One thing adversaries are doing is investing in the ability to jam communications, which is fairly inexpensive, reversible, and easy to employ. If an adversary attacks the communications infrastructure either by jamming or other similar tactics you'd want to know that the signal is being impacted. You would also want to know what choices or options you have to communicate or operate through the contested environment.

...the goal is to show the government they can achieve this operational capability faster.

Kratos has been working on programs that provide signal monitoring, RF situational awareness, virtualized command and control, interoperability between military and commercial networks, and the ongoing capability to communicate across domains in congested and contested environments.

Can you give us an example of those programs?

FB

Kratos and its partners have been working with the U.S. Air Force (USAF) to develop an Enterprise Management & Control program, or EM&C, which is a flexible resilient communications infrastructure. This system will combine domain awareness for the warfighter with the ability to respond appropriately to mitigate the threat.

In the jamming example previously mentioned, EM&C would have the capability to automatically switch to a different communications link to maintain satellite-dependent operations.

Can you explain how that works?

FB

EM&C will provide an enterprise-wide view of all SATCOM resources, which includes the health, availability, and status of the satellites, networks, and gateways. The Common Operational Picture, or COP, will detect the interference and the impact to the network. The system logic would then determine why, when, and how to perform the mitigation, which for example, would be to roam to a suitable satellite network to keep users connected. That switchover and re-provisioning would occur in seconds or minutes, much like our cell phone networks.

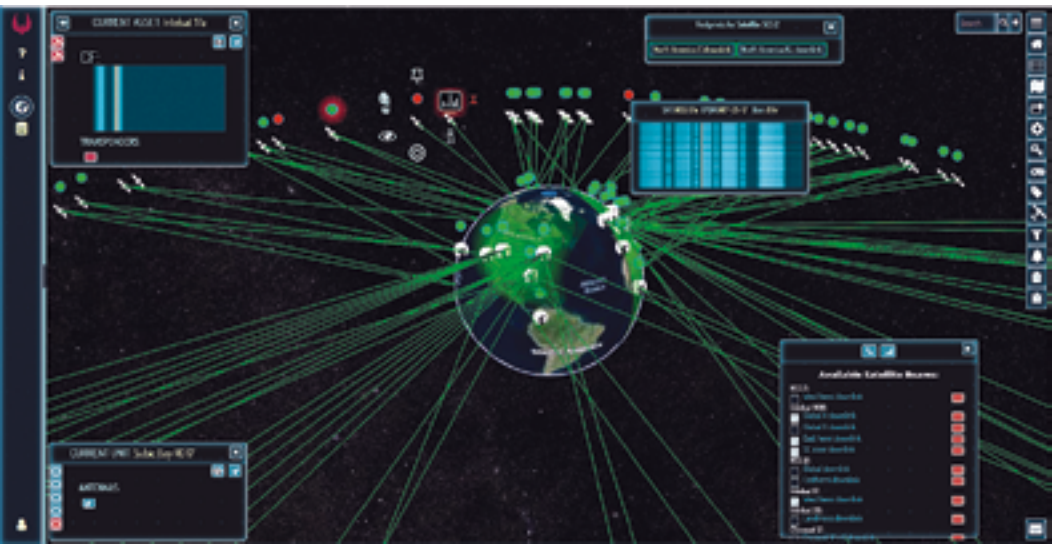
What is the status of EM&C, as it represents many elements of the new Kratos enterprise architecture?

FB

The USAF has multiple phases to achieve EM&C. Kratos has developed the prototype and successfully demonstrated the system's ability to roam across different networks, enabling secure SATCOM in response to interference, congestion, or changing mission needs using equipment typical of current DoD infrastructure.

That timely, automated re-provisioning will be of immense value to the mission. The next phase will be to prove it can scale, and then to deploy operationally.

A network operations center — photo is courtesy of Kratos Defense.



An RF Common Operational Picture (COP) provides space domain awareness, a capability provided through the Kratos global sensor network.

How is the system able to view the SATCOM resources and detect issues?

FB

Kratos possesses a global commercial RF network to deliver RF spectral services. That network consists of 21 worldwide RF monitoring sites, hosting more than 80 sensors and antennas specially tuned for high-speed, accurate RF signal collection and measurement.

The global infrastructure is supported by Kratos' Network Operations Center (NOC), a dedicated workforce servicing government and commercial customers around-the-clock.

How does this help with Space Domain Awareness?

FB

Kratos' earlier work monitoring RF spectrum was used primarily in a benign communications environment. For example, to monitor the U.S. government's utilization of leased capacity, which has saved them millions of dollars per year. The NOC now monitors and geolocates interference for services across the DoD, for commercial satellite operators, and many others.

Now with the threat environment more active, Kratos has extended that RF monitoring infrastructure, transitioning from a more neutral environment to a more contested one. We've expanded on that network and those sensors and systems to look at how the entire RF domain is used by the U.S. and our adversaries. That spectral awareness can tell you a lot, from seeing satellites as they maneuver, to determining their capabilities and intent, to geolocating jamming and interference.

Kratos is applying all these technologies, and accelerating the speed in which data is processed, to support space domain awareness. Once you can understand what an adversary is doing to impact your satellite capabilities, then you can figure out what to do to mitigate it.

That's where the rest of the Kratos management architecture can come into play. If the satellite is being jammed and the systems need to point to a different satellite on a different frequency to continue communicating, the system is able to determine the mitigation and execute a response to solve the problem.

How is the Kratos approach different from a traditional ground infrastructure?

FB

Using the latest technical advances from the commercial sector, Kratos is virtualizing the ground segment architecture, which includes replacing many of the traditional RF hardware elements (such as splitters, combiners, and frequency converters) with an equivalent family of virtual functions.

Additionally, traditional management functions that have relied on specialized hardware, such as spectrum monitoring systems, geolocation systems, and even element and network management systems will also transition to virtual functions. This includes command and control, which can be deployed and torn down in minutes and then quickly applied to new missions.

This virtualized ground technology will allow the U.S. DoD and its allies to automatically manage the transition of communication links between diverse satellites and systems, such as MEO, GEO, and eventually LEO constellations.

Kratos is integrating all these capabilities – the awareness, the analysis, and the control component – into its management architecture. The approach will automate and orchestrate those processes to support space domain awareness and resilient satellite communications.

What is the status of this architecture?

FB

Components of this architecture are available now, with several components or modules currently installed and working on programs. It's important to note that Kratos is working with the DoD to develop solutions allowing them to accelerate the transition to a digital realm while retaining their existing legacy hardware.

Can you explain how this new approach works with existing systems and hardware?

FB

Yes, the Kratos approach is being developed as an open, software-defined enterprise architecture, not a proprietary or purpose-built one. It will unify and automate many new SATCOM functions for DoD that simply aren't possible with existing, manually-configured hardware and stove-piped systems. The DoD will gain a fully integrated enterprise environment that can respond to threats with agility and flexibility, without needing to replace the majority of their existing infrastructure.

Much of it will consist of low-impact software upgrades, integrating new processing blocks into the existing architecture, and for the terminals, it will be either a software- or lightweight hardware-based interface upgrade. Those upgrades will help the government realize its goal of using as much infrastructure as possible without reinvestment (including thousands of field terminals), while enabling compatibility with new, modernized approaches.

This supports a transition from the limitations of legacy, analog systems to more flexible, software-oriented, IP compatible approaches. By digitizing the RF signals at the antenna, existing gateway antennas don't have to be recapitalized. That converted RF data can then be sent securely and reliably over IP networks for software processing, whether onsite or in a cloud architecture.

With adversaries moving more quickly and deliberately, are there concerns with keeping pace?

FB

One of the things Kratos will be doing in parallel with the E&MC program is showing the USAF and other services how to get to operational capability sooner than the current timeline. Through the investments we're making in our enterprise architecture and our work with our partners, which include multiple satellite operators, the goal is to show the government they can achieve this operational capability faster.

Kratos believes we are in a unique position to do this because of our customer base, and the systems we've deployed for the past thirty years representing the vast majority of space infrastructure used by the commercial, military, and international communities. We are one of the few companies that equally serve the commercial and government worlds. They have all been using Kratos technology independently for a long time.

What Kratos is doing now is integrating through an enterprise approach all those capabilities into an open architecture. This will support a new level of resiliency which depends on the ability to dynamically roam and transition across varied military and commercial satellites and networks in response to threats. To do this, we believe you need an open architecture, and that's what our Kratos solution is designed to accomplish.

KRATOS®
DEFENSE & SECURITY SOLUTIONS

ADVANTECH WIRELESS TECHNOLOGIES

A Baylin Technologies Company

Melding two competing companies into one consolidated team is a complex mission — and it's extremely satisfying when the parts come together.

This has been a busy year for Advantech Wireless Technologies.

In January of 2018, Baylin Technologies ("Baylin") acquired the Advantech name, logo, and brand along with the RF product lines comprised of Solid-State Power Amplifiers, Frequency Converters, SNG Antennas and Terrestrial Microwave products.

Additionally, in July 2018 Baylin purchased Alga Microwave & MitecVSAT bringing increased engineering and manufacturing capabilities that includes a complete line of microwave passive components.

In 2019 Baylin officially announced the grand opening of Advantech Wireless Technologies' ("Advantech") Center of Excellence, located in Kirkland, Quebec. The 66,000 sq. ft. facility currently houses the operations of Advantech, Alga and MitecVSAT.

Together, these teams have embarked on one of the most ambitious R&D road maps in the industry. Combining the three entities into one symbiotic operation has enhanced processes, design philosophies and market strategy.

Baylin made significant investments in the facility, creating one of the best state-of-the-art manufacturing facilities in the SATCOM industry.

The new location includes a machine shop with a dozen CNC machines, enhanced quality systems,

Ku-Band-300W-400W-500W BUC SSPB SSPA GaN.

advanced ESD protection, CO2 distribution, a new data center, anti-static flooring, power, LED lighting, ventilation, 15,000 square feet of new office space and superior working conditions, which have optimized the operational efficiency.

The bulk of Advantech's business is comprised of Solid State Power Amplifiers, however they also design and produce a line of Frequency Converters, Terrestrial Microwave Radios and Pulsed Amplifiers. The main differentiator for Advantech is the portfolio of SSPAs that range from 8 watts to more than 10,000 watts in S-, C-, X- and Ku-band frequencies.

Advantech is one of a small number of companies experienced in the provision of high-power, soft-fail SSPA systems which are featured in the 'Summit' product line.

Thousands of watts of RF power can be pushed, thanks to Advantech's proprietary, high efficiency combining structures.

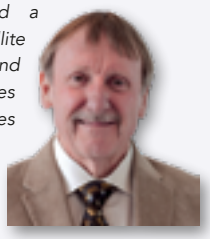
Current R&D initiatives also include high-power Ka-band, Q- and V-band amplifiers for LEO and MEO applications, pulsed amplifiers for RADAR and Troposcatter amplifiers and LNBs.

The Advantech design team is hard at work on 'hybrid' initiatives to combine the best elements of multiple products and increase performance and manufacturability.

Collaboration is both important and powerful when it comes to meeting the goals that have been set for the brand. Melding two competing companies into one consolidated team is a complex mission — and it's extremely satisfying when the parts come together.

The multiple perspectives and leading industry expertise have the team excited for 2020 and the years ahead.

3kW Ku-band GaN.



Tony Radford has amassed a 30 year career in the satellite communications industry and has worked in a variety of roles including engineering, sales and sales management at such companies as Scientific Atlanta, VertexRSI, STM Wireless, Paradise Datacom and Teledyne Technologies. Incidentally, Tony co-founded Telecom International, a SATCOM systems integration company that was ultimately purchased by STM.

ADVANTECH WIRELESS
A Baylin Technologies Company

AVL TECHNOLOGIES

From the outset, AvL has been an engineering-led company. What this means is that AvL products are engineered and re-engineered to the point of ultimate performance.

Founded in 1994, AvL Technologies reached a huge milestone this year: 25 years of connecting the world with mobile satellite communications!

From the company's humble beginnings — founded in Jim Oliver's garage as he tinkered together a custom solution at the request of BAF Communications — AvL Technologies has grown into a global mobile SATCOM industry leader.

What started as Jim's passion for solving problems and helping a former customer grew into a business, which then grew into a new passion for creating jobs in Jim's beloved adopted community of Asheville, North Carolina.

In 25 years, the company has outgrown several small industrial spaces to occupy two custom buildings with 100,000+ square feet of product development, manufacturing and testing space — and created an AvL Technology Park in the process.

The company's 300 skilled employees continually innovate and create new products, and find new ways to work with customers to solve challenging communications problems. The company has shipped more than 30,000 antennas, most of which are still in operation today.

If you were to ask Mr. Oliver about these achievements, he would tell you that 25 years passed in the blink of an eye and the company is on a trajectory to continue growing, innovating and creating lasting jobs in Asheville.

The 25 Years milestone was celebrated during the entire year. The company's Sales and Marketing teams enjoyed hosting in-booth events at trade shows and made sure to reconnect with customers, business partners, vendors and competitors at every opportunity.

Company celebrations were held for employees and their families, with yet a few celebrations planned before the end of the year (as well as a surprise for Mr. Oliver).

Though AvL shipped 1,200+ antennas this year, the company's passion for product development did not slow. In 2019, the company

AvL Technologies' 1.35 meter manual ARSTRAT antenna.

The AvL Technology Park.

embarked on several new products, many product improvements, new low-PIM and cyber security capabilities, and several ARSTRAT certification efforts.

AvL's product developments for U.S. Department of Defense (DoD) applications were numerous. The company continued its development of a Ka-band electronically steered array antenna (ESA), which is on track with respect to AvL's SBIR contract with the U.S. Air Force.

AvL incorporated enhanced cyber security protocols into the AAQ Antenna Control System this year for a specific military program, and the capability will be available by request to other customers soon. The company also integrated protected SATCOM modems as requested for key customers.

A next generation 1.2 meter, tri-band, flyaway tripod antenna, Model 1235-T, currently undergoing Inmarsat GX and ARSTRAT certification, was a priority.

AvL's engineering team built upon years of experience with 1.2 meter reflectors (the company's most popular aperture size) to design a robust, ultra-accurate and ultra-lightweight reflector for ARSTRAT operations.

The tri-band antenna is a modernized version of our Model 1035 terminal including an AAQ Antenna Control System, new packaging, an upgraded tripod and wideband Ka-band capability for operation with commercial Inmarsat GX and WGS.

AvL's new 85 cm. Model 824i and 1.2 meter Model 1224i flyaway antennas with two-case pack-ups have integral bonded cellular capability. The compact and functional designs enable either terminal to be set-up and operational in minutes by one person.

This is one of the many reasons these terminals have been selected for the FirstNet program and have been widely adopted for homeland security, law enforcement and public safety applications.

As part of the General Dynamics Mission Systems GBS solution, PathFinder Digital selected AvL to provide the 85 cm. Ka-/Ku-band flyaway antenna as part of the BAT-GBS-85 Terminal.

This robust terminal packs into two airline checkable transit cases and operates with GBS one-way wideband transmissions to support the timely delivery of classified and unclassified data and video products for mission support and theater information transfer.

The terminal completed MIL-STD-810G environmental testing and late in the year received ARSTRAT certification.

Several new configurations of AvL's Family of Integrated Terminals were developed in 2019. A lightweight weight version of the 1.35 meter tri-band terminal was selected for ARSTRAT certification to support the ISR Stingray program by Sigma Defense. Now in Phase 3, the 1.35 meter terminal is expected to be certified by year-end.

Two of AvL's larger trailer-mount antennas, sized at 2.5 and 3.8 meters, received design upgrades to operate with multi-carrier low-PIM X-band operation and EMI/EMC hardening. The 2.5 meter antenna also completed Ku-band certification testing by the GVF.

AvL was selected for important refurbishment and modernization programs in 2019. In doing so, the company is enabling the warfighter to use modernized equipment at a significantly lower cost than for new equipment.

Modernization efforts include adding the AAQ Antenna Control System, new RF equipment and the latest technology modems.

From the outset, AvL has been an engineering-led company. What this means is that AvL products are engineered and re-engineered to the point of ultimate performance. And sometimes re-engineering comes in the forms of improving parts of the antenna that are often overlooked but have a significant impact on performance.

One of those parts is the latches that hold together AvL's segmented reflectors. Latches are critical parts as they can contribute to the stiffness of a reflector or cause it to sway. They can impede reflector pack-up, cause damage to other reflector segments while packed, or nestle so as to hold reflector segments safely within a case.

During 2019, AvL's engineering team relentlessly pursued improvements to several types of latches and made monumental breakthroughs. Though difficult to describe, the improvements have made AvL's reflectors even higher performing, if that's possible.

To see proof in action, stop by AvL's booth at the upcoming SATELLITE 2020 show and ask one of our engineers to show you just how cool latches can be.

www.avltechnologies.com

Krystal Dredge is the director of marketing for AvL Technologies. Krystal has 15+ years of product marketing experience in satellite and wireless communication, and worked at Honeywell and EMS Defense & Space Systems prior to joining AvL in 2012. She holds a BSJ degree in Journalism from the University of Kansas and an MBA from Wichita State University.

CENTAURI

In addition to the threat of unintentional collisions, adversaries are advancing technologies with the intention of one day performing nefarious actions to the nation's assets in space.

2019 was a formative year — in the literal sense — for Centauri. In April, Centauri was created by bringing together three leading companies in the national security sector: Integrity Applications Incorporated, Xebec Global and Dependable Global Solutions.

Unique in the industry, Centauri is an elite prime contractor in the national security marketplace with extensive new capabilities that enable it to deliver innovative solutions for the most demanding mission needs within the Intelligence Community and Department of Defense (DoD).

The selection of the new name was purpose-driven: Centauri is the closest star system to Earth, made up of the brightest stars in the southern sky. And like the constellation, Centauri is made up of the brightest minds dedicated to solving the toughest challenges facing our customers' missions.

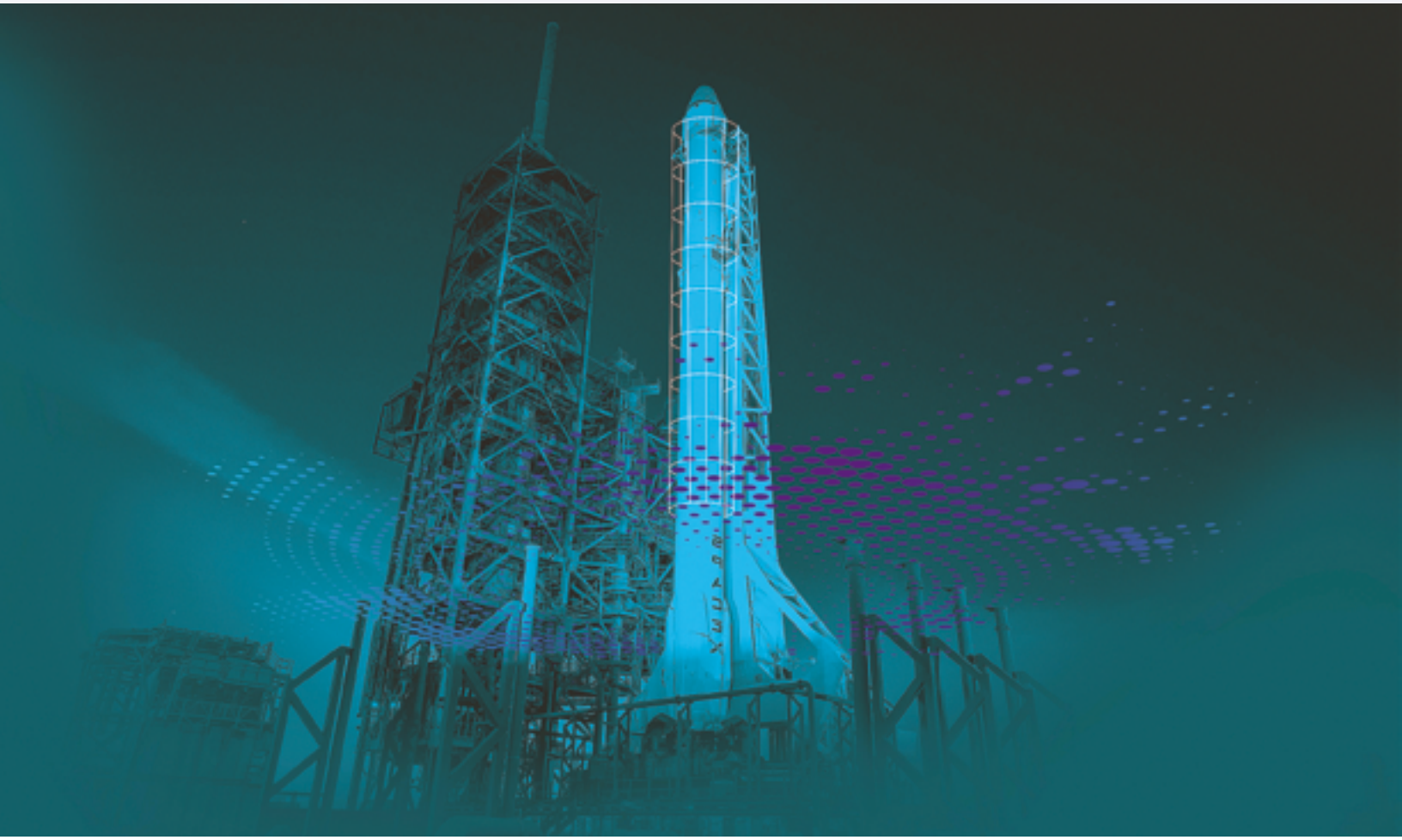
Centauri space solutions keep our nation ahead of adversaries Space solutions are a key component of Centauri's capabilities. Centauri's team of dedicated, mission-focused experts keep our nation at the forefront of space-based sensor technology development — and always ahead of our adversaries.

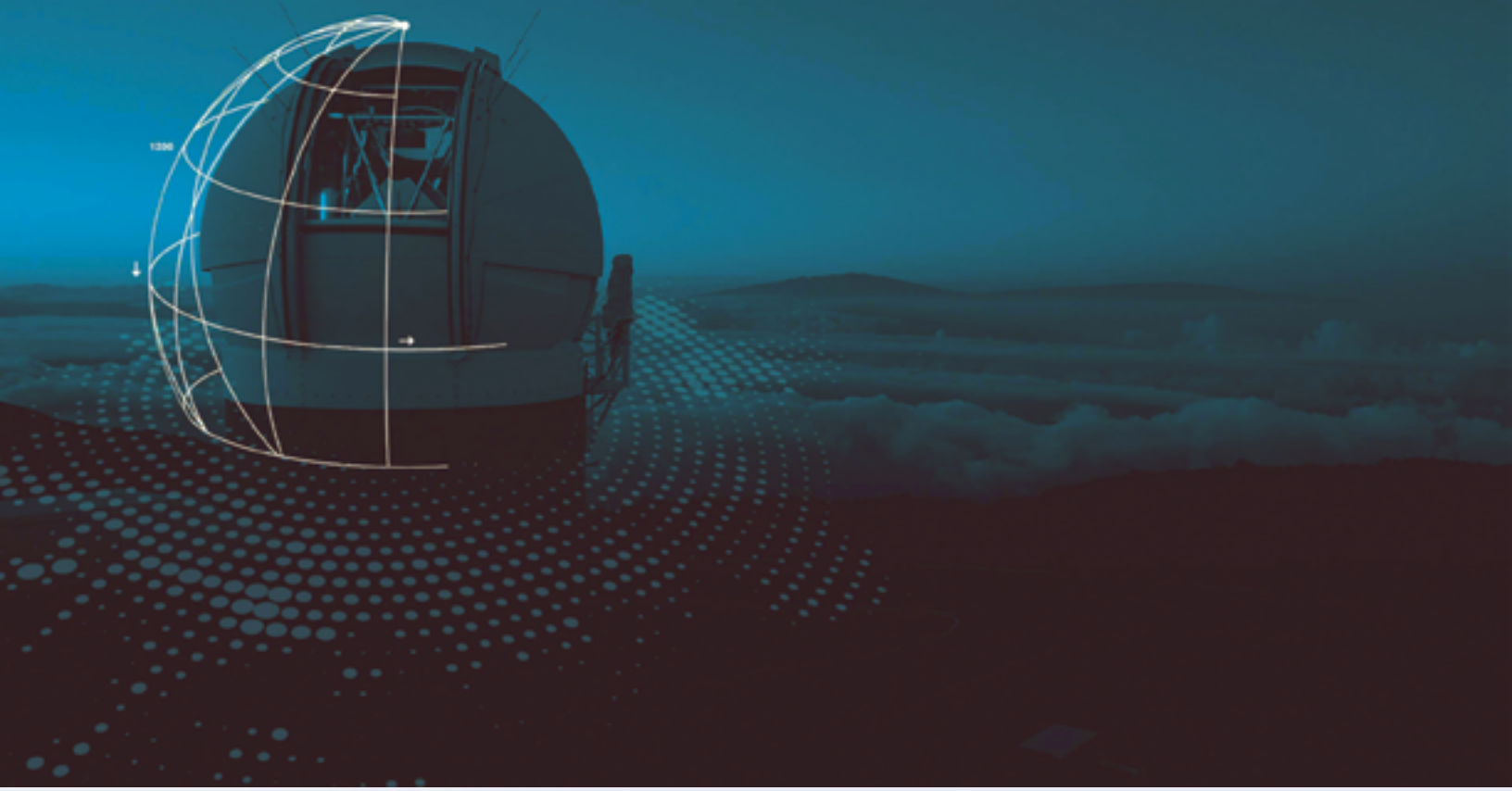
Because defending the nation requires accurate and timely information, our research and development initiatives are designing the next generation of defensive technologies to ensure that every threat is detected, analyzed and mitigated.

Centauri has extensive experience in all aspects of surveillance technologies required to identify threats against in both volumes of air/space, as well as identifying threats directed towards specific assets of interest.

Centauri sensor expertise in active (radar) and passive sensors as well as network command and control for timely and accurate threat identification. Specific Centauri expertise includes:

- *System engineering expertise, approaches and processes to distill the most complex customer needs into system requirements needed to ensure successful development and delivery of detection/ situational awareness systems. Extensive experience and modeling and simulation tools that provide the ability to accurately assess key surveillance performance parameters including individual and integrated system/ network of sensors coverage and minimum detectable threat determination in various operating conditions.*
- *System architecture, design, fielding and testing of advanced sensor technologies for automated threat detection. Experience includes integration and deployment of COTS, GOTS and custom sensors as well as the development of software solutions that enable persistent operations in deleterious conditions including contested environments, poor signal to noise scenarios, very dim targets, and highly cluttered environments. Extensive experience detection, custody maintenance*





(persistent tracking of potential detected threats), accurate characterization (high confidence in determination if an object id a threat or not), and cueing of counter-surveillance systems to abate detected threats. Extensive software design, prototyping and development in support of situational awareness command and control. Including automated and advanced planning, tasking and scheduling algorithms and software. Related areas of expertise include support of internal software organization and communications approaches such as microservices, service-oriented architecture as well as communications external system communications protocols.

- *Custom design and implementation of graphical user interfaces (GUIs) to provide optimum situation awareness for systems with "humans in the loop" requiring "decision support, or fully automated systems that simply need to alert those in times of threat identification. Machine Learning techniques that improve detection and false detection rejection in sensor systems where traditional object detection approaches may be insufficient and require automated decision aid metrics to ensure 99.XXX detection accuracy requirements.*

Kord Acquisition

In September, Centauri acquired Kord Technologies, Inc., an integrated defense and aerospace firm based in Huntsville, Alabama. The acquisition strengthened Centauri's defense technology capabilities and allows the organization to provide a broader range of solutions to customers across the intelligence and defense communities.

Kord Technologies was founded in 2008 by Allen and Tom Young and quickly became one of the fastest-growing government contractors in the country. The company has an extensive portfolio of cyber, aerospace, defense technology, aviation operations and training and logistics capabilities to include expertise in directed energy and computational fluid dynamics.

Kord provides a wide range of integrated aerospace services for complex systems, to include the Space Launch System (SLS). They play a crucial role in the development of core transportation capabilities for NASA's journey to Mars and have extensive experience in rocket design, test, and development. Their capabilities include propulsion; computational fluid dynamics; vibro- acoustics; manufacturing, production and testing; mechanical design; and thermal, stress, fracture modeling and analysis.

Renewed Focus on Space Situational Awareness

As more and more satellites and commensurate debris proliferates the space around our planet, the need to keep track of these objects and their orbits is vital to preventing damage or even loss of life due to unintended collisions.

This field of endeavor is often referred to as Space Situational Awareness (SSA). SSA includes the functions of artificial object detection, tracking, orbit determinations, and characterizing in all Earth orbit regimes.
These orbit regimes range from relatively close LEO that range from 100 to 1,200 miles above the Earth to Geosynchronous Earth Orbits (GEO) which go out as far approximately 22,000 miles from Earth.

The primary SSA mission of determining the position of objects is referred to as "catalog maintenance." In addition to the threat of unintentional collisions, adversaries are advancing technologies with the intention of one day performing nefarious actions to the nation's assets in space.

These assets provide many basic foundations of everyday life including weather forecasting, global positioning system (GPS), communications, and even providing our television signals.

Maintaining timely SSA is critical for the nation to detect and abate nefarious actions by our adversaries

centauri

CPI ANTENNA SYSTEMS DIVISION

The organization looks forward to pursuing strategic partnerships and acquisitions that strengthens the CPI brand while adding value to the solutions offered to the firm's global customer base.

During the past year, the Antenna Systems Division (ASD) of CPI has reached major milestones as the company moves further in building a diverse antenna portfolio with the quality brand that's expected worldwide from CPI.

In the first full year of operation of the consolidated Antenna Systems Division, which includes the former Malibu Division, ASC Signal Division and recently acquired Orbital Systems and Quorum Communications, the combined talent has yielded enormous synergies from R&D collaboration as well as realizing significant operational benefits.

Orbital Innovations

One of the major areas of focus in FY19 was the integration of Orbital Systems into ASD, following the August 2018 acquisition. Orbital Systems continues to be a leading supplier of full-motion TT&C (*Telemetry, Tracking and Control*) and EOS-DB reception antenna systems. In 2019, they expanded their technical capabilities by designing dual-band antennas using dichroic sub-reflectors that minimize the need for combiners, which in turn allows for best-in- class G/T performance.

CPI ASD's three-axis 5 meter S- and X-band antenna system with a Cassegrain X-band feed and prime focus S-band feed.

Two new designs were completed and shipped; first a three-axis 5 meter S- and X-band antenna system with a Cassegrain X-band feed and prime focus S-band feed, and a second system design consisting of a 3 meter, three-axis, Ka-band antenna with integrated S-band. The latter antenna incorporates a Ka-band Cassegrain feed, with the S-band feed mounted at prime focus.

A frequency selective (dichroic) surface sub-reflector is used to split the bands between the feeds. Today, Orbital Systems is able to ship these new products with similar lead times to the legacy product designs, with typical delivery averaging four to five months.

In addition, Orbital Systems has developed a new "RF over fiber" option that is integrated into these antenna systems. This capability provides superior performance in dynamic range, and adjustable matching of the range to the antenna, compared to aftermarket "RF over fiber" solutions.

Plus, Orbital Systems has shipped antenna positioners to radar systems developers for specialty radar applications in use today to help fight wild fires in California.

Internal Collaboration Continues to Pay Off

ASD has focused on technology and service enhancements. The company has advanced their development of products for high bandwidth SATCOM at Q- and V-bands by collaborating across the pools of expertise within their three operational facilities in Texas and California.

ASD's advanced, multi-disciplined simulations have validated their technical approach toward an optimized system from IF to RF. As a testament to their efforts to exceed customers' expectation on project execution, this year they have deployed two, turn-key, Ka-band large-aperture gateway systems in record times.

The company's mobile solutions have become the products of choice for many demanding applications. Sophisticated features such as ARSTRAT compliance and low PIM operation have distinguished their 2.5, 4.0, and 4.6 meter products.

The company's manufacturing facility in Whitby, Canada, is now able to produce antenna up to 13 meters in diameter.

Whitby operations has made significant strides towards streamlining their manufacturing operations and have now demonstrated their capability to produce large quantities of LEO/MEO antennas, having shipped more than 100 during 2019 for a leading LEO constellation.

Some of these antennas have been in active service for TT&C since February 2019. ASD believes that the experience gained from such a large undertaking will serve them well on future pursuits of a similar nature.

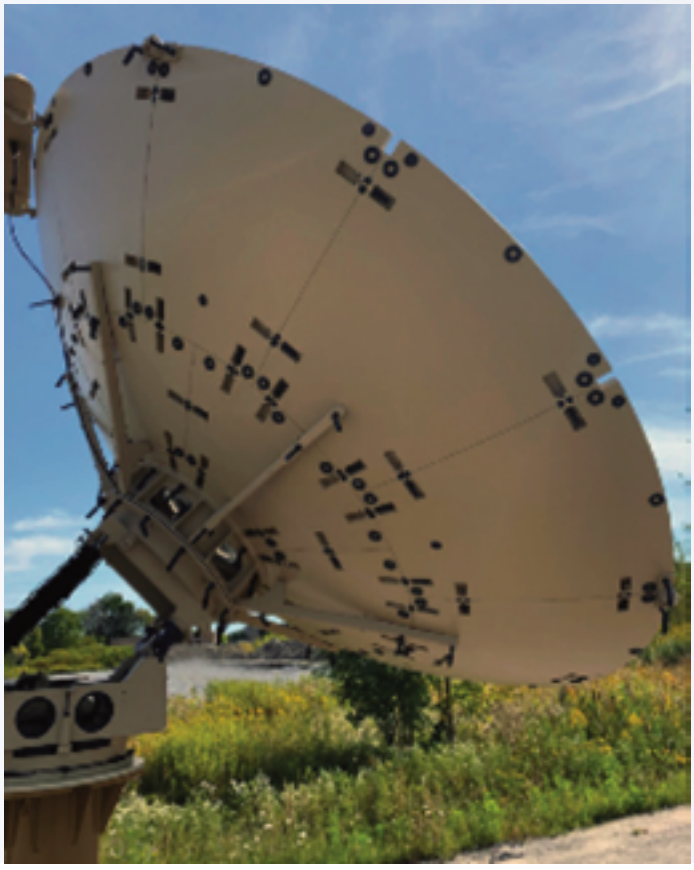
Popular Trifold System Update

CPI ASD's Trifold trailer-mounted antenna.

The ASD Trifold trailer-mounted antenna continues to set the standard for versatility and reliability and has been widely adopted by commercial and military end customers.

The company has commenced Trifold deliveries to satisfy commitments made as a result of a significant award from an existing customer on a major program of record, with expected duration of 10 years.

ASD has had a long history of using composite materials in the firm's antenna solutions and expects the market demand for composite materials to increase due to their unique thermal and mechanical properties.
CPI has been incorporating proprietary techniques in the composite material reflectors to meet certain required specifications, such as the stringent low PIM (passive intermodulation) performance requirements for ARSTRAT. These sophisticated features that facilitate ARSTRAT compliance and low PIM operation have distinguished ASD's 2.5 to 4.0 meter products from competing systems.



ASD's Camarillo, California (Malibu), operations has followed a similar strategy in 2019 as they did in 2018; build upon the existing customer base by focusing on the core technologies for ground and airborne Line of Sight (LOS) data terminals.

The Camarillo operations have won several major programs this year, including solutions for the coveted MQ-25 program with Cubic, which will introduce a new variant of their AT-2 airborne terminal with a short-can configuration, plus the Sentinel program with Raytheon, which will incorporate their custom-designed high precision Radar pedestal.

ASD continues to manufactures the complete line of the former Andrew/GRANGER brand HF antennas operating in the 2 to 30 MHz frequency range. CPI ASD is one of a few remaining suppliers of such antenna systems in the world and continues to supply these systems to NATO and several foreign governments.

Additionally, the company received a major order for their L-band ATC (Air Traffic Control) Radar antennas, with additional orders expected in 2020.

Continuing to Strengthen the CPI Brand

On August 5, 2019, CPI announced that the company had entered into an agreement to purchase SATCOM Technologies, the antenna systems business of General Dynamics Mission Systems, a business unit of General Dynamics.

SATCOM Technologies designs, manufactures and installs satellite communications antenna systems used in commercial, defense and scientific applications.

This business will complement CPI's existing portfolio of communications products for government, military and commercial applications and enables them to provide their customers with a wide range of complementary products, capabilities and resources to support this dynamic and growing market, making it an excellent fit for CPI.

Author Tony Russell is the President of CPI Antenna Systems Division and possesses 36 years of experience in the RF industry, primarily serving airborne and maritime radar, ground and airborne communications, and millimeter-wave science segments.

Mr. Russell has been with Communications & Power Industries (and its predecessor) for more than 25 years, serving in technical and management roles in CPI's electron device solid-state HPA and antenna businesses. Currently, he serves as the president of the CPI Antenna Systems Division. Mr. Russell has an Honors degree in Physics from the University of York (UK) and an MBA from York University (Canada).

CPI Communications & Power Industries
Antenna Systems Division

IDIRECT GOVERNMENT

The year of 2020 is going to show iDirect Government making some big moves and providing fresh and innovative products for the government sector and maybe even beyond.

We were fortunate to have a tremendous amount of growth in the year of 2019 at iDirectGov.

We hit the ground running in March of this year when we received our wideband global SATCOM certification for the 9-Series Defense portfolio of satellite routers and line cards on the Evolution 3.4 software. The new WGS certification validated our 9-Series Defense line and Evolution 3.4 as the "go to" communications solutions for military communications requirements worldwide, and we are committed to play a part in keeping the military connected as they defend our nation.

In May, we had the esteemed honor of being awarded the Mobile Satellite Users Association (MSUA)'s 2019 Annual Mobility Innovation Award (Top Cybersecurity Solution) for our TRANSEC capabilities.

We also received the 8th ranking on the *Washington Business Journal*'s Best Places to Work within the Large Company category. This is a special accomplishment for us as our company recognizes that people are instrumental in helping our customers to meet mission success via our product engineering, our onsite professional services engineers, our Technical Assistance Center (TAC) and customer service.

We pride ourselves on hiring veterans and were happy to present one of our military service members for a Distinguished Service Award, and we celebrated his recognition as Veteran Employee of the Year by the Northern Virginia Chamber of Commerce. Our veterans have contributed to the building of exceptional, high-performance products that work effectively during missions.

Anti-Jam Technology

Last, but certainly not least in any of our eyes, is our exciting acquisition of Glowlink in September. This is truly acting as the catalyst for our newest products to come in 2020.

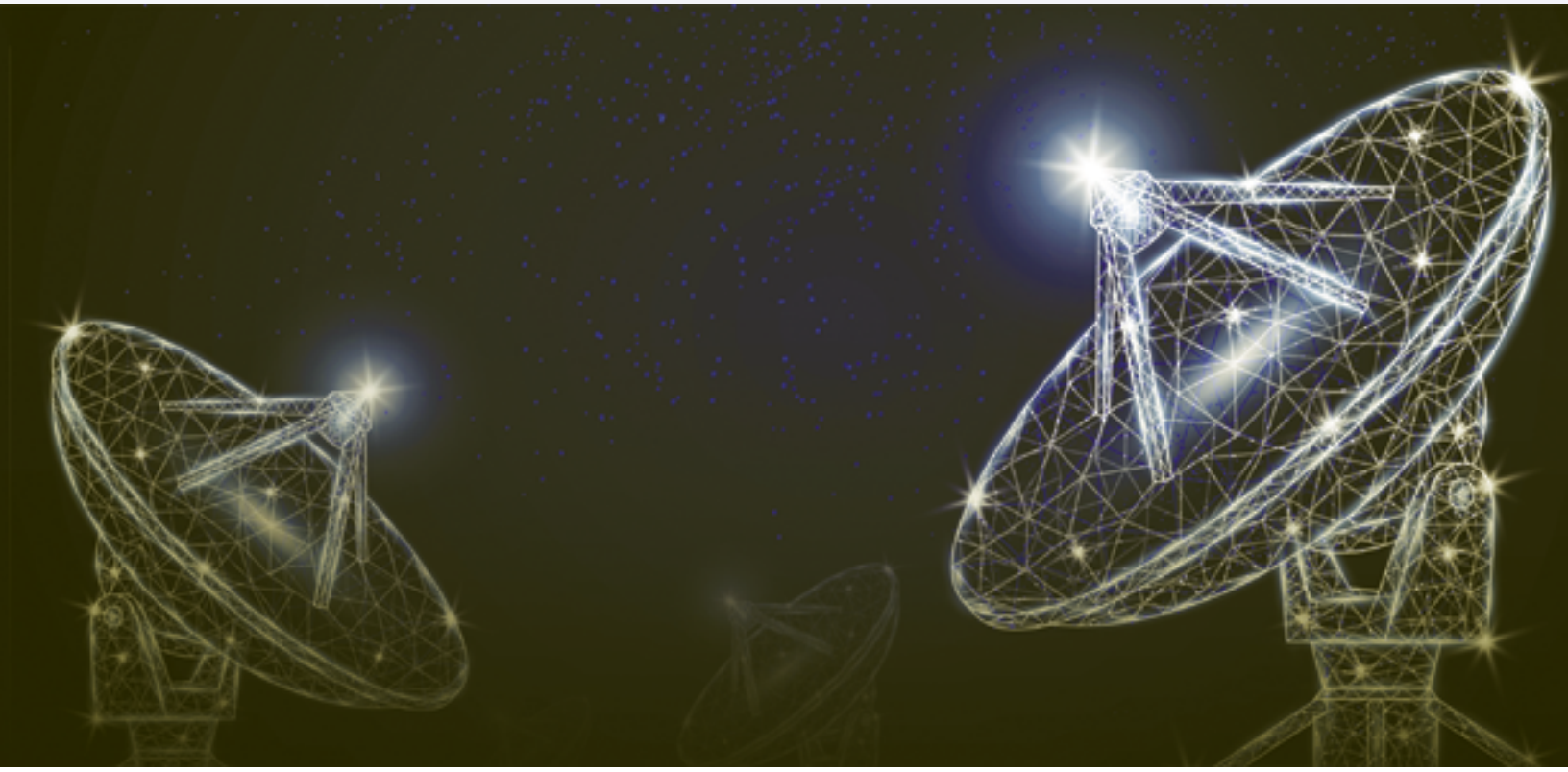
Glowlink's robust technology and engineering prowess are ideal additions for both our organization and our customers. A great consternation for all our military around the world is satellite signal interference. About 85 percent of interferences are caused by the "good guy" who interferes inadvertently with a signal. However, adversaries purposely try to disrupt communications channels as well.

Glowlink has manufactured a technology to pinpoint and eliminate any kind of interference whether intentional or unintentional. They have a mathematical algorithm that looks at the RF waveform and determines whether anomalies exist. If those anomalies are in existence, the technology removes them.

Glowlink's sophisticated technology has been developed over many years and can be used beyond the SATCOM world in any digitally modulated carrier, including Bluetooth communications and Wi-Fi. We think the biggest market it can address — if properly executed — is 5G, the next generation of cellular communications.

Glowlink products (including the earliest product) both monitor satellite spectrum and determine where signal interference is occurring.

Another Glowlink product — a geolocation product — provides the location of the interfering signal, allowing users to learn who is causing the interference. The anti-jam technology, Communication Signal Interference Removal (CSIR™), functions to remove the interference. All of these products are immensely valuable to our nation's military and government users.



The iDirect Government and Glowlink acquisition signing event. Jeffrey Chu, President of Glowlink (l) and John Ratigan, President, iDirectGov (r).

Our strategy is to integrate the Glowlink products into our existing core flagship products. We will be taking this powerful technology and delivering it to our customers.

Putting Tactical Hub to the Test

When it comes to MILSATCOM products working effectively in the field, real-world testing is critical. That is why we make it our mission to tag team with our defense customers whenever possible and participate in joint exercises.

We did this with the Series 11000 Tactical Hub, which was field tested as part of the Saber Guardian joint exercise that took place throughout Germany, Bulgaria, Hungary and Romania.

iDirect Government Tactical Hub imagery.

Co-lead by Romanian land forces and the U.S. Army Europe, troops from the 35th Signal Brigade (35th ESB), Fort Gordon, Georgia, home to the U.S. Army Cyber Center of Excellence, U.S. Army Signal Corps and U.S. Army Cyber Corps, took part in the international military field tests.

As part of the testing, the 35th Theater Tactical Signal Brigade (35th TTSB) deployed our Series 11000 Tactical Hub for the exercise using FIPS-certified Transmission Security (TRANSEC). The hub was connected to multiple iDirect Satellite Routers throughout Europe in six different countries.

Designed with ideal size, weight and power (SWaP) considerations, the Tactical Hub provides a smaller alternative to the much larger — and heavier — 20-slot hubs, keeping tactical operations in mind on the engineering front with this new design. Two new Defense Line Cards, the DLC-T and DLC-R, come embedded in the Tactical Hub, packaged neatly in a single 2RU (rack unit) rack-mount chassis.

By conducting real-world tests in complex environments, it was demonstrated that iDirectGov's Tactical Hub was up for the challenge of SATCOM security, efficiency and performance to bring the best information sharing to defense and government users wherever they are communicating across land, sea and air platforms. The tests showed how the hub's size makes it ideal for a wide array of missions for military personnel, first responders and disaster recovery personnel.

With the Tactical Hub, military users were able to connect safely and effectively for their field performance, showing how the hub is well-suited for mission-critical applications.

2020 Outlook

2020 is going to be a busy year for iDirectGov.

We are continuing to develop and engineer faster, smaller and more powerful remote technology now with the added features and benefits of the Glowlink products. Glowlink products deliver innovative solutions for fighting satellite interference and improving the quality and integrity of satellite communications. Products span carrier and spectrum monitoring, interference detection and mitigation, geolocation and satellite capacity planning which will directly complement the iDirect Government product line.

We plan to first start with taking the CSIR anti-jam product to market first as a standalone product. Our next step is to integrate this into our 9-Series hardware and Defense Line Cards. We expect this to be an extremely popular and well received among our customers.

The CSIR signal excision anti-jam solution provides immediate benefits to our user community. The CSIR technology does not require additional bandwidth compared to other technologies. This saves our customers bandwidth investment while helping the military overcome threats.

We also see expansion of the Tactical Removable Airborne Satellite Communications System (TRASC).

We teamed up with our partners to unveil the TRASC System, a commercial off-the-shelf (COTS) solution that was reviewed for its flight worthiness and viability for the C-130 aircraft. The partners tested the COTS solution for the aircraft to bring cutting-edge technology to the warfighter much more quickly.

The year of 2020 is going to show iDirect Government making some big moves and providing fresh and innovative products for the government sector and maybe even beyond.

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

Author John Ratigan serves as President of iDirect Government, Herndon, Virginia.

PARADIGM

Additional feature sets for all terminals will continue to be released by Paradigm, working closely with partners and key customers to deliver enhancements and developments to suit specific requirements.

Paradigm has continued with their industry leading goal to make SATCOM simple and used their expertise in technology, manufacturing and integration to swiftly respond to market requirements.

Central to this progress has been the popular PIM® (Paradigm Interface Module) which allows an unskilled user to easily and rapidly point a VSAT by using onboard audio cues with a visual cross-hair LED target
.
The PIM provides the modem, baseband switching, power management, assisted pointing and setup functions for VSATs. Temperature management and maintenance-free operation is achieved with fanless convection cooling or heating. This makes it ideally suited for the harshest of extreme environments proven by its successful deployment in the sub-zero climate of Antarctica and the dust and high heat of the African desert.

The PIM is already certified for use on all major satellite networks using a range of RF, antenna and modem combinations. By integrating the PIM into existing and new terminals, the time needed for network testing and certification is drastically reduced thus shortening a product's development time. All of Paradigm's terminals below are PIM-enabled and present a range of terminals all linked by a common operation process which also minimizes training requirements.

MANTA®

Launched in 2018, the MANTA is Paradigm's solution to satellite Comms-On-The-Move (COTM) and Comms-On-The-Pause (COTP). In less than a year, it has transformed mobile SATCOM and become the most reliable, proven solution for COTM and COTP applications.

Its rapid adoption is partly due to it requiring no specific satellite skill set from the user and, once fitted to a vehicle or used straight from its case, you just need to add power to be transmitting and receivin in minutes.

Even the vehicle or vessel fitting process has been made simple by Paradigm with the MANTA quickly attaching to standard roof bars using the supplied quick deploy vehicle kit.

Global roll-outs of the MANTA have been achieved over 2019 with high levels of demand from aid agencies and governments. Following trials and feedback from operational customer deployments over the year to date, demand is expected to increase even further.

MANTA®+

During a demo of the MANTA in late 2018, a user suggested adding an integrated cellular capability to the terminal. Rather than just a rudimentary plug-in cellular connection, this request was for a sophisticated terminal system that could offer users complete autonomy over the backhaul method from a ruggedized, single user interface with smart routing and a VPN capability.

In response, and by end of Q1 2019, Paradigm had developed and launched the MANTA+, the first flat-panel COTM/COTP VSAT system with a fully integrated cellular capability. An impressive turnaround in an industry traditionally slow to respond to technological advancements.

Paradigm's MANTA+ offers all the advantages of the MANTA but with the added benefit of services either connected via various satellites or routed via available 2G/3G/4G LTE, 2.4/5GHz Wi-Fi services, with UHF/VHF radio connection options also available.

The MANTA+ is a discreet, plug and play unit that provides seamless network switching between cellular and satellite to offer an 'always connected' service. The user can 'weight' their operational services depending on their specific needs for availability, least cost routing, load balancing and failover/ fallback.

As the MANTA+ transitions between cellular, Wi-Fi and satellite (or any other sequence), the IP (Internet Protocol) path automatically routes without the need for any user intervention (*e.g.*, creating of routing tables or port re-wiring) and, depending on the weighting rules implemented, will keep the user's services connected.

In addition, VHF and UHF solutions can also be connected to the MANTA+ to provide extended reach communications for the connected operator.

The MANTA+ has revolutionized COTM capabilities for its users by harnessing the best of both worlds in mobile connectivity.

As High Throughput Satellite (HTS) networks grow and cellular coverage expands, the MANTA+ will act as a force multiplier for the NGO and first responder communities.

It is ideally suited for border protection, coastal surveillance and any areas of critical operation where constant connectivity is required through communication blackspots.

HORNET

Paradigm's PIM-enabled HORNET terminals are designed to be lightweight, portable and simple to use. They are ideal for situations where a tough and rugged solution is needed without compromising simplicity and throughput.
In 2019 the HORNET was developed further so as to be available as an interchangeable modular system operational on Ka-, Ku- and X-band frequencies.

This provides a highly flexible solution for users needing to configure antenna size and frequency bands either in the field or at the planning stage. This interchangeable solution is available on all major network providers.

The HORNET terminals are extremely rugged and weatherproof with low power consumption.

They are modem agnostic, supporting all high performance modems and provide single case solutions which are IATA compliant for easy transportation.

Using the integrated PIM, pointing HORNET terminals is very fast and simple using the audio and visual cross-hair cues and target of LEDs. The PIM also integrates adjustable legs to provide a low and wide operational footprint to maintain stability.

By fulfilling requirements for flexibility, cost reductions, rapid tool-free deployment and portability, the HORNET is the ideal solution for first responders, government and broadcast users.

HORNET deployments during 2019 include providing fast, reliable and critical communications for the Argentine Antarctic Summer Campaign at a number of sites including Argentina's southernmost permanent base; a fantastic example of how 'internet at the Earth's extremes' is a reality.

As Paradigm's MD Ulf Sandberg remarked, "*not only can our PIM-enabled terminals be operated by anyone, this also proves that location is no longer a restriction.*"

SWARM

Demand for this discreet and powerful terminal continues to grow, with key 2019 global deployments.

The SWARM terminal provided broadcast-level communications for a 6,000 km. African continent motor rally and a television production company filming in the sparsely populated Patagonian region of South America.

Once more, the SWARM was able to provide vital communications channels to aid agencies: in Mozambique following Cyclone Idai and in the Bahamas after the devastation caused by Hurricane Dorian.

The SWARM and the CONNECT100T terminal have now been adopted by the UN and other NGOs.

Together, they enable assessment teams to respond rapidly to emergency situations, using the ultra-portable SWARM to provide critical emergency communication channels with the co-ordination teams following up with the larger CONNECT100T to provide higher throughput for longer-term setups.

Paradigm's SWIFT terminal in action.

Developments at Paradigm

As Paradigm continues to grow, the company's main facility in the UK expanded further during 2019 to accommodate an increase in manufacturing and staff.

Paradigm's website was updated in Q4 to give prominence to the latest PIM-enabled terminals and to underline the company's ethos of *Making SATCOM Simple*.

Additional feature sets for all terminals will continue to be released by Paradigm, working closely with partners and key customers to deliver enhancements and developments for the terminals to suit specific requirements.

2020 Plans and Opportunities

Paradigm sees lots of really exciting industry developments coming on line into 2020.

The introduction of new satellite constellations, in particular, the potential of Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) satellites which will bring new capabilities to a variety of users.

Paradigm will continue to position and structure their products to enhance these advances.

Ulf Sandberg, the Founder and Managing Director at Paradigm, has more than 30 years of experience in the global satellite and telecommunications world. He served in the Swedish Armed Forces and, from there, Sandberg joined Notelsat, the operating company for Tele-X, one of the earliest Nordic Communication satellites. From there, he was with the Swedish Attaché for Science and Technology office, based in the USA. Leaving the Government sector, Mr. Sandberg worked for Swedish Telecom International and then Unisource, where he advanced to be Managing Director for the satellite business based in the Netherlands. Mr. Sandberg was also involved in the start-up and creation of a number of companies and ventures in Europe and the USA. In 1993 Sandberg became Managing Director, EMEA for ComStream, where he was responsible for growing regional operations. He was then with ACT Networks prior to starting Paradigm in 1996, where he has spent the past 23 years as Managing Director.

Paradigm
Clear Sighted Solutions

PHASOR

Though 2019 has been a year where milestones have been achieved in preparation to get the product to market, years of hard work have provided a solid foundation for the future.

It's been a non-stop year for Phasor, where the antenna developer has been in the midst of the transformation that will take it to the commercial market.

As the company has focused on its end goal of bringing about seismic change to the global satellite mobile connectivity market, it has been busy reaching key milestones in terms of technical development and the move to commercialization. The enterprise-grade electronically steered antenna is poised to offer a new level of connected experience to passengers and crew on land, sea and in the air.

Technology Development

Phasor has been working with Vicor, a manufacturer of high efficiency power supply systems, and the two companies have developed a new power architecture that enables Phasor to deliver extremely high current at low voltage, thus ensuring robust mobile communications. The power solution provides connectivity speeds and bandwidth previously unachievable while on the move.

The Factorized Power Architecture™ (FPA) represents a major breakthrough in the delivery of satellite connectivity in aeronautical, maritime, land mobile and defense applications. However, it will also enable the end user traveling on any mode of transportation to enjoy true mobile broadband connectivity, and all the applications that this will enable.

The FPA technology plays an integral role in Phasor's ESAs and the support of Vicor in the technical innovation of the products helps to differentiate Phasor in what is a very competitive marketplace. Vicor's FPA package consists of a Pre-Regulator Module (PRM) and a Voltage Transformation Module (VTM)/Current Multiplier which together deliver the full, regulated, isolated DC-DC converter function. The Voltage Transformation Module (VTM) is a resonant converter and therefore also has very low noise when compared to a hard switched converter.

Vital to realizing performance targets in small and large aperture Phasor ESAs is the ability of Vicor's systems to transform a 48V supply into a 1.5V supply (1V in the next generation of antenna with even higher current).

Phasor's desire to make this transformation at 65A (or even 80A) represented a major design challenge for powering its application-specific integrated circuits (ASICs). Offering superior power delivery and efficiency than traditional DC/DC converters, Vicor's approach to transforming voltage eliminates the need for multiple hard-switching converters with several different phases to attain 65A.

Certification

Phasor achieved ISO 9001 Certification ahead of the release of its product range. ISO 9001 is the internationally recognized standard for a quality management system (QMS). This enables companies to operate more effectively on several different levels, including the ability to focus on customer requirements and constantly finding ways in which to improve and become resilient and sustainable.

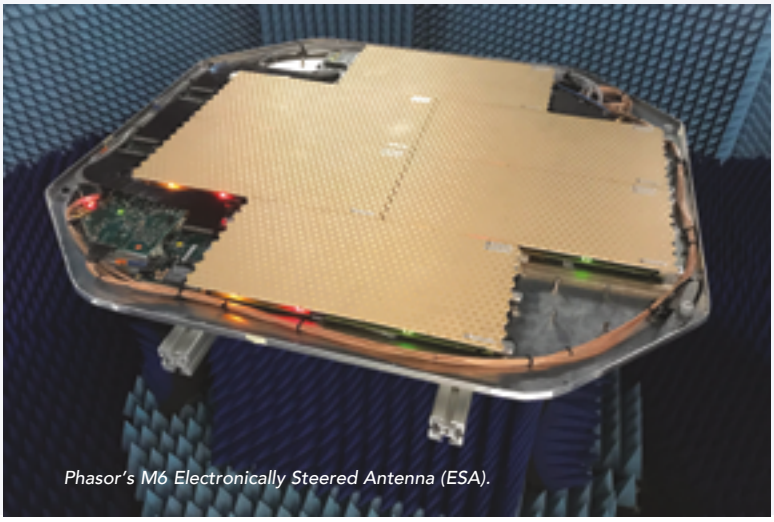
Why is this significant? It shows Phasor's evolution from development company towards a process-centric commercial products organization. The processes and procedures that have been implemented and also approved by BSI, will enable better management of the business and will demonstrate to customers that Phasor will support them as they grow.

Preparation for Production

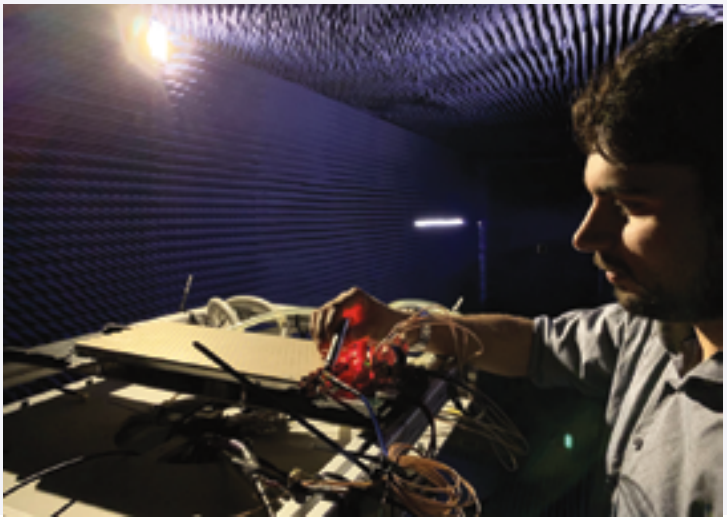
In order to prepare for commercial production, and to be able to scale -up to meet projected demand for its revolutionary ESA system, Phasor created a partnership with industry-leading electronics contract manufacturer Surface Technology International, (STI). STI will bring best-in-class manufacturing capability and will enable Phasor to continue to focus on new technology and product development. In a rapidly expanding market such as mobile broadband, it is important that production is scalable and able to grow with the projected market demand. Therefore, contract manufacturing with a leading partner is a core tenet of Phasor's strategy.

STI is a specialist Contract Electronics Manufacturer, serving world-class customers in high-reliability industries by providing a complete set of electronics design and manufacturing solutions in both printed circuit board assembly (PCBA) and full box-build manufacturing. The products will be manufactured in the STI Poynton facility, in Cheshire, UK, which is an industry-leading center manufacturing high-quality electronic systems.

Headquartered in Hampshire, UK, and part of the AC Industrials group, STI has decades of experience in the manufacture of complex aerospace, military and satcom systems. This will ensure that Phasor can successfully ramp up production as required with a renowned partner that is located within easy reach of Phasor's London Technology Center.



Phasor's M6 Electronically Steered Antenna (ESA).



Showcasing Capabilities

The Mobile World Congress (MWC19) in Barcelona gave delegates the first glimpse of Phasor's land mobile Advanced Compact Terminal (ACT) for connected emergency vehicles from partner, HISPASAT.

The satellite operator participated in a demonstrator of a 5G and satellite communications (satcom) connected ambulance at the stand of the Generalitat de Catalunya, showing how future satellite and cellular-based hybrid connectivity will make it easier for emergency medical personnel to receive instructions from specialists in a hospital enabling a full ubiquitous audio-visual connection between the vehicle and the hospital. This will allow the specialist to monitor the patient's status in real time, which may be key to their survival and subsequent recovery.

An ambulance equipped with Phasor's Advanced Compact Terminal, will enable the crew to connect via satellite so that the first responder team may use applications such as video teleconference, real-time operational telematics links and high-quality Internet access during the journey to the hospital, regardless of their location or access to terrestrial networks. The ACT including an ESA, which is designed and in-development by Phasor in cooperation with HISPASAT, has full electronic steering and enables mobile connectivity services to be efficiently and reliably offered with high bandwidth.

It was another opportunity to highlight the versatility of the system and its ability to deliver mission critical connectivity, when every second counts.

Our Partnerships

Airbus

Phasor announced a Memorandum of Understanding (MoU) with Airbus through its Network for the Sky (NFTS) program. The two companies are working together to adapt Phasor's commercial-off-the-shelf (COTS) aeronautical electronically steerable antenna (A-ESA) already in development, for use on Governmental air-transport aircraft and unmanned aerial vehicles (UAVs).

Reliable, resilient aero connectivity that can support the highest data rates is essential to Network Centric operations today to enable a broad range of applications and services.

The Phasor ESA will be capable of supporting high bandwidth data communications with Ku-band satellites in both commercial GEO and LEO orbits and will also include an integrated radome, as a single line replaceable unit (LRU). Delivering as one, NFTS securely and reliably connects airborne assets together with the rest of operations. Operating over a mix of technologies to form one, resilient, high speed global network. NFTS sets the foundation for connected airborne network centric operations.

Gogo

Phasor and Gogo also confirmed that their development partnership achieved its initial core-technology performance objectives and will progress to the productization phase. During the next phase, the technology will be packaged as an airborne terminal to address the commercial aviation market.

Gogo identified the promise of Phasor's innovative solution due to a range of factors, including its multi-constellation capabilities and form factor and sees a number of potential applications for the technology, with initial applicability targeted at smaller commercial aviation aircraft.

Astronics

Astronics Aerosat previewed its next-generation SATCOM connectivity solutions, in conjunction with Phasor at AIX in Hamburg. The new SATCOM inflight connectivity antennas feature electronically steered array (ESA) technology that will deliver unprecedented connection reliability for both civil and military aircraft.

Available in three configurations and with an ultra-low profile, the E-Series will provide Ku- and Ku-HTS connectivity for today's Geostationary Earth Orbit (GEO) networks, as well as tomorrow's Medium Earth Orbit (MEO) and Low Earth Orbit (LEO) networks. The system also will offer dual-beam capability, enabling it to support the future "make before break" requirement of non-GEO networks from a single array, or the ability to communicate with two independent GEOs or a LEO & GEO network simultaneously.

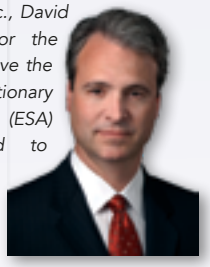
Astronics' E-Series antennas will feature Phasor's active electronically steered array to provide maximum antenna performance. Unlike competing systems, the E-Series will feature technology that enables a simultaneous transmit and receive from a single antenna array, with no need for bulky extra panels that drive up costly size and weight.

Everywhere On

As Phasor approaches the year of its product launch, it can reflect upon five years of development of a system that will bring fundamental change to on-the-move connectivity.

Though 2019 has been a year where milestones have been achieved in preparation to get the product to market, years of hard work have provided a solid foundation for the future.

The team relishes the challenge of bringing this transformative technology to the people that want and need a completely new and connected experience that is always on, no matter where they go.



As president and CEO of Phasor Inc., David Helfgott has the responsibility for the company's strategic direction, to drive the development of its new & revolutionary Electronically Steerable Antenna (ESA) products and technology, and to implement its operational programs.

As a 20-year industry veteran, he has extensive experience in satellite broadband, mobile telecommunications and commercial and government SATCOM networking services.

Mr. Helfgott has held leadership positions at Inmarsat, Cobham, DataPath and SES. He holds a BA Degree from the University of Virginia and an MBA from the Darden School.

PHASOR

QUADSAT

With more and more consumers and industries adopting online applications, we must be sure that the connectivity we are delivering is of the highest quality.

2019 has been a big year for both SATCOM and QuadSAT respectively. We've seen the first satellites launched into LEO for the planned mega constellations, processes being virtualized within the cloud and plenty of discussion regarding the 5G rollout.

Mega Constellations

We're entering into an interesting era in SATCOM; during the next few years, we're expecting the number of orbiting satellites to dramatically increase. With approximately 1,800 currently on-orbit, we could see numbers rise to as many as the tens of thousands of satellites. This increase is sure to raise operational challenges, both on-orbit and at the ground terminal.

LEO is promising more connectivity, something that consumers are expected to fully embrace. The increase in SATCOM use will see RFI management become as important as ever; however, the industry must ensure it is as cost-efficient as possible. The need for SATCOM to be financially competitive must be offset by the need for high quality equipment to deliver reliable coverage.

The mega-constellations could potentially open up huge opportunities for the maritime and aviation industries. Offering consumers constant connectivity is appealing. But beyond this,the company anticipates that these industries will be adapting workflows and procedures to incorporate the seamless connectivity that LEO offers. The opportunities are vast — we just need to make sure that we have the tools to deliver the robust connectivity required.

5G has been one of the most talked about aspects of connectivity in 2019. There's no doubt the discussions around C-band have seen some of the most experienced professionals stop and consider the implications it may have on the industries involved.

The objective is clear; technology must keep improving to manage consumer demands. As always, when using radio frequencies, care must be taken to avoid accidental interference.

As more operators — and even industries — use RF, managing interference will become increasingly important to ensure that services don't inadvertently impact upon one another.

Use of the Internet of Things (IoT) is growing quickly. According to a 2019 report by Gartner, the enterprise and automotive IoT market will grow to 5.8 billion endpoints in 2020, a 21 percent increase from 2019. Consumers are turning more and more to the convenience that IoT offers, with building automation, utilities and physical security being some of the more common uses.

IoT is centered around consumers remaining connected with their surroundings, regardless of where they are located. But in addition to consumers adopting the tech, we're seeing industries employ the technology to improve efficiencies.

Maritime organizations are turning to IoT to streamline operations and to make data driven decisions that improve efficiencies. The

aviation industry is also noting huge benefits in adopting IoT tech. Predictive maintenance, in-flight customer behavioral patterns, in-flight data collection, baggage tracking and flight efficiency are all examples of the role IoT can play in aviation, which is saving airlines time and money.

As always, seamless connectivity is key in delivering these services. The aviation and maritime industries have an obvious need for satellite due to the geographically remote nature of work. This does also highlight the industries' reliance on SATCOM; there is little room for error in connectivity and reducing the risk of RFI is hugely important.

RFI RF interference is a challenge that has faced the industry since its inception, with human error and poor-quality equipment being some of the most common reasons for RFI incidents. An antenna that is being used daily, especially on a moving vessel, can easily become misaligned and see a break in connectivity.

Testing and calibration must be performed at regular intervals to mitigate RFI, although performing these tests can be costly, technically challenging and inconvenient on an in-service plane or ship. However, antenna testing remains important; we can see efficiencies improving in many industries as a result of improved connectivity.

Drone Tech to Reduce RFI and Increase Efficiency

During 2019, the company completed significant steps forward in reaching business goals. At the start of the year, QuadSAT's drone tech was in the early stages of development.

In January, QuadSAT secured 700,000 euros in seed funding, led by Vaekstfonden, with participation from Seraphim Capital and additional, existing investors. In addition to the testing and calibration capabilities mentioned above, QuadSAT has always aimed for the product to be used to deliver type approvals, allowing quality testing at the sourcing of equipment.

These investments were critical in developing the prototype for key testing and has allowed us to expand the team, as well as advance our technology. We moved the office to the Hans Christian Andersen Airport in Odense. This has given us useful access to the airfield as well as the great tech community at HCA.

The firm's drone technology applies a consistent method to determine the performance of new antenna models. All new antennas have to pass through a validation process to ensure that satellite users are sourcing the correct equipment and processes... QuadSAT plays the role as a portable farfield test range, making it location flexible and cost effective. The solution is set to promote consistent calibration and testing procedures of VSAT antennas and, in turn, reduce RFI.

Following months of development, July found the company signing an important contract with ESA, GVF and the Danish Technological Institute to develop the QuadSAT testing solutions to comply with the industry-wide antenna performance SOMAP (Satellite Operators' Minimum Antenna Performance) requirements, providing our product with certification to deliver compliant type-approvals.

The company's team traveled to Aflenz in September with SES and Eutelsat for a demonstration of our product and its testing results. We delivered thorough antenna testing on-site using this drone technology, which was witnessed by representatives of both organizations.

The results were sufficient enough for SES to consider adopting QuadSAT`s antenna testing product for future, commercial, antenna qualification activity.

Increasing Connectivity and Minimizing RFI

2019 has undeniably seen many changes within SATCOM; organisations within the industry are adapting to the ever-increasing need for constant connectivity.

However, with LEO, 5G and IoT, companies must be confident in delivering uninterrupted services. RFI is linked to an increase in equipment cost and increase in antenna power levels. To keep SATCOM competitive, it is crucial to keep interferences low.

With more and more consumers and industries adopting online applications, we must be sure that the connectivity we are delivering is of the highest quality. RFI must be both prevented and mitigated to allow seamless connectivity to become a reality.

However, to promote discipline within RF management we must make the tools accessible and cost-effective.

www.quadsat.com

Joakim Espeland is the Chief Executive Officer of QuadSAT.

W.B. WALTON ENTERPRISES

Walton De-Ice delivers the most innovative and effective solutions to help protect critical satellite networks from degradation and outages due to weather.

2019 has been an exciting year for Walton De-Ice, (W.B. Walton Enterprises, Inc.) as the company marks 40 years of satellite industry experience helping to protect SATCOMS terminals, gateways and teleports from the effects of weather.

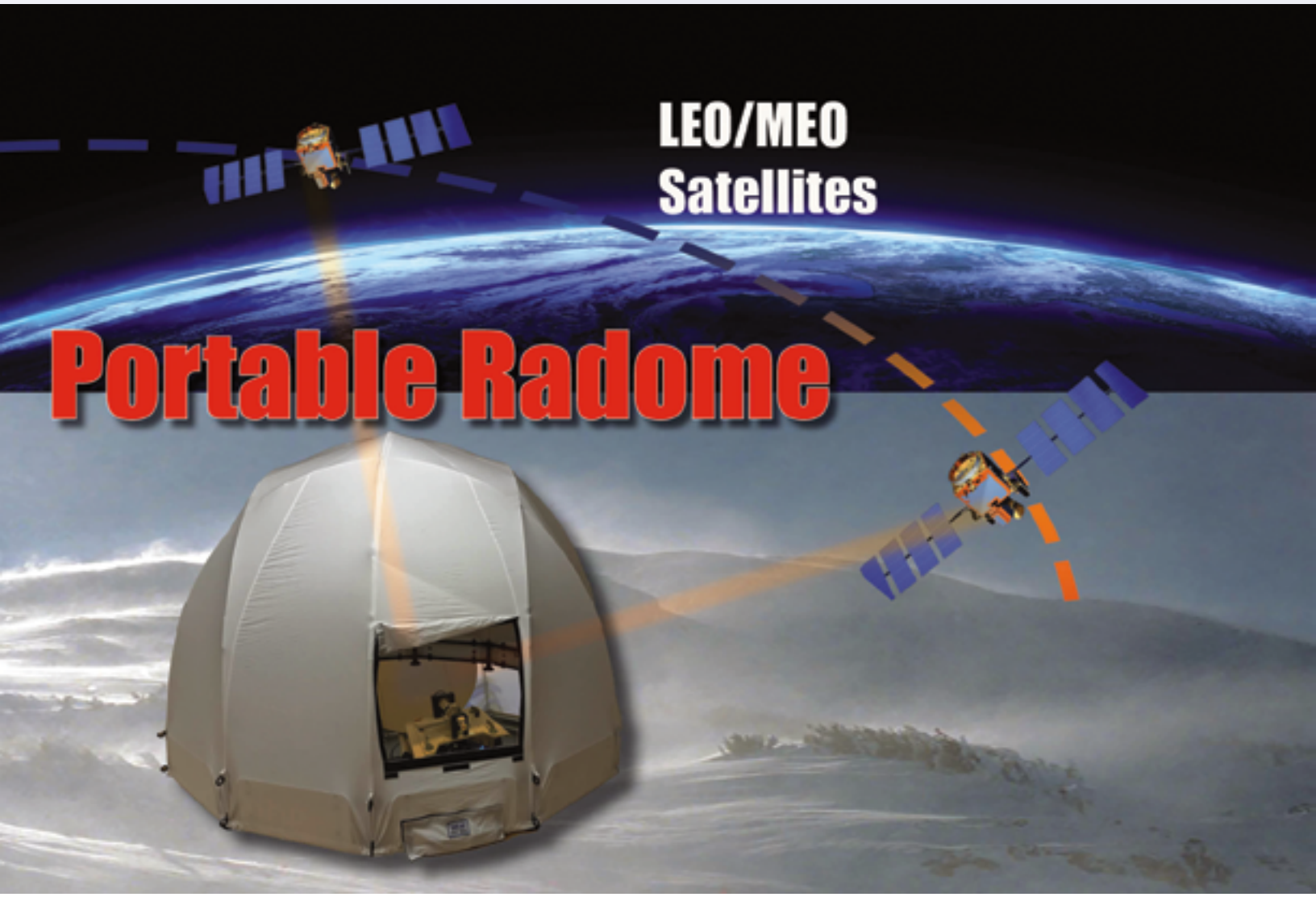
In May, our Chairman, ***William Bartlett Walton*** Jr., "Bill Walton" was honored with a Lifetime Achievement Award by the World Teleport Association (WTA) for his leadership and contributions to the industry. In announcing the award, WTA noted that "*Today, it is hard to imagine the C-band industry delivering reliable services without de-icing. Walton De-Ice has become synonymous with Earth station antenna De-Icing. Bill Walton was there from the beginning, growing with the industry, and building Walton De-Ice over the last four decades.*"

Walton De-Ice delivers the most innovative and effective solutions to help protect critical satellite networks from degradation and outages due to weather. The company's main focus has been keeping Earth station antennas snow and ice-free. The original Walton Hot-Air (Plenum) De-Ice design mounts behind antennas from 3.7 to 32 meters. Walton De-Ice's energy-saving Snow Shield, Rain Quake, and Ice Quake systems for 0.6 to 6.3 meter antennas,

Ka-Band Market Leadership and Growth

Market demand from continued HTS and mobility growth has helped to grow the company's 2019 business from satellite operators, service providers and integrators this past year as they continue to invest in new Ka-band ground infrastructure. In 2019, we continued to expand Ka-band leadership in the De-Icing field, with many hundreds of Ka-band large antenna systems now successfully deployed. For Earth station antennas from 3.7 to as large as 32 meters, the Walton Plenum Hot Air De-Icing system maximizes pointing accuracy that is so critical for protecting Ka-Band services.

Unlike competing anti-icing solutions, such as electric pad systems that can cause reflector distortion, Walton Hot Air De-Ice systems heat the entire antenna reflector uniformly, which minimizes reflector distortion that can cause signal problems at the Ku- and Ka-bands. Walton systems also uniquely offer maximum flexibility with electric, natural gas and liquid propane gas heater options. Infrared testing of optimal antenna heating distribution offers precision performance validation for the most demanding Ka-Band customer applications.



C-/Ku-Band De-Icing, More Automation, Energy Efficiency in Heating

Customers with C and Ku-band traditional services continued to leverage the firm's new automation and control features, along with the Ice Quake system, a super-low energy consumption solution for shedding snow off antennas from 0.6 to 6.3 meters.

The Ice Quake can deliver up to 100X energy-savings compared to traditional anti-icing solutions, which is why it has been adopted in teleports as well as cable and broadcast facilities.

In the third quarter of 2019, we also announced that a global sports TV leader had tapped Walton De-Ice to protect its satellite broadcast facilities, joining a Walton De-Ice user community of top operators in SATCOMs around the world.

The top global sports media company added Walton's Hot Air De-Ice and Snow Shield systems to maximize uptime for critical satellite signals at major TV broadcast centers.

New Markets: The Portable Radome

Traditional antenna radomes are not built for transportable operation, yet many of today's military and first-responder applications on land require deployable systems where harsh elements demand radome-like protection.

Enter the world's first portable satellite Earth station antenna radome, the Walton Portable Radome, which unleashes a whole new set of possibilities for operating Satellite Transportable Terminals (STT) and micro-VSATs in extreme and mobile conditions to support military requirements for high capacity data, voice and video capabilities worldwide.

It provides a uniquely deployable weather protection solution for applications, such as Military vehicular mount terminals, Comms-On-the-Pause (COTP) or Comms-On-The-Halt (COTH) terminals, VSATs, Transportable uplinks as well as some Enterprise terminals LEO/MEO gateways.

The Walton Portable Radome can protect transportable, trailer and flyaway antennas from high winds, sandstorms, intense heat, snow and ice. Lightweight and airline-shippable for rapid deployment, with easy setup in less than an hour by one person, the Portable Radome goes where no radome has gone before to help live broadcast remotes stay on air.

Complementing protection in harsh winters from snow and ice that the product offers, in burning desert sun heat conditions, an efficient forced air/HVAC system can be added to protect RF and electronics equipment underneath the Radome from overheating damage.

Portable Radome in Remote Broadcast Markets

In September at the IBC 2019 media technology exhibition, Walton showcased the Portable Radome for protecting remote broadcast and sports uplinking applications in extreme weather.

Whether it is for snow at a Winter Olympics, burning sun and dust storms at a Dakar Rally, or heavy winds at a football venue, the Portable Radome protects both on-air signals and satellite equipment from damage.

Portable Radome Traction in Government and Defense Markets

In May, the company announced shipments of the Portable Radome product for U.S. Government and European Defense agency projects. Units were sold for deployment with a U.S. Government agency and a European defense agency in separate customer projects.

We noted then that growing numbers of large government and military contractor customers acknowledged the unique advantages that the Portable Radome can enable for their end-customer's applications around the world.

New LEO/MEO Design Introduced

In Q3, Walton announced its re-designed Portable Radome for Low Earth Orbit and Medium Earth Orbit (LEO/MEO) satellite Earth station applications, enabling expanded full satellite-arc line-of-sight protection for ground antennas such as LEO gateways and MEO terminals that take advantage of low-latency, high-throughput and next-gen satellite constellations.

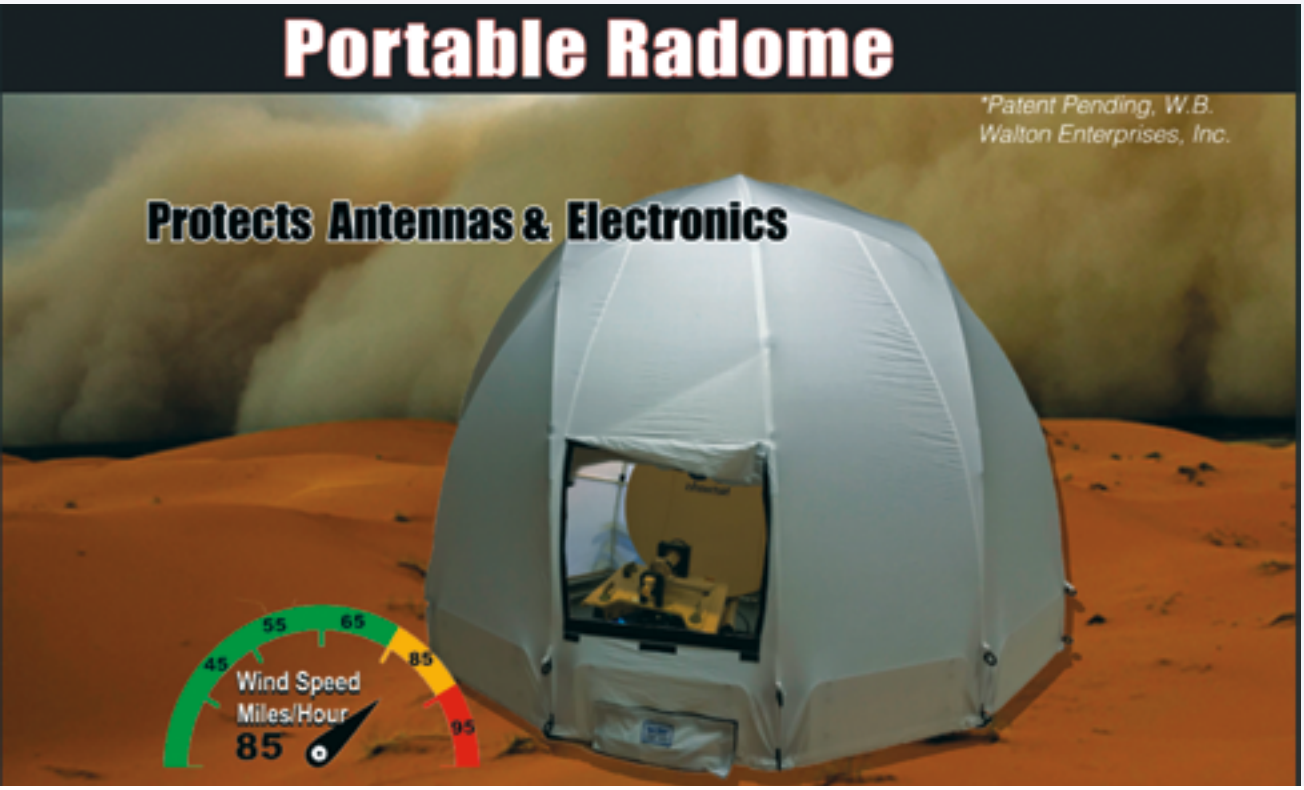
The Portable Radome can also be used for fixed site ground networks, and deliver gateway site cost-savings and other advantages

Looking Ahead

Looking to 2020, the company is very excited about opportunities to work with existing and new industry customers, partners, operators and integrators to help deliver the benefits of the firm's latest technologies into LEO/MEO/GEO infrastructure, DoD programs, 5G Earth station systems, and other missions.

www.de-ice.com

David Walton is Vice President of Walton De-Ice (W.B. Walton Enterprises, Inc.), where he is responsible for the Snow Shield, Ice Quake products and new product development. He has over 37 years of satellite industry experience in the design, manufacture, and deployment of earth station technology, and holds several patents for his inventions in this field. He can be contacted at: david@de-ice.com, or visit.



COMMAND CENTER: RICK LOBER, VICE PRESIDENT AND GENERAL MANAGER, DEFENSE AND INTELLIGENCE SYSTEMS DIVISION, HUGHES NETWORK SYSTEMS

Rick Lober is the Vice President and General Manager of the Defense and Intelligence Systems Division (DISD) at Hughes Network Systems, LLC. In this role, he is responsible for applying the company's broad range of SATCOM technologies and services to the worldwide defense marketplace and intelligence community. Applications cover satellite communications on the move for both ground-based and airborne platforms along with numerous classified development programs. He has more than 30 years experience with both COTS-based and full MIL communications and intelligence products, systems and major programs starting as a design engineer and progressing to a P&L executive.

Mr. Lober previously worked at Cubic Corporation as Sr. VP/GM of the Communications Business Unit. In this role, he led the company's development of the Tactical Common Data Link (TCDL) for application to both manned and unmanned military ISR platforms. Mr. Lober holds a patent in wireless communications.

Good day, Mr. Lober… thanks for chatting with us… before discussing the current and future environments for Hughes Defense, what substantive changes have you seen for the company over your time with the firm? How has the company accommodated the various policy and mission changes for government/military systems over the years?

Rick Lober (RL)
Since I joined to run the Defense Division in 2008, Hughes has focused on innovation of ground and terminal system architectures, advanced waveforms and optimizing network management for resilient systems. The overall goal is to deploy highly flexible and interoperable communications networks by adapting our successful commercial technologies to suit defense users — such as providing expert network management services along with advanced terminals developed for airborne ISR platforms.

What successes has Hughes had this year? How do they fit into DoD's current technology modernization efforts?

RL
Hughes has had strong success in 2019 with exponential growth in its Defense business, winning several major DoD network modernization contracts that will help maintain superiority in today's contested environments. Early in the year, Hughes started supporting the U.S. Air Force (USAF) to add much-needed resiliency to military satcom systems with a contract from Boeing for the Air Force's Protected Tactical Enterprise Service (PTES) program. We will develop the mission management, system control, networking and ground hub capabilities to add new anti-jam satellite communications capabilities. This program will provide tactical warfighters with a joint ground platform designed to deliver protected communications services through the Wideband Global Satcom (WGS) satellite constellation, commercial satellites and eventually, the DoD's Protected Tactical Satellites running the Protected Tactical Waveform (PTW).

This fall, we were awarded a contract funded by the USAF's Space and Missile Systems Center (SMC), through the Space Enterprise Consortium (SpEC), to modernize USAF satellite management using an Enterprise Management and Control (EM&C) prototype for satellite communications (SATCOM). The prototype will include the Hughes Flexible Modem Interface (FMI) Solution, which will enhance interoperability across military and commercial SATCOM networks helping create a unified hybrid network architecture.

We are also supporting the U.S. Army Narrowband SATCOM modernization through a recent $12 million contract award for R&D services to enhance the U.S. Army's Narrowband SATCOM Transport Controller. This work will again strengthen network management, automate control and system interoperability by demonstrating a new, end-to-end Narrowband SATCOM Architecture incorporating Machine Learning (ML) and Artificial Intelligence (AI) features. This Army contract is based on our work helping the USAF continue creating a more resilient, interoperable hybrid satcom architecture.

Most recently, we won another large contract to upgrade and modernize the SATCOM systems on a major DoD UAS platform. We appreciate Hughes being entrusted with this critical program as an alternative to a long-time incumbent.

What role can industry play to quickly build more resilience into DoD's SATCOM networks?

RL
Major commercial satellite operators have more than 100 advanced satellites on-orbit today that DoD users could potentially access if their ground systems could communicate with the variety of space assets. Our work with the USAF and the U.S. Army to implement our software-defined FMI capability will build greater resiliency and help ensure user terminals find alternative satellites when a disruption or outage occurs. Adversaries will find it quite challenging if they try to interfere with DoD SATCOM terminals that can access these 100+ commercial and military-operated satellites as well as future constellations, interoperating as part of the DoD's migration to open-systems, enterprise satcom architecture.

Could you explain the work Hughes Defense is undertaking in regard to Protected SATCOM for warfighters?

RL
Hughes Defense has become keenly focused on the growing need for more protected comms as DoD's AEHF system cannot be the only resource with strong protection. As mentioned above, this year's major contract to support Boeing's PTES team uses advanced software capabilities and agile processes to increase protection for military and commercial satellites. PTES also incorporates interoperable SATCOM networking to deliver higher availability and resiliency which creates greater protection for military SATCOM operations. We have also seen increased interest in our specialized waveforms that have enhanced Low Probability of Intercept/Low Probability of Detection (LPI/LPD) characteristics which can protect against attempted disruptions to a Warfighter's comms.

Do you see wideband SATCOM capabilities becoming a more common technology used across DoD platforms in the air, on the ground and at sea?

RL
Yes, we absolutely see this happening. We see increased interest for wideband comms across the DoD and among other militaries worldwide as they move to add this high data rate comms to fixed-wing, rotary-wing and UAS platforms having specific bandwidth requirements for wideband services. Wideband SATCOM is growing as a priority because wideband service costs for tactical operations are decreasing at the same time as manufacturers are making much smaller and lighter terminals to meet mobility requirements in all domains. Having a wideband SATCOM channel to send and receive mission-critical data to and from platforms means more effective operations.

No matter the application today or in the future, a reliable wideband satellite connection must find its place in tactical operations. Our technology is highly flexible and scalable, so it can support increasingly data-intensive missions today and the data demands of the future.

YOUR BRIDGE TO THE SMALLSAT FUTURE

Build It.

SMALLSAT SYMPOSIUM™

SILICON VALLEY 2020

WORKSHOPS: February 3rd, 2020

CONFERENCE: February 4th - 6th, 2020

SMALLSATSHOW.COM

Would you please explain the role that new commercial LEO satellite constellations can serve for the DoD?

RL

As data is becoming as important as the weapons our soldiers carry, connectivity must become ubiquitous. As our president, Pradman Kaul, stated earlier this year, the goal of Hughes is to connect everything together economically and at high speeds. To do this for national security requirements, the military needs industry's innovative GEO and Non Geo-Stationary Orbit (NGSO) satellites — a broad solution leveraging the diversity and inherent advantages that deliver greater operational strength.

LEOs will have two primary advantages for the military: global coverage, as they aim to cover every square inch of the globe, and lower latency with less distance for the data to travel. Geostationary satellites on the other hand, offer bigger data pipes, higher capacity density and on most of the latest commercial satellites, smaller spot beams for greater efficiency and flexibility. The coverage of a LEO system combined with the power and frequency re-use of GEOs will offer the military a dynamic and flexible solution, especially if services are brought together through a proven and trusted managed services provider, like Hughes.

The company understands that LEO and GEO satellites will largely complement each other and that is why the company has invested in, and is working closely with OneWeb, to develop the ground infrastructure to support their LEO constellation. Hughes has produced for the project, a first-of-its-kind gateway that can handle an unprecedented 10,000 beam hand-offs per second. And on GEO developments, Hughes will be launching our JUPITER™ 3 Ultra High-Density (UHD) Satellite, designated EchoStar 24, in 2021, and will provide 500 Gbps of new capacity for all the various markets across North and South America.

With satellites at LEO, MEO and GEO orbits, and soldiers and platforms relying on more connected sensors, can you tell us what benefits you see for the layered space architecture that has been proposed?

RL

Hughes has been following the DoD's efforts to create a new space architecture that includes a layered approach. Earlier this year, the Space Development Agency (SDA) outlined a notional architecture of seven layers of satellites: space transport, tracking, custody, deterrence, navigation, battle management, and support. We agree that a layered space architecture will deliver the resilience and security needed for today's information-centric battlespace. For mission success in contested environments, soldiers must be able to connect to decision makers in real time to ensure they can make fast and well-informed tactical decisions despite adversarial attempts at disrupting communications.

What is your perspective on speeding up DoD space acquisition?

RL

We are seeing great progress in DoD space acquisition initiatives as the faster pace enables industry to develop advanced prototypes in months rather than years. For the USAF, Hughes has leveraged both Other Transaction Authority (OTA) and Section 804 acquisition processes. We support the SpEC, Space Enterprise Consortium, becoming a central player in the Space and Missile Systems Center's (SMC) work to increase collaboration between the USAF and industry. In fact, our latest contract from SMC to produce an Enterprise Management and Control (EM&C) prototype for satcom networks, mentioned above, was awarded through SpEC.

The USAF's PATS program for protected tactical satcom (PTS) is moving quickly, and the PTES program used the new Section 804 authority to award our contract. It's important to remember why DoD is enacting these rapid acquisition initiatives — to ensure solutions get to the warfighter as quickly as possible to give them a tactical advantage. If it takes too long, money is wasted, and the upper hand is likely lost.

What role do Commercial-Off-The-Shelf (COTS) technologies play within the Hughes Defense product families?

RL

Hughes offers flexible COTS products across our commercial and government/military businesses. This includes our HM400 which is a software driven modem for Comms-on-the-Move (COTM). The modem uses software to enable flexibility in the overall system, including the capability to host a large suite of standardized and commercial waveforms. We have other development efforts that may not use a COTS device but still leverages the foundation of proven commercial technology, and then is adapted for a DoD system specification.

What is the difference between a military grade and a commercial grade satellite terminal and what does Hughes Defense offer as far as tactical communication support is concerned?

RL

Right now, the major difference is cost and complexity. We manufacture more than 50,000 Ka-band, JUPITER terminals a month at our factory here in Gaithersburg, Maryland using an advanced and largely automated assembly line. These terminals cost less than 1 percent of what the military pays for a fixed terminal, and already come ready to stand up to heat, cold, wind, rain and snow for years mounted on rooftops around the world. Granted they are built in high volumes, operate on a single band, fixed point, and are not full MIL-SPEC, but I think the military can learn a lot from our processes.

Going forward, the military needs to develop a standard size and open-control interface standard for modems — even if the waveforms running on the modem are proprietary. Using FMI, multiple modems can be plugged into a terminal and operate over multiple commercial and military networks. The RF portion of the terminal presents some challenges — this can be better standardized to control costs.

What are the most pressing concerns for the MILSATCOM community — how can Hughes address these needs now and in the future?

RL

I see two very important concerns — availability and resiliency, which have emerged as a result of near-peer militaries building up capabilities to disrupt all types of communications networks. At Hughes, we are helping the DoD through our global partnerships, like our Joint Venture with Yahsat that enables us to deliver HTS services in the ME/A regions.

We also see our advanced software technologies and modular open systems architecture approach as critical to delivering more resilient systems. Our AI and ML capabilities ensure that satellite networks can access the most available and reliable satellites, modems and services available when the warfighter needs them.

Hughes Defense continues to look for more ways to adapt our advanced commercial networking capabilities to military requirements. We understand the contested environment that DoD faces and have developed specialized waveforms to strengthen user terminals. For example, our advanced comms systems delivered to General Atomics for its Predator B Sky Guardian include new anti-jam enhancements.

What goals do you personally wish to accomplish for Hughes Defense over the next several months?

RL

Hughes Defense has experienced a pivotal year in 2019 receiving several large and long-term awards for major new DoD SATCOM programs. We won these programs to better support the modern warfighter by providing new levels of commercial innovation and leveraging our long-standing technical expertise as the global leader in satellite networks and services. Our opportunity pipeline has dramatically increased because we are committed to delivering cost-effective systems and customer satisfaction. This is and has always been the culture that has driven Hughes for over 45 years and has helped us become the go-to SATCOM provider customers can trust for an honest answer or proposal response. The highlight of my year is when customers tell me "they enjoy working with Hughes because we always answer the call," and my goal is always to work hard to maintain that reputation.

Going forward, we expect to keep this momentum and compete for opportunities to support new programs that enable airborne ISR, connectivity services and resilient network management. We are also exploring new capabilities like next generation narrowband SATCOM systems to support IoT and sensor enablement, LEO architecture management, and continuing to apply AI and machine learning to military SATCOM.

I personally hope to create a stronger brand identity in the military market — similar to what many in our community remember from years past.

HUGHES

36TH SPACE SYMPOSIUM

SPACE FOUNDATION

The Broadmoor Hotel • Colorado Springs • Colorado • USA

March 30 – April 2, 2020

The Premier Global, Commercial, Civil, Military, and Emergent Space Conference

Where the World and Space Connect

BUILD YOUR UNIVERSE

Where Ideas Launch • Connections Are Made • Business Gets Done!

SpaceSymposium.org

SAVE $600 – Register Today for Best Savings!

Special Military Rates!

+1.800.691.4000 Share: #36Space #SpaceSymposium

Official Media Partner

satnews

HOW TO OVERCOME THE BIGGEST CHALLENGES OF CONNECTED OPS

By Obie Johnson, Founder and Chief Executive Officer, CopaSAT

Keeping forward-deployed units safe, informed and connected are the difference-makers in remote missions. The best way to accomplish this is to ensure communications and power are available even where neither are available. Traditional solutions cannot achieve this though.

Reliable tactical communications rely on infrastructure and power supplies that work even in the harshest environments. When units operate in places that are completely disconnected from the rest of the world, they need SATCOM hardware that works on-the-move and ruggedized, independent power supplies that can withstand everything nature and people can throw at them.

Four Chief Challenges of Remote, Mobile Military and NATO Operations

Constantly changing circumstances
Wherever the cooperative efforts of NATO and the U.S. military may go in the world, situational awareness is crucial — particularly in austere environments. The need for quick deployment, tear down and redeployment of communications infrastructure and power means operations can move quickly to adapt to changing and unpredictable circumstances. In addition, clandestine operations led by special operations have even more exacting and extensible requirements for communications and power.

SATCOM On-The-Move (SOTM)
NATO and military forces rarely stand still, whether they are operating on land or on the water. This introduces an entirely new set of challenges and requirements. SOTM has always had its limitations, particularly on small military vehicles and vessels like MRZRs, 11-meter ridged hull inflatable boats (RHIBs) and the combatant craft medium — CCM Mk 1. These vehicles and vessels operate at high speeds, and on rough terrain and extreme sea states further exacerbating connectivity challenges.

Remote, hostile environments
Deployments can happen anywhere in the world at a moment's notice. High-risk dismounted operations often occur where communications and power are not available. The importance of further remaining inconspicuous makes off-the-grid infrastructure necessary. Keeping the location of mission operations concealed is critical. These units also need equipment that can withstand extreme weather, dust and sand, water spray and rough handling.

An installed CopaSAT STORM terminal.

Ruggedized communications and power considerations are required to support situational awareness for remote, commercial and military mobile operations.

Sustainable, autonomous operations
Self-reliance is crucial for forward-deployed units. Operations often continue for extended timelines, whether planned or unplanned, requiring sustainable field power and communications. Expeditionary units need autonomy and the discretion to execute in fluid situations.

Addressing Military and NATO Communications and Power Requirements

Today, there are means to addressing each of these challenges. Innovative SATCOM on-the-move (SOTM) and sustainable, ultra-portable field power solutions are supporting our military and NATO forces around the globe.

Powering sustained, mobilized operations is challenging. Wherever missions may deploy, military operations need rugged, reliable, expeditionary power solutions that are scalable to support a variety of demanding requirements from simply charging devices to powering full SATCOM communications terminals. There are many environments where trailers and generators are not an option. Eliminating the logistical hassles of transporting, maintaining and supporting traditional power generation sources means missions can go on, even in harsh, isolated locations.

Here's a checklist for reliable, field-deployable power.

Portability
Getting power to remote locations means the lighter the better when it comes to making power available. Today, there are expeditionary power solutions that are easily man portable. The ability to provide power at nearly any location without a logistics trail can make a critical difference in many missions.

Sustainable and renewable
Look for power that is autonomous and renewable, particularly when missions can end up stretching out past the normal 72-hour window.

Military-grade
Field power needs to meet military-grade requirements. Solutions that are designed to MIL-SPEC standards will ensure power continues to flow even after being exposed to inclement weather and unexpected drops or rough handling and transport.

Water and dust infiltration
Working in remote environments often means equipment is exposed to the elements such as dust and rain. Ensuring your power generation equipment is designed to withstand the elements is crucial. Look for passively cooled devices that do not rely on fans or filters. This will reduce maintenance and increase reliability.

Flexibility and usability
Systems should provide scalable field power designed to meet fluid requirements and extended operations. Support for regulated, unregulated output power and MPPT solar charging is also important. While protection against overvoltage, undervoltage, over current and short circuit are a requirement.

Modular
Specifying modular systems that can support multiple power sources including AC, DC, battery and solar is vital. Having multiple input and output types provides maximum flexibility and adaptability to a variety of environments, situations and requirements.

Fast set up and tear down
With units constantly on the move and situations being fluid, easy set up and tear down of power systems helps keep forward-deployed units powered while allowing maximum transportability.

Keeping the Lines of Communication Open

There are so many places, vehicles and vessels where you can't use commercial off-the-shelf (COTS) SATCOM solutions. On-the-move communications and SATCOM for MRZRs, 11-meter rigid hull inflatable boats (RHIBs) and other special operations craft have not been available. Legacy solutions don't fit and cannot track fast enough to remain connected with a satellite while the vehicle or vessel is moving at high speeds. This has always been a challenge. However, now there are solutions addressing the challenge, making all of these applications possible for the first time.

Here's a checklist for what to look for in SOTM.

SOTM
Reliable tactical SOTM connectivity and communications are critical to remote, austere operations. Keeping vehicles and vessels that have never been connected before connected over rough terrain and high sea states is now possible. Even 11-meter RHIBs, MRZRs, CCM Mk 1s can all have on-the-move broadband connectivity.

Mobile hotspot
The best alternative is to have a mobile hotspot that can use SD-WAN and select between cellular, Wi-Fi and satellite networks for optimization, failover and balancing. This offers maximum flexibility.

Connect into communications networks and equipment
In addition to being able to select between cellular, Wi-Fi or satellite networks, integrating other devices like MANET handheld radios provides interoperability between a flexible mobile network and various communications devices.

Plug and play
Another important thing to look for is fast deployment and provisioning. Setting up a satellite network can be complicated. However, there are solutions available today that only require a simple push of a button to auto-provision and acquire the satellite.

Anti-spoofing
Identify communications solutions that will protect the networks. SATCOM solutions need to accept external GPS sources such as Defense Advanced GPS Receiver (DAGR) for selective availability and anti-spoofing.

Military-grade
Equipment used in the field needs to be able to withstand rough handling, drops and weather. Look for solutions that have an IP68 rating and protection against water and dust infiltration.

Maximum flexibility and usability
Real estate to install SATCOM terminals is limited on small, fast-moving vehicles and vessels. Solutions that can both transmit and receive on a single terminal, make communications to and from vehicles and vessels that would have never been connected in the past.

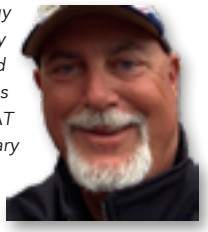
Low visibility
Keeping a low profile is important. Portable solutions that don't call attention to forward-deployed units make all the difference. Making sure it isn't obvious that a vehicle or vessel has satellite communications capabilities is also useful for clandestine missions.

Capacity flexibility
Predicting satellite usage and purchasing satellite capacity typically means commissioning capacity that may never get used. Getting access to flexible satellite services that are designed to have the connectivity follow the terminal means only paying for the satellite capacity that is actually used.

Expeditionary Power and SOTM

Ultimately, military and NATO operations require low visibility, standalone expeditionary power and SOTM solutions that can withstand remote and unforgiving environments and use. Combining these solutions into a single package helps maintain communications so every deployed unit can remain vigilant while remaining situationally aware at all times.

www.copasat.com



Obie J. E. Johnson is a technology entrepreneur and Auburn University electrical engineer that has worked with military satellite communications systems for nearly 40 years. CopaSAT is focused on providing expeditionary communications to U.S. and NATO forces.

In 2008, Mr. Johnson pulled together a small team to develop very successful X/Ku/Ka band manpacks and fly-away terminals while a co-owner at Tampa Microwave. In 2017, CopaSAT acquired Eclipse Composites Engineering in Salt Lake City, which provides carbon fiber composite antennas used in WGS certified satellite terminals.

In 2019, CopaSAT completed the acquisition of Virideon's intelligent power management product solutions. Mr. Johnson enjoys time with his wife and two sons racing and fishing.

CopaSAT helps government and commercial organizations turn missions in some of the world's most extreme and remote environments into realized objectives by providing reliable SATCOM on-the-move (SOTM) communication and renewable expeditionary power solutions. CopaSAT has been recognized with the 2019 Mobile Satellite Users Association (MSUA) Mobility Innovation Award for the Top Public Safety Solution for its CopaSAT STORM SOTM terminal. The company also recently acquired the Virideon Intelligent Power and Energy Router (VIP/ER) product line.

CopaSAT professional services and AxialOne managed services employ professionals that understand mission critical because they have been deployed in some of the world's most demanding missions. We partner with leading satellite operators, satellite service providers and satellite hardware manufacturers to deliver reliable communications on a global scale.

When commercial off-the-shelf (COTS), one-size-fits-all satellite communications services and solutions don't meet your mission requirements and you require a custom-engineered solution, that's where CopaSAT comes in. CopaSAT brings on-the-ground, real-world field experience to every engagement. CopaSAT knows mission critical because we have lived mission critical.

MANAGING THE HIGH VOLUME OF MISSION-CRITICAL DATA FOR DEFENSE OPS

By Ken Chadder, Defence Business Development Consultant, Hexagon's Geospatial Division

"We're currently faced with a security environment that is more complex, inter-connected, and volatile than we've experienced in recent memory – one which will require us to do things differently if we're to navigate ourselves through it successfully."

These words were spoken at the GEOINT 2019 Symposium by Vice Admiral ***Robert Sharp***, Director of the National Geospatial-Intelligence Agency, as he was discussing the organization's new strategy and goals.

The requirement to "*do things differently*" touches multiple facets of the Defense and Security environment, including the management of the information and intelligence that powers missions and critical decision-making processes. As Lt. Gen. ***James M. Dubik***, U.S. Army Retired, pointed out in his 2018 article, "*Decision-Making Process May Need an Update*," a shift from an industrial model of decision-making to a network model is taking place at the tactical operations level.
In an industrial model, the structure is more hierarchical, with decision-making remaining with select few, and "*making decisions, taking coherent action, and adapting is predominately sequential.*"

The network model is certainly a shift from the traditional industrial structure. It requires more dependence on leadership from different levels of command and lessens the gap between information availability and action. In the network model, according to Dubik, "*Mission Command and intent predominates rather than directive command, staff work is more simultaneous and continuous than sequential and episodic, and overall the organization is more decentralized than centralized—all without loss of coherence in execution.*"

The network model is "*the military's response to the Information Age*," according to the Department of Defense's Office of Force Transformation in their paper, "*The Implementation of Network-Centric Warfare.*" As the capabilities of information technology have transformed the way commercial industries do business, a similar effect has taken hold on Defense and Intelligence operations. The network model means embracing technology such as sensors, communications systems, and other intelligence products for true situational awareness across the organization.

According to the paper, major impacts of this trend in U.S. operations were particularly beginning to be noticed during the 2001-2002 period of Operation Enduring Freedom (OEF) and in 2003 during the Iraq War (Operation Iraqi Freedom, OIF).

When speaking about his observations on a net-centric approach, retired U.S. General ***Tommy Franks***, commander of coalition forces for OEF and OIF, noted that the approach bypassed previous "*stove-piped*" processes, and instead provided a wealth of invaluable information. For instance, when discussing a force tracking system that let him know the location of his forces in near-real-time, he stated, "*I've died and gone to heaven and seen the first bit of net-centric warfare at work*!"

Aligning with modern information technology trends and having the necessary information for informed decision-making is at the heart of the modern military. Having the correct information faster than opposing forces — which are also experiencing increased accessibility to smarter technology, due to globalization in the Information Age — can be critical to success.

To break down intelligence siloes and to empower more distributed, network-enhanced decision-making, each level of leadership requires the relevant intelligence to be timely and accurate. The necessary data and information can be hard to collate and analyze not because of a lack of sources, but due to the number of data sources are growing exponentially, forming a data deluge that can hinder accuracy, timeliness, and efficiency.

A Common Operational Picture (COP) provides common situational awareness for all levels of command and staff across an operation facilitating the decision-making process.

Commanders need to be able to act in minutes, which requires a greater need for situational awareness and data sharing across the entire Defense network – from the geospatial intelligence specialists who integrate and analyze data, to the planners who need to understand the battlespace, to the operators who must make decisions and act based on timely and accurate information.

Facing an Abundance of Data in the Defense Space

It is well-known that an influx of data is being generated every minute. Futurist, author, and business and technology consultant ***Bernard Marr*** quantified that data in a 2018 article. He said that we produce 2.5 quintillion bytes of data each day, and that 90 percent of the data in the world was generated in the previous two years.

Defense and Intelligence organizations have not been spared from this abundance of data. As ***Nathan Houser***, a principal at Deloitte Consulting LLP, reported in his article, "*Data-driven deployments: How analytics can transform military positioning,*" it's estimated that from 2001 to 2011, "*the amount of data gathered by military drones and other surveillance technologies alone rose by 1,600 percent.*"

Houser also referenced research from the *New York Times*, which specifically looked at data surrounding U.S. Air Force (USAF) intelligence. According to Hauser and New York Times, "*Every day across the Air Force's $5 billion global-surveillance network, cubicle warriors review thousands of hours of video, thousands of high-altitude spy photos, and hundreds of hours of (foreign communications).*"

The volume, variety, and velocity of Intelligence, Surveillance, and Reconnaissance (ISR) data available today has exponentially increased, creating many challenges that include:

- *A time-consuming and labor-intensive process of sifting through huge geospatial data sets to find the small percentage of data that is relevant for tipping and cueing.*
- *Difficulty in quickly visualizing and analyzing large geospatial data sets, such as LiDAR and hyperspectral imagery.*
- *Integrating, analyzing, and visualizing large amounts of disparate data, including real-time data, into a common operational picture streamed/shared across a network.*
- *Supporting mission-specific requirements that may require a custom solution.*
- *Finding alternative data sources to remedy gaps in situational awareness.*

In this age of Big Data, the acquisition of data is no longer the challenge. It is in fact the organization that can process this data the fastest that will win the future battle.

To overcome these challenges, technological solutions are needed to better discover, manage, integrate, visualize, and analyze large amounts of mission-critical data.

Simplifying Visualization and Analysis

Before visualization and detailed analysis of geospatial Big Data, commanders and their staffs have to first sift through and analyze huge geospatial data sets to find the relevant data in order to develop the

intelligence required for decision-making and action. For decades, intelligence agencies have relied on tipping and cueing to streamline this process, where intelligence analysts are "*tipped off*" by the presence of something suspicious and "cue" the AOI for higher resolution imagery, data, or information and further analysis.

The key to streamlining this process in the data-era lies in embracing the latest computational capabilities, such as machine learning and artificial intelligence. Introducing these capabilities into the tipping and cueing process will help reduce the time and resources required, by filtering non-relevant data and alleviating the need to manually sift through large amounts of data. For example, being able to tip the analysts or automated algorithm towards a particular region/person/object in the data is useful in reducing search and processing time.

For geospatial analysis, AI and machine learning can already be taken advantage of in proven remote sensing solutions, adding a higher level of speed and accuracy to robust imagery analysis tools that are capable of processing vast amounts of geospatial data every day — consolidating remote sensing, photogrammetry, LiDAR analysis, analytics, and radar processing in a single product.

Those same automation capabilities are also available in the latest smart analytics platforms, bringing a new level of analysis to dynamic visualization of data, in a way that can be securely hosted on networked systems. These systems similarly can provide advanced visualization and integration for multiple types of data, including vector and point cloud data, or even non-geospatial operational data, allowing operators to quickly filter through mounds of information in order to apply the necessary analytics required for decision making.

Similarly, accelerated visualization and analysis solutions can support not only simple data filtering, but additional analytics and querying methods such as styling, heat maps, geofencing, and distance calculations, bringing geospatial Big Data to life to support operations.

Fusing Relevant Data into a Common Operational Picture

A Common Operational Picture (COP) provides common situational awareness for all levels of command and staff across an operation facilitating the decision-making process. Shared situational awareness of friendly and enemy forces, resources, assets, and infrastructure can mean the difference between mission success and failure.

Jim Garmone, a reporter for *Department of Defense News*, explored the modern-day requirements of military decision-making in his feature on Marine Corps Gen. ***Joe Dunford***, who served as the 19th chairman of the U.S. Joint Chiefs of Staff.
In the article, called, "*Dunford: Speed of Military Decision-Making Must Exceed Speed of War*," Dunford said that "*information operations, space and cyber capabilities, and ballistic missile technology have accelerated the speed of war, making conflict today faster and more complex than at any point in history.*"

To make certain decision-making can be effective and just as timely, Dunford said that there must be "*a common understanding of the threat, providing a clear understanding of the capabilities and limitations of the joint force, and then establishing a framework that enables senior leaders to make decisions in a timely manner.*"

He went on to say that the joint force "*depends on leaders who anticipate change, recognize opportunity, and adapt to meet new challenges.*"

For military leaders and their staffs to meet these requirements, they must have access to a rich and dynamic COP, one that can integrate and visualize large amounts of data, including live air, maritime, and land tracks, using military symbology and providing real-time analytics for better situational awareness.

Market-leading platforms that support COPs can accomplish even more. From handling millions of static and live feeds or tracks, to connecting to a range of data sources without the need for translation or conversion, these solutions can interact with and visualize diverse types of data feeds (air, land, sea, space, and cyber) across a network. The latest technology can also visualize and drape data feeds and sources in 3D, including radar and (aerial) video in real-time, providing additional versatility within the COP.

NATO was an early adopter of such technology, beginning back in the 90s. After discovering a customizable and advanced visualization platform, they used that platform to build the interim Geo Spatial Intelligence Tool, or iGeoSIT.

While looking for a platform suitable for their COP, their requirements included finding an affordable solution which could leverage an agile development concept, facilitating a timely development to deployment cycle. They also required a solution that would be easy to learn in the field. Most importantly, they sought a solution that could directly read multiple large data sets in various formats, and would easily visualize a wide array of geographical references while overlaying important operational data (both static and real-time).

Now, almost 20 years after they found the correct platform for bringing iGeoSIT to life, iGeoSIT is the preferred COP tool for NATO and many NATO member countries, supplying the necessary data for military and humanitarian operations.

Filling In the Gaps with Alternative Data Sources

An increasingly common manner of supplementing traditional data sources is through imagery collection using unmanned aerial vehicles. Technological advances are occurring within the UAV space that further extend the tactical edge intelligence gathering capabilities in order to provide a more complete picture to support decision making.

Drones provide a level of resolution and accessibility that satellite data can't compete with, collecting and providing imagery that broadens the scope of situational awareness. Modern drone solutions can also be deployed in low or no-bandwidth environments, collecting data offline for viewing in the field, command centers, and across military networks.

Other advances include more efficient design, meaning smaller and more compact drones can easily and quickly be deployed by hand, to gather imagery of specific targeted mission areas prior to and during an operation.

Turning Location Intelligence Data into Decisions

As military operations shift to favoring a network model where decision-making is a more distributed process that lends itself to simultaneity, it's more important than ever that the right data, information, and intelligence be readily available at the tactical, operational, and strategic levels. This is especially crucial as the Information Age continues to produce intelligence solutions with increasing capabilities, which can be accessed from either side of a conflict.

There is a requirement for a real-time integrated COP in order to provide a common shared situational awareness for operations across the levels of command. This requires increased data exploitation, integration, analysis, visualization, and dissemination capabilities that need to leverage AI and machine learning to help overcome the Big Data challenges of today. By achieving this, we will be able to provide that timely and relevant intelligence for decision making.

As Vice Adm. ***Robert Sharp*** said, it's time to "*do things differently.*" Let's start by embracing the latest situational awareness technology to better manage operational data and act on it to achieve mission success.

www.hexagongeospatial.com/industries/defense

Colonel (retired) Ken Chadder is a Defence Business Development Consultant for Hexagon Geospatial. He joined Hexagon in 2014 after 36 years as a Military Engineer in the Canadian Armed Forces. A graduate of the Royal Military College in Kingston where he received a Bachelor of Engineering, Colonel Chadder held command appointments at all levels during his extensive military career. In his role as Director of JOINTEX, Colonel Chadder gained extensive experience in C4ISR and modeling and simulation.

COMMAND CENTER: RON LOPEZ, PRESIDENT AND MANAGING DIRECTOR, ASTROSCALE US

Ron Lopez joined Astroscale as President and Managing Director in April of 2019 to lead the company's business operations in the United States.

He brings more than 25 years of government and industry experience, encompassing systems engineering, program management, sales and marketing, technology/research and development management, and strategy formulation.

Ron started his career as an Intelligence Officer in the United States Air Force (USAF), serving as the focal point for Space Situational Awareness capability development at Air Force Space Command's Space Control Division.

He then joined Boeing and worked on various programs as a Systems Engineering Manager within Boeing Research and Technology and Phantom Works and led business development activities for the Network & Space Systems division throughout the Asia Pacific region.

Prior to joining Astroscale, Ron led the Defense and Space Asia Pacific sales team at Honeywell Aerospace, helping the company achieve significant sales growth and expansion into new markets.

More than half of Ron's career has been spent working and living in Japan and he is an active member of The Maureen and Mike Mansfield Foundation's U.S.-Japan Space Forum. Ron earned a Bachelor of Science from The United States Air Force Academy in 1993.

Mr. Lopez, would you please give our readers details about Astroscale and the firm's business operations in the U.S.?

Ron Lopez (RL)

Let me explain a bit about Astroscale's background and the business we are pursuing. Astroscale was founded in 2013 by Mr. *Nobu Okada*, who at the time was an IT executive. He created Astroscale as he believes innovative technologies can help to reduce the amount of debris on orbit lessening the risk of significant damage that the growing amount of debris can cause. Forecasts show that by 2030, approximately 20,000 satellites or more will be launched and of these new satellites, at least 10 percent will fail and become potentially harmful debris.

We placed the business' R&D in Japan in 2015 and it remains there now based on the technology-oriented, highly skilled workforce available to the company. Astroscale opened an office in the UK in 2017 to support the momentum coming from updated UK space policy and innovation in the space arena, establishing an on-orbit servicing command and control center.

Astroscale US opened in March of this year in Denver, Colorado, to take advantage of its highly skilled workforce and the variety of space-related business that can support our growth and to be able to support the delivery of orbital services and de-orbit capability to the U.S. government.

These global locations will help us leverage the three most active countries/regions in terms of space development and utilization — Japan, the UK/Europe and the U.S. In the U.S., we plan to expand our offerings by leveraging key Rendezvous & Proximity Operations (RPO) technologies developed by the company and applying them to other on-orbit services (OOS), for DoD and commercial customers.

We have read some recent information about on-orbit satellite services for commercial satellites, most specifically the MEV launch by Northrup Grumman. Can you explain how this area of on orbit services can benefit our Department of Defense readers?

RL

It will be exciting to see Northrup Grumman's MEV conduct the first commercial servicing mission to extend the life of a GEO satellite. This type of technology will lengthen the life of important space assets, instead of needing to replace these highly capable and expensive spacecraft with new ones. In addition, these services can ensure that critical national security satellites receive upgrades every few years instead of relying on satellites with decades-old hardware and technology. This will give a much-needed technology refresh at the fast pace of innovation so the US can stay ahead of emerging threats.

Also, as DoD starts disaggregating and distributing capabilities to enhance resiliency, I believe capabilities will slowly migrate down to LEO, which will extend and enhance — not replace — the capabilities of DoD's assets at GEO. I anticipate a growing need for OOS at LEO as well, such as the ability to refuel, maneuver, and raise or lower orbits to enhance mission performance or achieve other operational objectives. All of these on-orbit servicing technologies will be force multipliers for DoD while helping save valuable budget dollars.

As space is so important to government and commercial users, can you tell us how the DoD and other government agencies will benefit from Astroscale's business plans?

RL

The LEO environment is changing rapidly. With greater access through launch, we are seeing more orbital congestion due to the thousands of satellites planned for future service. Additionally, the U.S. DoD sees LEO as an option to deliver more resilient and affordable capability focused on meeting its requirements. We will focus on LEO to respond to these changes.

Servicing in LEO will likely support reconstituting capability quickly, managing constellations, providing added maneuverability, and limiting the risk of collision through deorbit services. All of these can support DoD as it builds out its distributed LEO architecture that will deliver critical communications and situational awareness to soldiers, sailors, airmen, and marines. In addition, we will look at the GEO domain where Northrup's MEV is deploying by aiming to provide services with smaller, more cost-effective vehicles.

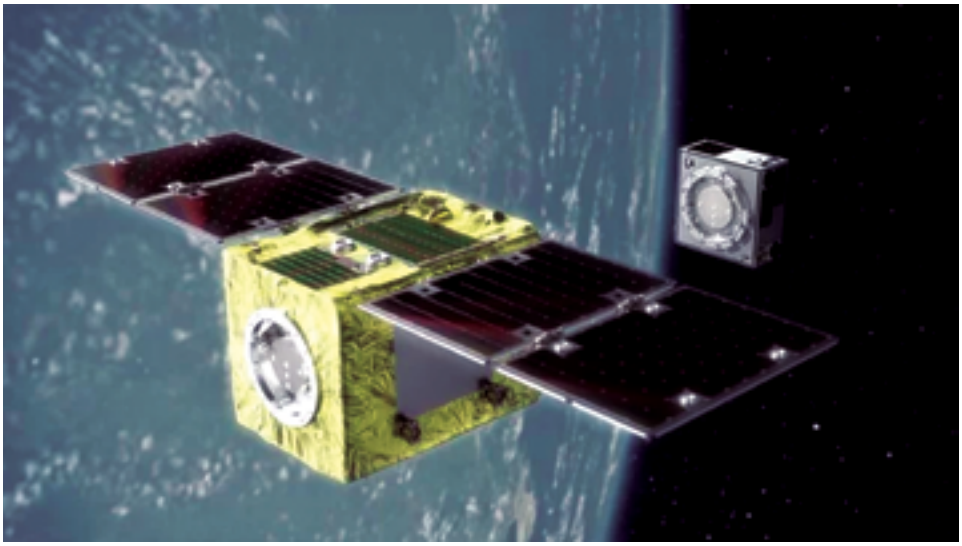
Astroscale can provide both the expertise and technology for life extension, inspection, refueling, repair, and orbit repositioning to reinforce much-needed resilience of national security space capabilities. More importantly, commercial services writ large can provide many benefits to government users, most importantly the inclusion of updated technologies and rapid response, provided the contractual/acquisition details enable this speed of action.

Please explain the company's plans for 2020 as it is just around the corner.

RL

We are very busy preparing for 2020 as Astroscale will be launching the world's first commercial end-to-end active debris removal demonstration mission, ELSA-d. This mission will demonstrate to government and commercial space users that there are expanded options for managing the growing debris issue, especially in the LEO domain that will soon have many more satellites.

Our End of Life Service by Astroscale demonstration (ELSA-d) mission will last approximately six-months. This will consist of a Servicer satellite that we designed and built, and a Client satellite which has been designed and built by one of our partners. Once these reach their desired orbit, the Client will separate from the Servicer and demonstrate all the core sequences of end-to-end debris removal technologies, including client search, inspection, approach, docking, detumbling and deorbit.



The ELSA-d mission (***artistic rendition above)*** will demonstrate a technology first — it will be the first to show the capture of a tumbling client on-orbit. In addition to technological demonstration, ELSA-d will also address operational best practices in Rendezvous and Proximity Operations.

Orbital debris removal and satellite servicing are complicated missions. Designing a spacecraft that can locate, rendezvous and dock with a defunct satellite is no easy feat as these satellites are orbiting overhead at thousands of miles per hour, making them difficult to approach. Additionally, practically all of the satellites that are in space were not designed for docking and repair. Astroscale understands this technology challenge and is committed to finding the best technical, cost-effective solution to better manage our precious and highly valuable space environment.

Have additional missions been identified within your company's Active Debris Removal (ADR) solution? Can you tell us about any of your new projects and how will ADR capture space debris?

RL

Removing debris that is currently on-orbit requires significant preparation from a technical and regulatory perspective. These objects were not prepared for servicing before launch and can be as large as a school bus. Also, these objects are very often owned by governments.

Working with national space agencies and international organizations, Astroscale is developing missions that incorporate innovative solutions for capture and removal of large 'passively cooperative' debris, such as rocket upper stages and defunct satellites that are already in orbit at congested altitudes. The key to the ADR services business is providing a highly reliable, low-cost service closely linked to the customer's requirements. Each object for an ADR mission is unique so the solution for its removal will require a bespoke technical approach. For these missions, capture mechanisms must be developed that can capture a 'passively cooperative' object.

The Rendezvous and Proximity Operations technology and practices we are developing for our ELSA-d EOL mission can be leveraged to support an ADR mission.

We are currently preparing a response to a Request for Proposal (RFP) issued by the Japan Aerospace Exploration Agency (JAXA) for an ADR mission. Phase I will entail conducting an RPO inspection of the object, and a follow-on Phase II program will actually de-orbit the object. With a global workforce of 100 people — 80 percent of which are engineers — and having raised $140 million in capital, Astroscale is well positioned to win and execute on this program.

Given the impetus of other companies who are becoming involved in, or plan to engage in, debris removal, what makes your technology the "go to" solution?

RL

It's not just about the technology, it's about delivering mission capability—an end-to-end integrated solution—at a price that customers can afford. Astroscale is not only developing the technology, but also defining business models and addressing the policy and regulatory issues that will allow us to deliver a cost-effective solution.

Astroscale is the only commercial solution in LEO that is being prepared for demonstration soon, in 2020. This timing will give government and commercial parties the chance to see how our end-to-end capability will function and learn about all the elements involved in the launch, rendezvous, proximity and inspection maneuvers we make.

What is Astroscale's Lunar Dream Capsule project?

RL

The Lunar Dream Capsule is a time capsule that gives people a chance to send their names into space. Partnering with Otsuka Pharmaceutical, Astroscale has specially designed and developed a capsule that will bring names to the Moon in the hope that future generations will be able to visit someday and retrieve it. The Lunar Dream Capsule Project will be taking the Capsule throughout Japan and selective countries in Asia to collect handwritten messages from people which will then be laser etched onto titanium plates to be packed inside the Capsule.

Astroscale is serving as the lead for the mission and is responsible for the design and overall technical management of the Dream Capsule and the message plates.

Astroscale is also leading communication between the Japanese team members and partners in Singapore and the United States. Astroscale has contracted Astrobotic to send the Dream Capsule on its first lunar mission on a United Launch Alliance Centaur rocket in 2021.

As you review your experiences within this industry, what project or projects brings a true sense of satisfaction to you?

RL

Our U.S. team is very focused on expanding the enthusiasm of the younger generation of space professionals and space users. We want to encourage their dedication to the future of space exploration.

Students and other young people want to be part of the space industry and fulfill the potential that the next frontier holds. At the same time, they want to see the practical benefits of space.

Astroscale U.S. fully understands this desire for something tangible so we are fulfilling the mission to make the space environment sustainable. Space sustainability is valuable for future efforts in space; these lessons and practices can be utilized in lunar and Martian orbit. Therefore, there is a strong connection to what we are pursuing today by creating a sustainable LEO environment and the future of exploration. As many of us learned in school, we should leave a place as clean or cleaner than when we arrived. In space, we like the idea of 'leave no trace.'

Our ELSA-d project launch will, no doubt, be a satisfying moment once complete. We have an international, passionate team, innovative solutions, and are excited to get started delivering a service to maintain the space environment and enable the success of our customers.

While all of this orbital debris activity brings challenges and rewards, working to deliver new on-orbit service capabilities to support the warfighter on the ground, in the air, and afloat is the most satisfying part of what we do.

Astroscale

SPACE REPORT 2019: Q3 — A GUIDE TO GLOBAL SPACE ACTIVITY

By Space Foundation

Highlighting a range of space industry activities, The Space Report Quarter 3 conveys the most pertinent and interesting findings of Space Foundation research and analysis conducted during the quarter.

These perspectives on commercial space revenue, STEM education, and emerging jobs provide key insights into trends that continue to shape the larger space industry and how it will continue to grow and evolve.

The global space economy crossed the $400 billion mark for the first time this year with revenues of $414.75 billion. Commercial space activity fueled much of that growth, with the largest single-sector gain coming from value-added services, which posted a single-year 20.5 percent increase in revenues.

Strong economic news in the space industry also was reflected in the second-quarter results of the The S-Network Space Index^{sm}. Of the 30 space-related companies it tracks, seven showed growth of 20 percent or more in Q2 2019. Overall, the index showed an increase of 8.7 percent and outperformed the two comparison indexes.

The full version of *The Space Report Quarter 3* provides more detail regarding 2018 activities. For more in-depth and up- to-date information, The Space Report Online captures the latest and most accurate space industry data.

Both the report and database subscription are available for purchase. To join major aerospace companies, universities, research firms, and government organizations that are serious about gaining in-depth knowledge about the global space industry, see the end of this summary for purchasing details.

Global Commercial Space Activity

- *Revenues from global commercial space activity in 2018 reached their highest levels ever, totaling $328.86 billion, an increase of 6.6 percent from 2017. Commercial revenue accounted for 79.2 percent of total global economic activity in space.*

The Space Report serves as a resource for government and business leaders, educators, financial analysts, students, and space-related businesses.

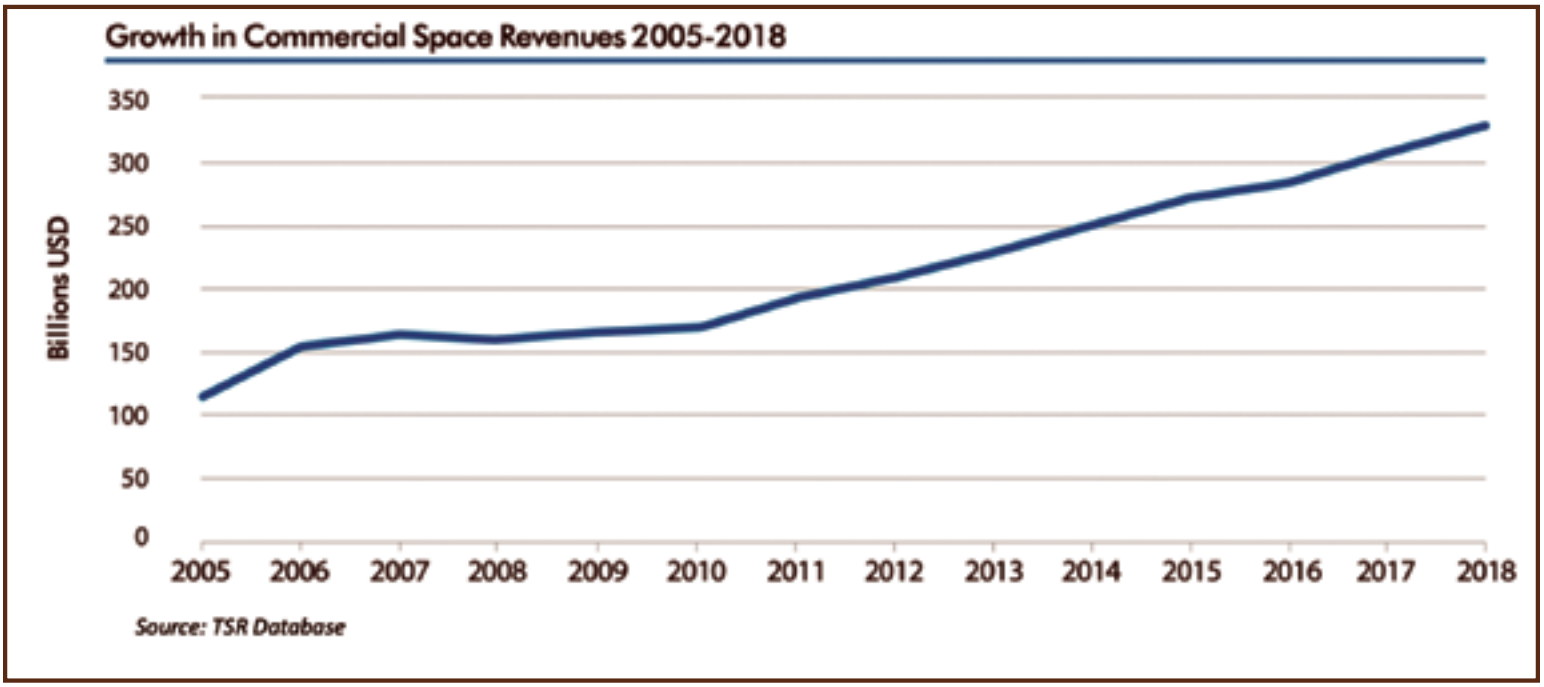
Starting in 2004, legislative mandates and private enterprise fueled a new era dedicated to space exploration and the involvement of private enterprises. From 2005 to 2018, those new efforts triggered a 13-year period of growth that resulted in a 162 percent increase in commercial space revenue.

Commercial Space Products and Services

Commercial space products and services accounted for 69.7 percent, or $229.17 billion, of total commercial revenue, during 2018.

Category	Revenue	Source
Ground Stations and Equipment	$92.47 B	Satellite Industry Association, European GNSS Agency (GSA)
Satellite Manufacturing (Commercial)	$5.28 B	Eurospace
Launch Industry (Commercial)	$1.49 B	Eurospace
Insurance Premiums	$0.46 B	XL Catlin
Commercial Human Spaceflight (Deposits)	$0.00 B	News Reports; Public Statements
Total	$99.69 B	

- *In 2018, value-added services, companies that receive and use satellite signals for a range of businesses including logistics and smartphone apps, contributed the largest portion of revenue in this sector, 43.1 percent, with $98.67 billion.*
- *Revenues from Direct-To-Home(DTH) television were close behind, providing 42.0 percent of total revenue in this sector in 2018, with $96.31 billion.*



Broadcasting

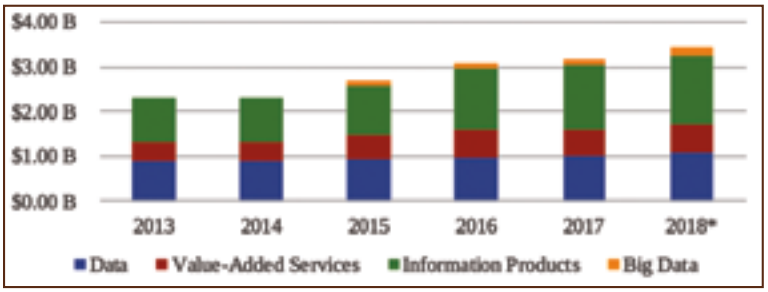
- *Satellite television revenues were estimated to be $96.31 billion in 2018, based on data from the Satellite Industry Association, public filings, and industry reports.*
- *Revenue has been relatively steady in this area, decreasing less than 1 percent from the estimated total of $97 billion in 2017. Satellite TV providers are losing customers primarily to over-the-top services that provide on-demand content, like Netflix, Amazon Prime Video, and Hulu*
- *In the area of satellite radio, provider Sirius XM increased revenue by 6.4 percent over the past year, from $5.43 billion in 2017 to $5.77 billion in 2018.*

Communications

Global revenue in 2018 was estimated to be $24.97 billion, 4.1 percent more than the estimated revenue of $24 billion in 2017.

Earth Observation

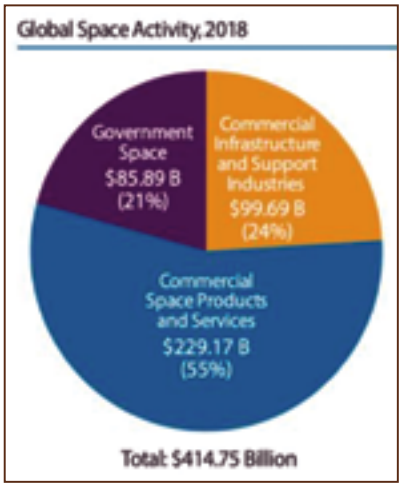
Total global revenues for this sector were estimated at $3.45 billion in 2018, an increase of 9.4 percent from the total revenues of $3.15 billion in 2017.



**Estimated Revenue: Source: Northern Sky Research, Public Filing*

Commercial Infrastructure and Support Industry

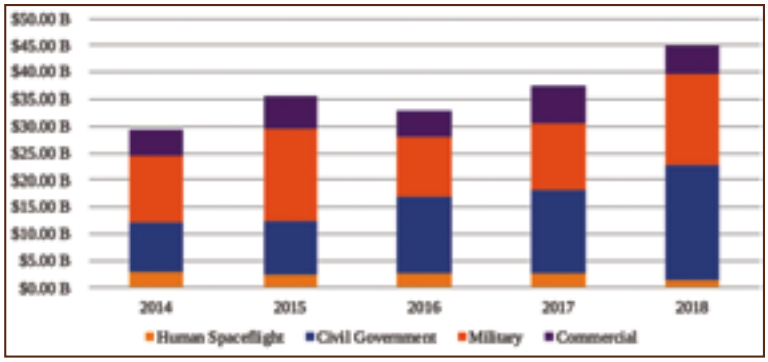
Commercial infrastructure and support industries accounted for $99.69 billion in revenue in 2018, which represented 30.3 percent of total commercial space revenue. This is 2.6 percent more than the $97.16 billion in revenue during 2017. The largest source of revenue in this area in 2018 was from ground stations and equipment, which accounted for $92.47 billion, or 92.8 percent, of total revenue in this category.



Source: The Space Foundation.

Satellite Manufacturing

- *From 2014 to 2018, the total manufacturing value of spacecraft/satellites launched each year increased almost 50 percent from just under $30 billion to $45 billion.*
- *The majority of that value in 2018 came from civil government and military sectors, but U.S. companies launched 167 spacecraft/satellites and earned $5.28 billion in revenue.*
- *Revenue from commercial spacecraft accounted for 11.7 percent of the estimated $45 billion total value of the spacecraft market in 2018. The remaining 88.3 percent, or $39.75 billion, was related to civil and military spacecraft, including cargo launched to the International Space Station as part of NASA's commercial resupply services.*



Source: Eurospace

Launch

- *Estimated global market value for commercial launch services in 2018 was $1.49 billion, according to Eurospace, the European space industry association. This is a decrease of 40.3 percent from the estimated total of $2.49 billion in 2017.*
- *Commercial launches accounted for 21 percent of the estimated total global market value for orbital launches in 2018.*
- *Launches for government customers accounted for the remaining 79 percent, or $5.60 billion of estimated market value.*

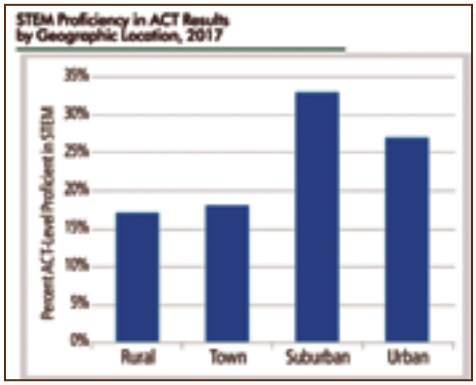
STEM Education

This analysis of the future of the space industry examines STEM proficiency rates of primary and secondary students, subsequent STEM postsecondary graduation rates, and the familial and educational background of STEM degree recipients.

STEM Proficiency in Primary and Secondary School

U.S.

Significant differences in STEM education can be found across public and private schools, and throughout grade levels.



Source: STEM Education in the U.S.: Where We ARE and What We Can Do — 2017, ACT

In science, eighth grade proficiency in private schools is 10 percent of that in public schools. Similarly, eighth grade technology and engineering literacy proficiency in private schools is also 10 percent higher. There's an additional disparity between all public and big-city public schools, namely, mathematics proficiency is 8 percent lower in big cities and science proficiency is 19 percent lower.

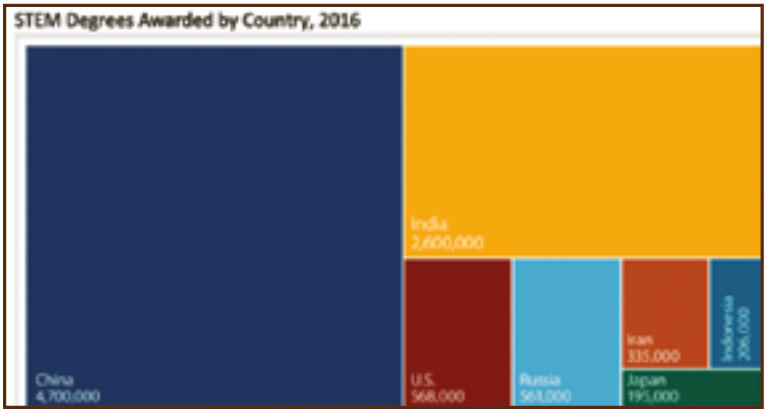
No school location produced a STEM-interested and STEM- proficient student base greater than one-third.

International
The Organisation for Economic Co-operation and Development (OECD) surveys 15-year-olds across the world in the Program for International Student Assessment (PISA). The 2015 survey included over half a million students in 72 participating countries, creating a baseline of STEM proficiency on a global scale

On a regional scale, Asia outperformed other continents, containing three of the top five nations in science proficiency, and all five of the top five nations in mathematics proficiency

On the other end of the spectrum, 46 percent of students surveyed scored an average of Level 2 or below on mathematics and in science. Of these, about 25 percent scored a Level 1 in science and over 30 percent scored a Level 1 in mathematics.

Postsecondary Degrees in STEM
The U.S. awarded only 6 percent of all STEM degrees awarded globally in 2016— approximately 568,000.



Source: World Economic Forum.

China produced eight times as many — 4.7 million — and more than half of all STEM graduates in 2016, followed by India (28 percent). Taking national population into account, Iran produced the greatest number of STEM graduates per capita (1:238), followed by Russia (1:258), and China (1:294). For comparison, the U.S. STEM graduate rate per capita landed at 1:569.

Emerging Jobs

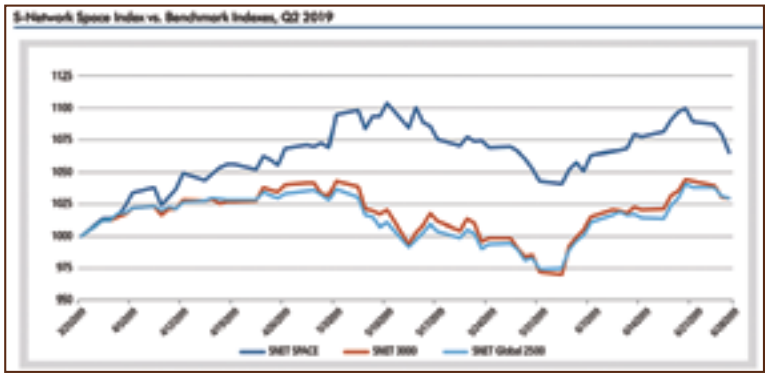
According to Pew Research, U.S. STEM employment has grown 79 percent since 1990. The Bureau of Labor Statistics tracked a 10.5 percent increase in employment (approximately 800,000 jobs) across all U.S. STEM occupations between May 2009 and May 2015. U.S. STEM employment in May 2015 reached 8.6 million, accounting for 6.2 percent of total U.S. employment. The Bureau of Labor statistics predicts 2.6 million U.S. STEM job openings between 2014 and 2024, with the most dramatic growth projected in mathematical science occupations.

- *With the sub-baccalaureate workers included, STEM jobs represent 20 percent of all U.S. jobs. By this metric, as many as 26 million jobs in the United States require significant STEM knowledge and skills in at least one STEM-related field.*
- *A 2014 Business RoundTable survey projected that during the next five years, major American companies will need to add a total of nearly 1.6 million employees to their workforce: 945,000 who possess basic STEM literacy and 635,000 who demonstrate advanced STEM knowledge.*
- *One in three workers ages 25 and older that have at least a bachelor's degree in a STEM field of study, but only about half (52 percent) of these STEM-trained workers are employed in a STEM occupation.*
- *The U.S. Census Bureau even reported in 2014 that 74 percent of those who have a bachelor's degree in a STEM major are not employed in STEM occupations.*

S-Network Space Index℠

The S-Network Space Index℠ tracks a global portfolio of publicly traded companies that are active in space-related businesses and compares their performance against two other indexes. The S-Network 3000 tracks the 3,000 largest U.S. stocks by market capitalization, and the SNET Global 2500 tracks a combination of the 1,000 largest U.S. stocks, 500 largest European stocks, 500 largest Pacific basin stocks (developed), and the 500 largest liquid Emerging Market stocks.

In Q2 2019, the 30 space companies the met the financial requirements for inclusion in the Space Index significantly outperformed the S-Network US Equity 3000 Index (SNET 3000) and the S-Network Global 2500 Index (SNET Global 2500).



Note: Performance shown for each index is for the gross total return, assuming all dividends are reinvested.

Report Purchasing Options

The Space Report serves as a resource for government and business leaders, educators, financial analysts, students, and space-related businesses. For more than a decade, *The Space Report* has chronicled the growth of the space community from around the world.

The Space Foundation's Research & Analysis team produces *The Space Report*, and earlier this year transitioned its annual summary into quarterly updates of global space activity.

This new format makes it possible to provide the most up-to-date information on space infrastructure, facilities, launches, and programs. Similar to other major economy- measuring indicators that inform our awareness of what is happening around the world, the quarterly installments of *The Space Report* are designed to improve our discussions and understanding of the reach, impact, and health of the space community.

To purchase *The Space Report 2019*, or to subscribe to *The Space Report Online*, go to ***thespacereport.org/pricing***.

For more information about the availability, pricing, and delivery of The Space Report, please contact ***TheSpaceReport@SpaceFoundation.org.***

For questions related to *The Space Report* content, or the space industry in general, or a request for customized research by the organization's Research & Analysis team, please contact ***Research@SpaceFoundation.org***.