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MilsatMagazine

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BAE SYSTEMS UNVEILS THEIR NEW, ULTRA-SMALL, GPS RECEIVER WITH M-CODE MILITARY GPS SIGNALS



BAE Systems, Inc. has unveiled their ultra-small **MicroGRAM™-M** global positioning system (GPS) receiver that is compatible with next-generation, M-Code military GPS signals that are resistant to jamming and spoofing.

About the size of a postage stamp, MicroGRAM-M is, according to the company, the world's smallest, lightest, and most power-efficient M-Code embedded GPS receiver – delivering assured positioning, navigation, and timing (PNT) for size-constrained and other micro-applications.



MicroGRAM-M features rapid secure GPS signal acquisition, enhanced security and resiliency, anti-jamming and anti-spoofing capabilities, and the industry's lowest power consumption for an M-Code device.

The 1.0" x 1.25" x 0.275" MicroGRAM-M has the same physical dimensions as its predecessor, enabling quick upgradability to M-Code and reduced system integration costs. At its core is a proven, tamper-proof M-Code Common GPS Module that encapsulates classified data and signal processing.

"We're delivering reliable PNT where our customers need it – from soldiers' handheld devices to small unmanned aerial vehicles," said **Greg Wild**, director of Navigation and Sensor Systems at BAE Systems. "MicroGRAM-M provides our armed forces and allies with a low-SWAP M-Code GPS solution that's resistant to adversaries' disruption efforts in highly contested environments."

"MicroGRAM-M is the latest BAE Systems M-Code military GPS product, joining MPETM-M and NavStrikeTM-M, which deliver enhanced awareness in highly contested environments and precision munitions guidance," said **John Watkins**, vice president and general manager of Precision Strike & Sensing Solutions at BAE Systems. "Qualification of MicroGRAM-M is underway, with full-rate production expected in 2022."

KRATOS DELIVERS FIRST ORDER TO NORTHROP GRUMMAN FOR U.S. ARMY'S TITAN PROTOTYPE PROGRAM



Kratos Defense & Security Solutions, Inc. (Nasdaq: KTOS) has successfully delivered the first set of products to support the U.S. Army Tactical Intelligence Targeting Access Node (TITAN) space-ground system prototype, which is being developed by **Northrop Grumman**.

The purpose of the TITAN system will be to provide near-real time data to commanders at all levels for timely targeting solutions. Northrop Grumman was selected by the **Defense Innovation Unit** and the **U.S. Army Tactical Exploitation of National Capabilities (TENCAP)** office to develop prototype Space to Ground TITAN systems.

As part of this effort, Kratos' OpenSpace quantum and **SpectralNet** products will provide virtualized downlink processing for the TITAN space-ground prototypes. Kratos was selected to the Northrop Grumman TITAN team due to the OpenSpace products' ability to virtualize uplink/downlink processing while meeting **Space, Weight, and Power (SWAP)** requirements. The Kratos products will enable the demodulation of downlinks from multiple commercial satellite systems.

quantum products are software replacements for traditional hardware components, such as modems, that operate at lower cost and with greater scalability to adapt more rapidly to changing missions and conditions. For example, where it can take weeks to deploy traditional ground system hardware, quantum products can be deployed and configured to support different missions in just hours.

Kratos' OpenSpace Platform, the most advanced line in the OpenSpace family, can go even further, enabling satellite operators to deploy, configure and adapt entire networks in just minutes using its orchestrated **software-defined network (SDN)** architecture. OpenSpace SpectralNet products digitize the satellite's **Radio Frequency (RF)** signals, acting as the on-ramp to digital transformation of ground systems.

In addition, Kratos will provide engineering and manufacturing of the modified tactical shelter and related subsystem hardware for the TITAN prototypes. Kratos' FMTV-mounted ground station platform will house and protect mission critical TITAN system components. One of Kratos' core strengths is providing custom mobility platforms that feature power and thermal management systems, rack-ready C5ISR equipment integration, and **Electromagnetic Interference (EMI)** shielding up to **High Altitude Electromagnetic Pulse (HEMP)** level requirements.

"OpenSpace technology is leading efforts across the satellite industry, both among commercial and government operators, to capitalize on the ability of virtualization and modern networking techniques to realize digital transformation goals," said **Frank Backes**, Kratos' Senior Vice President of Federal Space Solutions. "TITAN is the newest application of OpenSpace in the DoD that can better support the timely tactical needs of the warfighter."

LONG RANGE C&C CONNECTIVITY DEMO'D BY NORTHROP GRUMMAN



Northrop Grumman Corporation (NYSE: NOC) successfully demonstrated a data link for connecting aircraft in highly contested airspace for long-range command and control through an open architecture network.

This experiment is a critical milestone in the evolution of a distributed multi-domain battle management command and control architecture that maintains decision superiority for the U.S. military and allies.

The flight demonstration is the first integration of a new mission-specific military transceiver, multi-level security data switches, and open architecture wide-area networking, utilizing commercial technology into the observe, orient, decide and act loop – the decision-making chain for threat engagements. This is a key step toward harnessing the power of a network into critical domains for national security missions.



NGC Scaled Composite Proteus HALE research aircraft.

The flight demonstration linked the **Scaled Composites Proteus**, a High-Altitude, Long-Endurance research aircraft, with a **Firebird**, an unmanned air vehicle with the capability to be flown manned, through an advanced line-of-sight data link with low probability of intercept/low probability of detection characteristics that includes anti-jam properties.

The aircraft established a link, performed a simulated ISR mission, and connected back to a cloud-based 5G network testbed through a novel prototype multi-level security switch.

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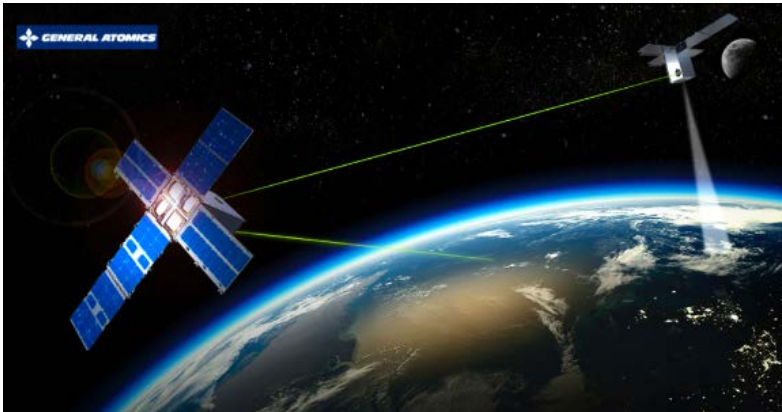


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GA-EMS EXPANDS THEIR SPACE SYSTEMS DEVELOPMENT INFRASTRUCTURE



General Atomics Electromagnetic Systems (GA-EMS) has expanded their space systems infrastructure with the addition of a 7,500 ft² Class 10,000 / ISO 7 cleanroom facility in San Diego, California, that will enable high-volume Optical Communication Terminal (OCT) production — this multi-faceted facility can facilitate fabrication of up to 300 OCTs per year.



GA-EMS' new cleanroom.

Over the last several years, GA-EMS has continued to invest in expanding its space systems capabilities with facilities in San Diego; Centennial and Englewood, Colorado; Huntsville, Alabama; Tupelo, Mississippi; and Herndon, Virginia. In total, GA-EMS has more than 144,000 ft² dedicated to space systems engineering, manufacturing, assembly, integration, test, and mission operations.

In addition to hundreds of OCTs, these facilities can concurrently accommodate large-quantity fabrication of constellation-ready satellites ranging from cubesats to ESPA-Grande class satellites.

“GA-EMS is fully committed to the deployment of optical communication as the backbone of future national security space architectures,” stated Scott Forney, president of GA-EMS. *“Leveraging 20 years of experience developing multi-domain optical technologies, GA-EMS’ low SWaP-C OCT is technologically advanced and designed such that it allows for greater production efficiencies to support large scale satellite constellation programs. The combination of a mission focused, manufacturable OCT design and large-capacity development infrastructure, means that we can meet requirements and deliver hundreds of units every year on budget and on time.”*

“The GA-EMS OCT is easily integrated onto a variety of satellites providing customers with tremendous flexibility in platform configurations to drive costs down and meet mission objectives,” added Nick Bucci, vice president of Missile Defense and Space Systems.

MISSION MICROWAVE HIGH POWER BUCS TO REPLACE TWT AMPLIFIERS



Mission Microwave Technologies, LLC, a manufacturer of SSPAs and BUCs, has received follow-on orders from a government contractor to provide Ku and Ka-band BUCs as components of complex SATCOM transportable terminals in support of the US Army.

This third order for the ongoing program is valued at \$6 million. At the completion of this third tranche of BUCs, the program will be roughly one-third complete.

Mission’s signature Stinger, Javelin, Titan, and MOAB products have been designed into families of terminals across X-, Ku- and Ka-band frequencies and are the high power product of choice for tactical end-users.

The common form factor and interfaces of these products allows SATCOM terminal designers to create flexible platforms, eliminating the need to re-engineer the implementation when missions change.

“Mission Microwave worked closely with one of the industry’s leading system integrators of these large transportable terminals to complete the certification cycle; allowing the replacement of Ku-band and Ka-band TWT BUCs with Mission’s MOAB Ku-band 400 watt BUC and Titan 200 watt Ka-band Solid State BUCs. Now that the authorization has been completed by the government program office, the value proposition of smaller, lighter and highly efficient high power Solid State amplifiers are available to the critical elements of the Army’s SATCOM terminal network. We look forward to continuing this progress with higher power capabilities on our customers’ new transportable terminals in the near future,” said Francis Auricchio, President and CEO of Mission Microwave.

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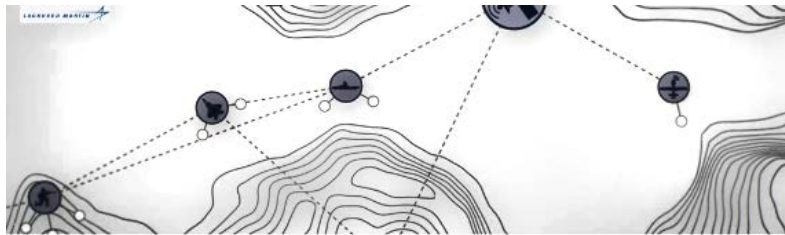
Operated manually or motorized with auto-acquire, the terminal's optional AvL antenna control system automatically acquires and tracks satellite beacons with an internal receiver. The antenna is ODU and modem agnostic, and optionally provided with multiple modem options.

- ◆ Tri-band: X-, Ku- or Ka-band wideband
- ◆ Configurable with Ka-band certified modems
- ◆ Axisymmetric 1.35m 12-piece carbon fiber reflector
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- ◆ High-wind stability kit
- ◆ Quick band changes & multiple RF packages available
- ◆ Standard 2-port feeds & optional 3-port
- ◆ Pre-configured SSPA/LNB kits
- ◆ Optional AvL terminal power supply



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LOCKHEED MARTIN INVENTS NEW SATELLITE DISH TECHNOLOGY



5G.MIL™ Connectivity from Space

Lockheed Martin (NYSE: LMT) has invented a new type of satellite dish technology with a wide range of use on satellites and ground terminals, including space-based 5G.

The **Wide Angle ESA Fed Reflector** (WAEFR) antenna is a hybrid of a phased array Electronically Steerable Antenna (ESA) and a parabolic dish and increases coverage area by 190 percent when compared to traditional phased array antennas at a much lower cost.

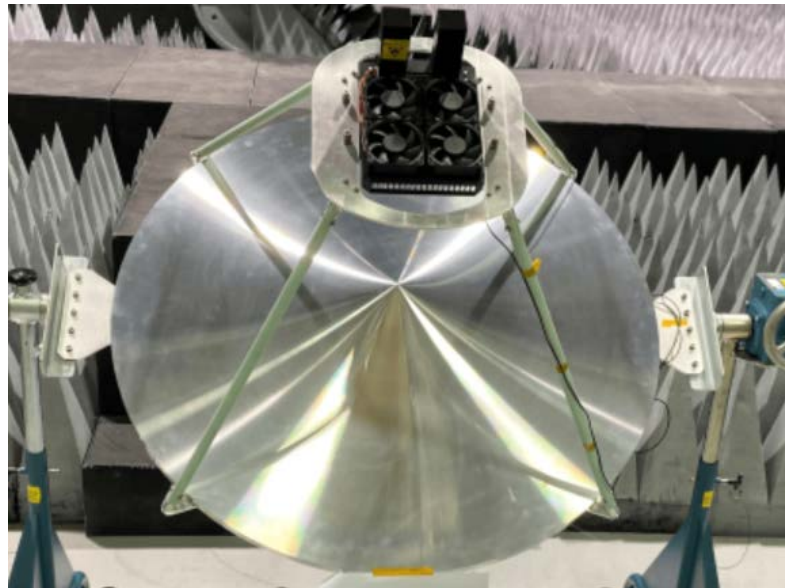


Photo of Lockheed Martin's Wide Angle ESA Fed Reflector (WAEFR) antenna.

This antenna is part of a larger research and development investment in 5G.MIL™ technologies that will optimize and securely connect warfighting platforms to enable **Joint All-Domain Command and Control** (JADC2).

Lockheed Martin is leveraging commercial best practices, strong partnerships, a broad supply chain and leadership expertise, to bring 5G connectivity and capabilities to the defense community, rapidly and affordably.

The team rapidly prototyped, tested and validated this system in a matter of months compared to what previously took years.



WAEFR also features:

- High performance gain of a dish with the beam agility of an ESA
- Low Size Weight and Power (SWAP) common product solution to accommodate any orbital altitude or ground terminal application
- Advances in 3D-printing technology and accelerated parts production This type of antenna will also benefit the broader communications and ISR communities by providing a more reliable scanning solution compared to gimbaled designs.

"We adopted a commercial mindset to quickly mature this technology and discovered there were multiple use cases and applications that could benefit from this new hybrid antenna," said **Chris Herring**, vice president of advanced program development at Lockheed Martin Space. "5G.MIL technologies like this will bring greater connectivity, faster and more reliable networks, and new data capabilities to support our customers as they navigate the complexity of 21st century battlefields."

"The primary benefit of the WAEFR approach is accomplishing more mission with fewer resources," said **Thomas Hand**, Ph.D., associate technical fellow at Lockheed Martin Space. "While state of the art ESA solutions can address more demanding link performance, capacity, and data rates using multiple agile analog beams, they do so at a premium."



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GILAT TO SUPPLY U.S. ARMY WITH HIGH PERFORMANCE BUCS FOR TACCOMMS



Gilat Satellite Networks Ltd. (Nasdaq: GILT, TASE: GILT) has received a multi-million-dollar award from the US Army to supply high-performance BUCs for tactical communications (TacComms). Gilat's fully owned subsidiary, ***Wavestream***, will supply additional, 50W, Ka-band BUCs for program sustainment that is well into its second decade.

Wavestream's Matchbox 50Ka MIL was originally fielded by the US Army in WIN-T Increment 1 as early as 2007 and is still active in service today. With more than 5,000 amplifiers shipped to date, this is easily the largest deployment of high performance Ka-band BUCs supporting ***Comms-on-the-Quick-Halt (COTQH)*** TacComms around the world.

"We are honored that Wavestream can continue supporting the US Army's communications requirements," said **Bob Huffman**, Wavestream's General Manager. "The longevity of this program, and the part that Wavestream Ka-band BUCs play in sustaining these services, is a testament to the long term value of solid-state solutions in the most demanding environments."

Wavestream, a Gilat subsidiary has, since 2001, provided system integrators with field-proven, high performance Ka-, Ku- and X-band Solid State Power Amplifiers (SSPAs), Block Upconverters (BUCs), Block Down Converters and Transceivers. The company designs, manufactures and repairs their products in-house and have delivered more than 40,000 systems during the past 15 years. Wavestream products provide high quality and reliability under the harshest environmental conditions, all currently certified to ISO 9001:2008 and AS9100D standards.

TTTECH'S RADIATION-HARDENED NETWORK CONTROLLERS FOR SPACE IN SERIES PRODUCTION



Electronic components used in a spacecraft need to fulfill very high quality and production standards and work reliably in extremely harsh environments. TTTech Aerospace and the firm's semiconductor partner, STMicroelectronics, have completed the development, industrialization and qualification of highly integrated, radiation-hardened TTEthernet® Systems on Chip (SoCs) network controllers.

They are used in deterministic, fault-tolerant, Ethernet-based networks for space applications. The successfully qualified TTESwitch Controller HiRel and TTEEnd System Controller HiRel are already being used in the avionics systems of two major launcher programs and on one robotic program. With the qualification successfully completed, TTESwitch Controller HiRel and TTEEnd System Controller HiRel are now available as series products, ready for use in a broad variety of space flight applications, such as launch vehicles, satellites or robotic applications.

TTTech Aerospace's TTEthernet® network controllers (TTEEnd System Controller HiRel and TTESwitch Controller HiRel) uniquely act as Systems on Chip (SoCs). They support three traffic classes: standard Ethernet (IEEE802.3), rate constrained and time-triggered traffic (SAE AS6802) for a wide variety of networking applications. Thanks to their high Gigabit/second bandwidths, the network controllers are ideal for real-time transfer of high data payloads (e.g. high-resolution images and videos) and hard real-time transmission of safety-critical control data with short latency over one single network. A wide range of interfaces allows for high flexibility in connecting to electronics hardware for easy integration.

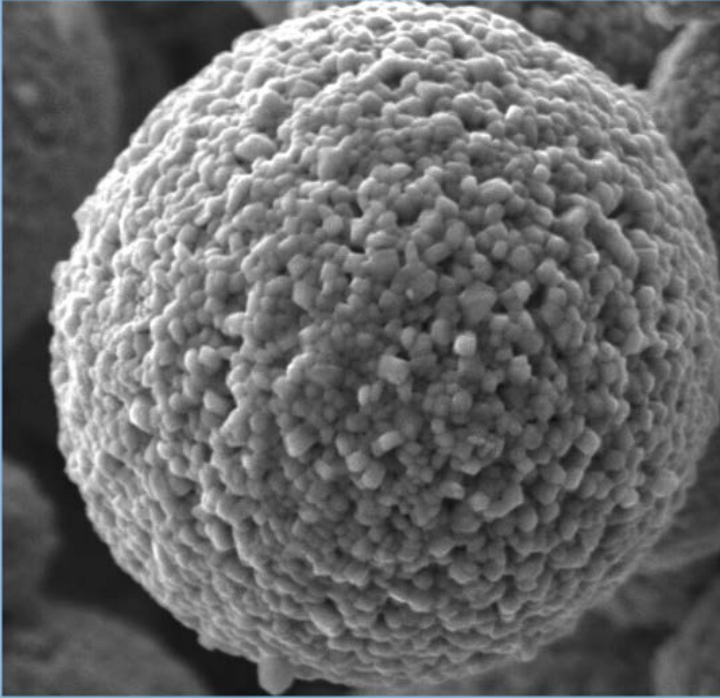
The TTEEnd System Controller HiRel and TTESwitch Controller HiRel are equipped with an integrated LEON2 CPU for system management and diagnostics that ensures automatic time synchronization of the application to the network. The chip is based on a radiation-hardened design process and packaged in a cost-efficient plastic package. This ensures reliability in harsh environments requiring high radiation tolerance for applications like launch vehicles and low earth orbit (LEO) satellites.

"Our TTEthernet® SoCs network controllers are the first of their kind worldwide to enter series production. They act as a 'central nervous system' connecting all systems in the spacecraft. Their modular and deterministic nature supports design optimization and a significant reduction in software complexity and equipment size," said **Christian Fidi**, Senior Vice President Business Unit Aerospace, TTTech.

USSF ASSIGNS ADVANCED BATTERIES CONTRACT TO CAMX



GEMX™ Cathode Platform



CAMX Power LLC (CAMX) has signed a \$1.7 million contract with the United States Space Force (USSF) to develop, fabricate and deliver, in 18 months, high energy, long-life, 18650 format batteries that are ultra-safe to meet stringent requirements and be capable of repeated zero-V discharge and survive BMS failures.

These batteries will use CAMX's globally patented and already commercialized high-nickel cathode platform GEMX® as well as other company proprietary technologies. GEMX applications to currently popular chemistries have been developed and branded as gNMC, gNCA, gNMCA and gLNO. GEMX has been licensed by **Johnson Matthey** and **Samsung SDI**.

President and founder of CAMX, Dr. **Kenan Sahin** said, "This is an important milestone and culmination of the CAMX core business and technology model to mature technologies to economically implementable products, which in the case of CAMX's high nickel cathode began more than a decade ago. In order to achieve that strategy, CAMX developed bench-top to pilot plant cathode synthesis coupled with advanced cell fabrication facilities. In this vertically integrated development environment coupled with exceptional staff, CAMX has pioneered the GEMX cathode platform which enhances all high nickel chemistries by placing metals where they have the greatest impact, improving performance and minimizing the use of Cobalt."

L3HARRIS TECHNOLOGIES MISSILE TRACKING SATELLITE PROTOTYPE DEVELOPMENT FOR THE SPACE DEVELOPMENT AGENCY ACCOMPLISHES KEY MILESTONE



L3Harris Technologies (NYSE:LHX) has accomplished a key milestone in the development of a missile tracking satellite prototype for the Space Development Agency (SDA).



The completed **Preliminary Design Review (PDR)** defines the spacecraft's design baseline for delivery to SDA and allows the program to move to the next stage of delivering ground-breaking new capabilities at speed.

When completed, the satellites will provide the capability to detect and track ballistic and hypersonic missiles via overhead persistent infrared sensing from LEO.

L3Harris received the tracking layer prototype award in 2020 to develop and integrate an end-to-end satellite system under a \$193 million firm fixed-price contract. Total period of performance runs through 2025 and covers four space vehicle launches.

L3Harris is prioritizing investments in end-to-end satellite solutions in spacecraft, payloads, ground software and advanced algorithms. L3Harris is also developing a prototype for the Missile Defense Agency's Hypersonic and Ballistic Tracking Space Sensor.

"We've worked closely with SDA to ensure our design taps proven technology that can scale to address the changing mission," said **Ed Zoiss**, President of L3Harris Space and Airborne Systems. "We understand the threat and are focused on delivery."

THE SPACE REPORT 2021: 36TH ANNUAL SPACE SYMPOSIUM SPECIAL EDITION EXECUTIVE SUMMARY

Article by Lesley Conn, senior manager of Research and Analysis at Space Foundation



This edition, a special publication for the 36th Annual Space Symposium, examines where we are as a global space industry and considers the steps still to be evaluated and taken to transform into reality what is envisioned for the future of the industry.



The long-anticipated return of **Space Foundation's** Space Symposium comes on the heels of two events that renewed public interest in space flight.

With the July 20, 2021, flight of **Blue Origin's New Shepard**, **Jeff Bezos** became the second billionaire that month — after **Virgin Galactic** founder **Richard Branson** — to fulfill a lifelong dream of going into space. Bezos and Branson represent the growth and growing influence of private commercial space enterprises.

Wally Funk, a passenger on the New Shepard flight, and in 2010 the first person to buy a ticket for Branson's suborbital spaceplane, represents sheer perseverance and a singular vision to venture beyond Earth. At 82, she became the oldest person to rocket from the planet. She was eager to go 60 years earlier, when, in 1961, she was the youngest volunteer in the **First Lady Astronaut Trainees** program. Her dreams were repeatedly dashed, but she never lost confidence in her belief that she would one day reach space. And in that, she is not unlike so many other people around the world whose personal hopes and dreams are wrapped into a larger goal of scientific achievement, overcoming every obstacle, and becoming part of a new future in space.

This special edition examines other facets of how the future of space is unfolding:

1 | Space Economy

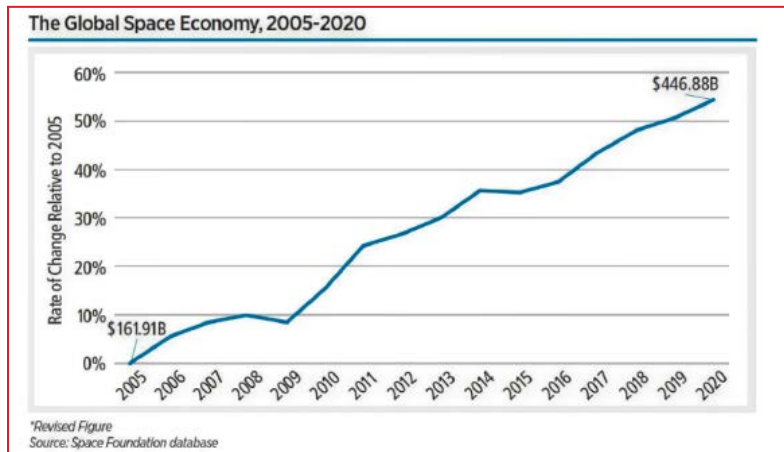
Commercial spending remained the significant driver of the overall global space economy, representing almost 80 percent of total revenue. Commercial Infrastructure and Support Industries is the smaller of two sectors — the other being Commercial Space Products and Services — but in 2020, Infrastructure and Support Industries showed the greatest growth, increasing 16.4 percent from 2019. Ground stations and equipment, valued at \$118.45 billion, captured more than 86 percent of the sector, but developing industries, such as on-orbit satellite servicing and human spaceflight, have captured more public attention and investor interest.

In February, **Northrop Grumman** subsidiary **SpaceLogistics** docked its **Mission Extension Vehicle-1 (MEV-1)** to a geostationary satellite

to provide fuel and thruster capability. Two more MEVs have since launched to extend service to other satellites. As for space tourism, **Virgin Galactic** before Branson's flight had sold more than 600 tickets, each costing as much as \$250,000, to people in 58 countries. After the flight, as demand grew, some industry observers expect new passengers to pay upward of \$500,000.

Commercial Space Products and Services, the largest commercial sector, grew only slightly last year, easing up 1.2 percent to \$219.44 billion. Earth observation satellites showed the strongest growth in the sector, increasing 9.1 percent to \$3.7 billion. The Space Economy section also provides a recap of 2020 government spending, detailed more extensively in **The Space Report 2021 Q2**, released in July. The majority of nations reviewed, largely influenced by the global pandemic, reduced space spending last year, resulting in an overall 1.2 percent decline in 2020 to US\$90.2 billion.

Compiling global space economy data that Space Foundation has tracked since 2005 finds that in the last 15 years, however, government and commercial spending have propelled total revenue to a 176 percent gain.



2 | Space Workforce

The U.S. space workforce grew more than 5 percent from 2019 to more than 192,000 workers. The European space workforce included 50,388 employees in 2020, an increase of 3.3 percent from 2019. In Japan, the space workforce included 8,725 workers in 2019 (the most recent year for which data is available), a 1.9 percent decrease from the previous year but a 10 percent increase over five years. India employed approximately the same amount of people within its Department of Space in 2020 as in 2019, totaling 17,099.

3 | Space Infrastructure

In this section, two articles probe what will be needed to move beyond initial exploration of the Moon and space. The United States' Artemis program has 11 partners, but China, Russia, Israel, and Turkey also have missions planned, as do a growing number of companies that are public partners or working as independent operators.

As they look to establish permanence on the lunar surface, these nations and companies must consider sustainability on three major fronts — economic, environmental, and infrastructure. Ian Christensen, director of private sector programs at Secure World Foundation, leads the examination of lunar sustainability.



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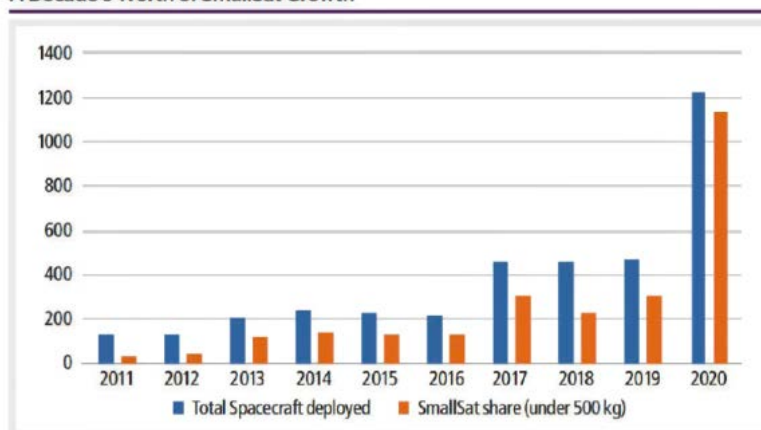
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Nuclear power and propulsion are parts of that equation. Chris Beauregard, the former director of commercial space policy at the White House National Space Council, offered a primer on the nuclear applications, some already long in use, that offer the most promise for efficient, powerful solutions for sustainable energy.

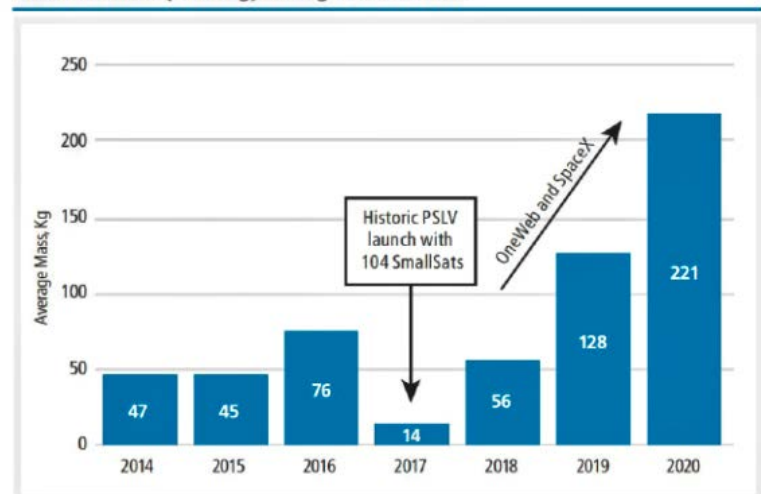
This section also features two pieces that examine recent shifts in small launch vehicle and smallsat development. More than 1,100 smallsats deployed in 2020, comprising 92 percent of all spacecraft deployed. This strong majority represents a reversal from a decade ago, when only 27 percent of spacecraft launched were smallsats.

A Decade's Worth of SmallSat Growth



Source: The Space Report Online database

Global SmallSat (<600 kg) Average Mass to Orbit



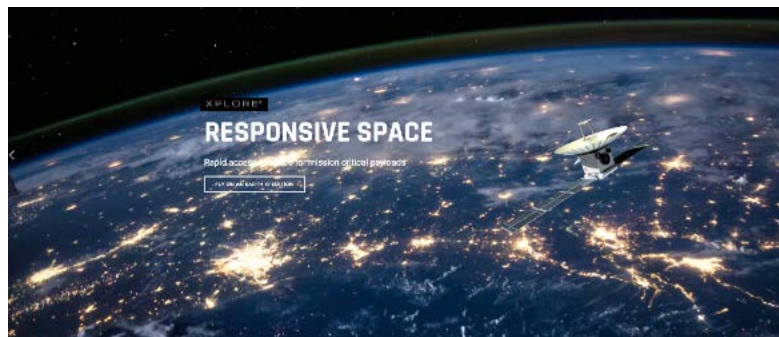
Source: Quality Analytics

4 | Space Policy

As space infrastructure and applications develop, so too must international policy related to government and commercial activities on the Moon and in the rest of space. Michael K. Simpson and Elias de Andrade, both affiliated with the Global Expert Group on Sustainable Lunar Activities (GEGSLA), outline the work of the group, provide examples of how similar initiatives have shaped global policy, and explain how GEGSLA is encouraging participation and input from around the world.

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USAF CONTRACT FOR A PNT SOLUTION TO BE DEVELOPED BY XPLORE FOR ADVANCED LUNAR MISSIONS + CISLUNAR SPACE



Xplore Inc. has announced a follow on contract with the U.S. Air Force, (USAF) to continue developing their positioning, navigation and timing (PNT) solution as a commercial service for cislunar space.

Xplore's current Phase II effort culminates in a hardware in the loop testbed that will demonstrate the required performance to enable precision cislunar missions while laying the foundation for a subsequent on-orbit test of the PNT system. This Phase II SBIR, awarded for commercial and technical innovations between the Earth and the Moon, provides the USAF with the necessary capabilities to extend precision operations to the Moon and across cislunar space.

The PNT system Xplore is developing enables exploration, operations and commercial activities in cislunar space — a vast region that extends past the Moon to the edge of interplanetary space and is more than ten thousand times the volume than nearly all space operations around the Earth. An equivalent GPS-like navigation and timing solution for this expanse does not currently exist, and Xplore's revolutionary solution leverages its internal platform development to provide critical infrastructure services beyond geosynchronous orbit.

Xplore's innovative solution to providing PNT services across cislunar space was developed by Xplore Founder and Chief Technology Officer, Dr. **Darren Garber**, who is leading the Phase II effort.

Navigation and communication considerations are core to Xplore's strategy to accelerate the commercial space economy and expand it beyond Earth orbit. The company's game changing PNT capability speaks to the USAF SBIR program goals to fund revolutionary, relevant and responsive technology. Xplore's PNT system is enabled and will deploy by the Xcraft®, their multi-mission, ESPA-class space vehicle capable of supporting missions across cislunar space and operating from Venus to Ceres; missions include Earth-Sun Lagrange points and near-Earth asteroids (NEAs).

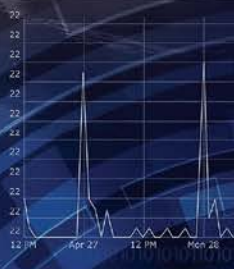
In parallel, Xplore has been advancing the design of the LightCraft™, an advanced solar sail-based vehicle with L.Garde as another potential deployment option for the cislunar PNT system.

Xplore will offer a multi-tiered services solution to customers operating in the cislunar region. The architecture's objective is to be extensible to accommodate current and future systems, and options for expansion are in alignment with current internal efforts and contracted work for other U.S. government customers.



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

USSF'S NEXT GEN OPIR PROGRAM COMPLETES BLOCK 0 GEO SPACE VEHICLE CDR

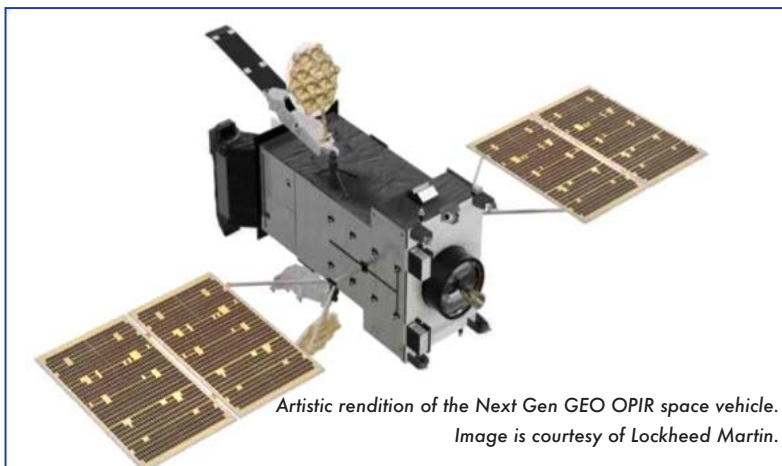


The United States Space Force's Space Systems Command, Next Generation Overhead Persistent Infrared program, successfully passed a major milestone, completing its Block 0 Geosynchronous Earth Orbit Space Vehicle Critical Design Review (CDR) on August 20, 2021.



This CDR milestone, the culmination of 34 subsystem and payload reviews, locks the space vehicle technical baseline, a key step in validating satellite design maturity and readiness to proceed with flight-unit fabrication, assembly, system integration, and test.

The Next Gen OPIR program will succeed the Space Based Infrared Systems program. Next Gen OPIR is designed provide a resilient space-based global missile warning capability against emerging missile and counter-space threats.



Artistic rendition of the Next Gen GEO OPIR space vehicle. Image is courtesy of Lockheed Martin.

The Next Gen OPIR GEO space vehicles integrate a new OPIR sensor with an enhanced Lockheed Martin 2100 common satellite bus. Early integration demonstrations on engineering developmental units were conducted to support this CDR. These demonstrations indicate that critical satellite components will meet the requirements established by the Department of Defense.

The Next Gen OPIR Block 0 GEO System Critical Design Review is expected later this fall.

SATELLITE PRODUCTION SITE EXPANSION BY L3HARRIS PLUS THE ADDITION OF AN UNCLASSIFIED SATELLITE LINE FOR NAT'L DEFENSE



L3Harris Technologies (NYSE:LHX) is expanding its satellite production site to include advanced production of unclassified satellites, which will deliver experimental capabilities for national defense.

The Central Florida location is home to more than 100,000 square feet of space used for development, manufacturing and testing of full satellites and components which already deliver complex, classified capabilities for national defense.

The increased production capability allows L3Harris to develop and test the experimental Navigation Technology Satellite-3 (NTS-3), which is a priority program for the U.S. Air Force. Facility investments also make it possible to develop and integrate three sizes of small-to-medium responsive satellites in support of urgent U.S. Department of Defense missions addressing evolving threats.



Artistic rendition of the U.S. Air Force's first Navigation Technology Satellite-3. Image is courtesy of L3Harris.

Two of the company's eight buildings have recently been upgraded to manufacture multiple end-to-end satellites per month. L3Harris has built eight satellites at the expanded Palm Bay facility that are currently on-orbit and another 10 are in various stages of development. The company plans to add more production capacity by the end of the year to produce six satellites per month.

An L3Harris engineer works on the Navigation Technology Satellite-3 (NTS-3), a U.S. Air Force vanguard program that will examine ways to augment the military's positioning, navigation and timing capabilities.

"Our customers face urgent threats that must be addressed in months rather than years," said **Ed Zoiss**, President of L3Harris Space and Airborne Systems. "We prioritized facility investments to meet their accelerating timelines."

AN ALTERNATIVE RF NAVIGATION SIMULATOR DEBUTS FROM SPIRENT FEDERAL SYSTEMS



Spirent Federal has launched an alternative RF navigation simulator. As GPS jamming and spoofing continue to rise, interest in complementary sources of positioning, navigation, and timing (PNT) data has likewise increased.



Recent government directives recommend a layered, multi-source approach, with much of the attention focused on non-GNSS radio frequency signals. These RF signals, coined alternative RF navigation, offer unique PNT capability in GPS-degraded or denied environments. The signals are secure and resilient and can act as an effective complement to GPS signals.

Spirent Federal's product can simulate resilient alternative RF navigation signals on its own or concurrently with GNSS signals. Testing can be static or dynamic, with stationary, pedestrian and ground vehicle trajectories available. The company is actively engaged with several alternative RF navigation technologies and technology providers to incorporate signal simulation capability.

"As a result of our extensive research and development incorporating a variety of Assured PNT technologies, we're pleased to be the first to provide this capability to our customers," said Roger Hart, director of engineering. "Our product enables developers to test early and often, from the first stages of R&D to integration and field testing. Solutions can be tested with edge cases, hardened against interference, and deployed faster with greater confidence they will work for our warfighters.



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NORAD AND U.S. NORTHERN COMMAND LEAD THE THIRD GLOBAL INFORMATION DOMINANCE EXPERIMENT (GIDE)



NORTH AMERICAN AEROSPACE DEFENSE COMMAND



The third in a series of [Global Information Dominance Experiments \(GIDE\)](#) occurred from July 8 through July 15, 2021, and was designed to enable cross-Combatant Command collaboration to generate globally integrated effects using artificial intelligence (AI) enabled information.

[North American Aerospace Defense Command \(NORAD\)](#) and [U.S. Northern Command \(NORTHCOM\)](#), in collaboration with all 11 U.S. combatant commands, have executed the third in a series of [Global Information Dominance Experiments \(GIDE\)](#), in partnership with the [Joint Artificial Intelligence Center](#), the [Undersecretary of Defense for Intelligence and Security](#)'s Project Maven and with significant funding and manpower support from the Department of the [Air Force's Chief Architect Office](#).

These experiments use technology that is available today to enable decision makers to have relevant information sooner, thus creating decision space for senior leaders by providing proactive options. The series of GIDE events are technology risk reduction experiments that complement a shift in focus from pure defeat mechanisms toward earlier deter and deny actions well left of conflict, consistent with the Department of Defense's prioritization of integrated deterrence.

Secretary of Defense [Lloyd Austin](#) recently said, "Integrated deterrence is about using the right mix of technology, operational concepts, and capabilities—all woven together in a networked way that is so credible, flexible, and formidable that it will give any adversary pause."

The *Global Information Dominance Experiment 3*, or GIDE 3, was executed in three synchronized but distinct stages. Stage one focused on cost-effective data solutions to increase decision space through earlier indications and warnings (I&W). Stage two evaluated the ability to respond to contested logistics and demonstrated global collaboration to rapidly create deterrence options and dynamic contested logistics planning.

The final stage, stage three, demonstrated the Joint Artificial Intelligence Center's *Matchmaker* capability for machine-enabled crisis deterrence and conflict defense options. This was tied to live representative threats and real-world assets allowing the participating organizations opportunities to exercise global integration.

"The GIDE 3 experiment showcased how the software tools designed for cross-combatant command collaboration, assessment, and decision-making can be used to enable more effective global logistics coordination, intelligence sharing and operations planning," said Gen. [Glen VanHerck](#), commander, NORAD and NORTHCOM. "By integrating more information from a global network of sensors and sources, using the power of AI and machine-learning techniques to identify the important trends within the data, and making both current and predictive information available to commanders, NORAD and USNORTHCOM are giving leaders around the globe more time to make decisions and choose the best options available, whether in competition, crisis or conflict."

The first GIDE was held in December of 2020. During that experiment, NORAD and USNORTHCOM, in coordination with U.S. Southern Command, U.S. Indo-Pacific Command, U.S. Transportation Command, U.S. Strategic Command, and the Under Secretary of Defense for Intelligence and Security, convened a digital table-top exercise to prototype cross-combatant command collaboration using AI-enabled early warning alerts of peer-level threat movements.

GIDE Two (GIDE 2) was held in March of 2021. GIDE 2 expanded participation to include all combatant commands and the JAIC. The goals of the experiment were to gain a common understanding and picture of the threat for each of the combatant commanders; obtain earlier indications of adversary actions through artificial intelligence and machine-learning tools; and conduct cross-combatant command coordination on response actions, thereby obtaining faster decisions and ultimately, improving deterrence. GIDE 2 incorporated "live-fly" events that provided additional input into the experiment which demonstrated not only increased global integration and cross-combatant command collaboration, it also introduced machine-enabled response options and links to live Service-level data sets.

During GIDE 3, NORAD and U.S. Northern Command received support from the Department of the Air Force Chief Architect Office who conducted ADE 5, the CAO's fifth in a series of Architecture Demonstration and Evaluation events that examine enterprise-wide architectures and their integration while facilitating information advantage and decision making superiority technology demonstrations to inform future architecture development. CAO provided significant funding and manpower resources to execute GIDE 3, enabling a much more robust real-world construct upon which to demonstrate and evaluate baseline architectures for the Services and DoD.

"Our nearly two-year experimentation partnership with NORAD and U.S. Northern Command on three of our five events has yielded tremendous progress in designing and evaluating and the technical architectures that enable our joint warfighters," said [Preston Dunlap](#), the Air and Space Forces' Chief Architect. "We're grateful to have willing and motivated partners like NORAD and U.S. Northern Command who are eager to get after the difficult decision superiority for strategic leadership challenges, all the way down to agile, distributed decision superiority at the edge problem sets that we tackled in GIDE 3 and ADE 5."

NORAD and NORTHCOM continue learning from these experiments and are working with partners to initiate planning for the next experiment in the GIDE series.

OMNISPACE + VULCAN WIRELESS DEMO COMMERCIAL SATCOM CONNECTIVITY WITH PORTABLE MILITARY RADIOS



Omnispace and Vulcan Wireless Inc. have announced successful voice and data communication between its NGSO on-orbit satellite and a widely fielded model of mobile tactical military communications radios (PRC-117G), seamlessly uniting mobile and satellite to create the world's truly global 5G mobile network.

As part of Omnispace's **Phase II Small Business Innovation and Research (SBIR)** contract, the demonstration was in cooperation with **U.S. Space Force's Space Systems Command**. The contract was awarded as part of the U.S. Airforce's "Space Pitch Day," enabling Omnispace to bring next-generation narrowband capabilities to the warfighter.

The Omnispace next-generation global 5G network is being architected to support "dual-use," mission-critical enterprise and secure government applications. Unlike legacy commercial and government networks, Omnispace's global system is being designed in line with 3GPP 5G NTN standards, which will enable interoperability for any compatible 5G commercial or government device.

Omnispace's 5G NTN platform will further enhance government customers' resiliency, reliability, and real-time decision-making by enabling advanced tactical handheld communications, military internet-of-things, and battlefield edge processing.

Together with Vulcan, the test successfully demonstrates the ability to connect the global Omnispace satellite network directly to existing mobile devices -- addressing warfighter needs "at the edge" within the joint all-domain command and control (JADC2) architecture.

Campbell Marshall, Omnispace's Vice President for Government and International Markets, said, "This demo proves that software-defined mobile, tactical user equipment can leverage our dual-use commercial infrastructure. Imagine the possibilities that 5G technology will enable for government -- from COTM handheld devices to IoT platforms."

The demonstrations with Vulcan Wireless were focused on connecting existing military hardware to satellites in commercial frequency bands and orbits, not traditionally used by government, to increase the resiliency of battlefield communications.

"The Vulcan wireless and Omnispace teams worked closely to successfully conduct a live demonstration, integrating existing tactical communication systems with the Omnispace satellite network," said **Kevin Lynaugh**, CEO, Vulcan Wireless Inc.

These communications capabilities are the cornerstone for next-generation warfighting concepts such as multi-domain operations (MDO) and expeditionary advanced based operations (EABO) which are focused on minimizing physical and RF signatures.

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PROCESSOR INTELLIGENCE FOR SPACELINK'S SPACECRAFT TO BE PROVIDED BY SEAKR



SpaceLink has selected [SEAKR Engineering, Inc. \(SEAKR\)](#) to provide key payload technology for the firm's relay satellite system.



SEAKR is developing technologies for [DARPA](#) and the [U.S. Space Force](#) and will provide advanced on-board processing for the SpaceLink network (infographic below), which provides secure, continuous, high-capacity communications for time-critical service between spacecraft and the ground.

Working together with SpaceLink, SEAKR is developing an advanced, high-performance processor that integrates with optical and radio frequency (RF) signals. The processor on each of SpaceLink's MEO satellites will control and direct data traffic to optimize the capacity and availability of the network in response to customer demand.

SEAKR, a firm that just agreed to a [definitive acquisition by Raytheon Technologies](#), is a leading-edge provider of advanced electronics for space applications and is developing one of the central technologies for the Defense Advanced Research Projects Agency's (DARPA's) Blackjack satellite network.

The SpaceLink relay system, planned to launch in 2024, will provide operational connectivity to commercial and government space missions using both RF and optical links to the relay satellites and laser crosslinks to route traffic to any SpaceLink ground entry point, and on to the users' Mission Operations Center. The system will support the growing bandwidth demand and security requirements of commercial, civil, and U.S. and allied national security missions.

With the growing space economy and proliferation of spacecraft in LEO, the demand for fast, continuous, high-capacity connectivity is accelerating. SpaceLink's unique architecture and location in MEO means the satellite constellation always has direct line of sight to satellites, space stations, tugs and servicers in LEO, as well as to its dedicated Gateway Earth Stations. SpaceLink will relieve the bandwidth bottleneck for organizations that need to transport data quickly and securely to users anywhere in LEO or on Earth.

The SpaceLink relay network is designed to pick up where the U.S. Tracking and Data Relay Satellite System (TDRSS) leaves off and go beyond with unprecedented capacity that leverages today's technology advances. Enhancing the business case for Earth Observation (EO) companies, commercial space stations, satellite servicers, and space tugs, SpaceLink also meets requirements for the U.S. Government and close allies that want to leverage industry solutions.

"SEAKR and SpaceLink are aligned in our strategic planning and technology roadmaps," said [Dave Bettinger](#), SpaceLink CEO. *"SEAKR is fully compliant with U.S. government standards and cybersecurity requirements, and our processor development and production will be done on U.S. soil by U.S. persons. For critical payload components, we know this is important to many of our customers."*

"SEAKR has developed multiple on-orbit reconfigurable payloads for both commercial and military missions for multiple orbital domains. The SpaceLink satellite communication processor leverages decades of successful missions and will represent one of the most capable systems deployed," said [Dave Jungkind](#), SEAKR's Vice President of Business Development.

"We share SpaceLink's excitement about the prospects for a relay system that provides continuous connectivity for spacecraft in LEO," said [Scott Anderson](#), president and co-founder of SEAKR. *"Our agreement with SpaceLink enables us to move forward with development of the advanced, high-performance processor that meets SpaceLink's relay requirements. Our companies have great synergy and we are enthusiastic to move forward with all the technical requirements and interfaces."*

SEAKR Engineering, Inc. (SEAKR) is a leading supplier of space qualified state-of-the-art electronics for advanced processors, networked systems, reconfigurable radio frequency (RF) and electro-optical (EO) payloads, and digital channelizers/beamformers. These systems use SEAKR's Radiation Hardened system By Design (RHBD) techniques that have successfully been deployed in over 300 missions with a 100% on-orbit success rate. SEAKR designs, builds, and tests these systems at their facilities in Colorado.

SpaceLink will help advance humanity to a new age of space commerce, exploration, environmental awareness, and security. The Always in Sight™ data relay system provides global coverage to empower space system operators to maximize use of their assets. SpaceLink Corporation is headquartered in the Washington DC area and has offices in Silicon Valley, California. It is a wholly owned subsidiary of Electro Optic Systems Holdings Limited, a public company traded on the Australian stock exchange.

AFRL INVITES NEW SCIENCE, TECHNOLOGY IDEAS THROUGH AIR FORCE, SPACE FORCE TECH CONNECT



Author: Bryan Ripple, Air Force Research Laboratory Public Affairs

On behalf of the Department of the Air Force, as one laboratory supporting two services, the Air Force Research Laboratory has developed the Air and Space Forces Science & Technology Front Door, to connect potential partners with S&T experts and opportunities. The Department recognizes that innovative ideas often come from small businesses, industry, academia, or even a project in your neighbor's garage that can help solve problems the department has identified.

Everybody has ideas. Many people have had an idea for a new product or technology only to have it dismissed or neglected. Sometimes we later find that others had the same idea, but were able to get it in front of the right people, resulting in their product on the market, not ours.

Ideas are relatively easy to come by; inventions and innovations are more difficult. It takes knowledge, time, money and effort to refine an idea into a workable solution, even on paper. There are formidable tasks and substantial barriers in the path of those who pursue innovation. Accomplishing these tasks and overcoming the barriers typically requires much careful planning and input from others.

The Department of the Air Force recognizes that innovative ideas often come from small businesses, industry, academia, or even a project in your neighbor's garage that can help solve problems the Department has identified. In April of 2019, the Air Force announced its Science and Technology 2030 Strategy which lays a path forward for the U.S. Air Force science and technology ecosystem to rapidly develop warfighting capabilities.

By expanding and strengthening our partnerships, and leveraging the innovation networks within industry, small business, academia, and government laboratories, the Department is committed to delivering an effective service to connect that will ensure more external innovations have a transformational impact on the Air Force and Space Force. On behalf of the Department, as one laboratory supporting two services, the Air Force Research Laboratory has developed the Air and Space Forces Science & Technology (S&T) Front Door, to connect potential partners with S&T experts and opportunities.

Partnering or connecting with the DAF science and technology enterprise can be challenging due to its structure and various platforms of engagement. The Air Force and Space Force Tech Connect website was built to help address this and support S&T ecosystem awareness, learning, engagement and unsolicited idea submission intake. The website provides access to current S&T opportunities, S&T events and other S&T enterprise connectors. It also provides innovators a portal where they can share their ideas and capabilities with an AFRL subject matter expert for potential feedback, collaborations and opportunities.

With a nationwide scope to invite and nurture game-changing ideas and technology that might come from anywhere and anyone that can ultimately benefit the warfighter, the S&T Front Door's long-term goal is to expand the science and technology ecosystem involvement beyond AFRL to include more mission-aligned organizations and organizations of the larger Department of Defense science and technology network.

Another partnering S&T entity, and also part of the AFRL team, AFWERX is expanding technology, talent and transition partnerships for rapid and affordable commercial and military capability through three efforts: AFVentures, Spark and Prime. AFVentures, which is AFWERX's commercial investment arm for the Air Force, creates simple pathways for commercial innovators and private capital investment to help the Department of the Air Force solve problems. Spark connects Airmen and Guardians to commercial innovators while Prime is all about accelerating emerging commercial markets using military missions and equities. Both Tech Connect and AFWERX are committed to exploring viable solutions and partnerships to further strengthen both our air and space forces and aim to make connecting potential partners with S&T experts and opportunities easier than before.

"The National Defense Strategy forecasts a highly-contested future fight with complex threats," said Maj. Gen. **Heather Pringle**, AFRL commander. *"Peer competitors are driving to overtake the United States as the science and technology superpower. The global commercial sector is outpacing our investment in S&T and exploding with innovative technologies. Nonetheless, we remain clear-eyed about the challenges ahead.*

"With the complexity of this evolving landscape, we accelerate change in line with the Air Force chief of staff's charge to us. We accept appropriate levels of risk in innovation and experimentation, as the chief of space operations urges. Above all, we recognize technological superiority is necessary to address these challenges. By expanding our presence and creating more visible and convenient virtual front doors, we are cultivating a world-wide ecosystem of research from basic to applied that drives the pace of technology and competition in the agile pursuit of innovative solutions for Warfighters and stakeholders alike," she said.

The Air Force and Space Force Tech Connect team, currently comprised of subject matter experts from AFRL's technology directorates, the Small Business Innovation Research/Small Business Technology Transfer program, Strategic Development Planning and Experimentation Office, Transformational Capabilities Office and AFWERX, reviews and connects quality, relevant submissions with S&T subject matter experts and S&T opportunities. The team provides feedback and if the submission is relevant, establishes dialogue with interested Air Force S&T programs.

If you are an innovator with promising ideas and are interested in collaborating with the Department of the Air Force on science and technology innovation and development, then the Air Force and Space Force Tech Connect team wants to hear from you.

BOEING TO BUILD THE FIRST OPERATIONAL, CARRIER-BASED, UNMANNED AIRCRAFT FOR THE U.S. NAVY



Boeing [NYSE: BA] will build the Navy's newest carrier-based aircraft at a new high-tech facility in Illinois, bringing the benefits of digital aircraft design and production to the Navy and as many as 300 advanced manufacturing jobs to the greater St. Louis region.

The new 300,000 square-foot facility at [MidAmerica St. Louis Airport](#), scheduled for completion in 2024, initially will employ approximately 150 mechanics, engineers and support staff who will build the **MQ-25™ Stingray™**, the Navy's first operational, carrier-based unmanned aircraft. Employment could reach up to 300 with additional orders.

Boeing digitally engineered the entire MQ-25 aircraft and its systems, resulting in high-fidelity models that are used to drive quality, efficiency and flexibility throughout the production and sustainment process. The new MQ-25 facility will include state-of-the-art manufacturing processes and tools, including robotic automation and advanced assembly techniques, to improve product quality and employee ergonomics.

"The team and state-of-the-art technology we're bringing to the Navy's MQ-25 program is unprecedented, and we're incredibly proud to be expanding both as we build the future of autonomous systems in Illinois," said Kristin Robertson, vice president and general manager of Autonomous Systems, Boeing Defense, Space & Security. "We've received great support from MidAmerica Airport and countless dedicated employees, and we're excited to build the Navy's first operational, carrier-based unmanned aircraft right here in the Metro East."

For two years, Boeing and the Navy have been flight testing the Boeing-owned MQ-25 test asset from MidAmerica Airport, where in recent history-making missions T1 has refueled an F/A-18 Super Hornet, an E-2D Hawkeye and an F-35C Lightning II.

The U.S. Navy intends to procure more than 70 MQ-25 aircraft to help extend the range of the carrier air wing, and the majority of those will be built in the new facility. Boeing is currently producing the first seven MQ-25 aircraft, plus two ground test articles, at its St. Louis facilities, and they will be transported to MidAmerica for flight test. The MQ-25 program office, including its core engineering team, will remain based in St. Louis.

The new MQ-25 facility will be in addition to existing manufacturing operations at Boeing St. Clair, which produces components for the CH-47 Chinook, F/A-18 Super Hornet, F-15 and other defense products.

TELESPAZIO SELECTS HUGHES HELOSAT FOR AIRBORNE SATELLITE COMMUNICATIONS



Hughes Network Systems, LLC (HUGHES) has announced that Telespazio, a joint venture between Leonardo (67%) and Thales (33%), has selected the Hughes HeloSat™ solution for satellite communications (SATCOM) for Leonardo's helicopters.



Hughes HM-40 modem for SOTM.

The solution combines the Hughes HM100 gateway and the HM40 modem for SATCOM on-the-move with technical support and systems integration. Once installed on helicopters like the Leonardo SW-4 Solo optionally piloted / rotorcraft uncrewed system, HeloSat will enable connectivity through-the-rotor using the Athena-Fidus Ka-band satellite capacity via the Telespazio ground station in Fucino, Italy.

"Building on a decades-long collaboration with Telespazio, last year we demonstrated our HeloSat technology with no packet loss through the blades of a Leonardo AW139 helicopter; now we are delivering a turnkey solution," said **Rick Lober**, vice president and general manager, Hughes Defense. "With low size, weight and power, HeloSat is the only reliable, validated, wideband Beyond-Line-of-Sight SATCOM capability for helicopters to transmit uninterrupted, full-motion video in real-time."

"For the fixed-wing and rotary-wing avionics market, Telespazio has chosen to create a technological team of companies with the best solutions on the market. The approach is to solve all the issues related to an avionic satellite solution by providing: teleport services, on-board technologies, ground technologies and space capacity on satellites most suited to the proposal."

When we looked for connectivity under the rotor, we turned to our strategic partner Hughes for the proof of concept, and we found an excellent solution that we can't wait to bring to market," said **Alessandro Caranci**, vice president and head of Satcom Line of Business, Telespazio. "Hughes technology, advanced waveform and in-flight experience deliver multi-megabit-per-second speeds through rotary blades without packet loss – a competitive advantage for military and commercial helicopter applications."

NILE BLOCK CYCLE 9 INTEROPERABILITY TESTING SUCCESSFULLY COMPLETED BY LEONARDO DRS LINK-22 SIGNAL PROCESSING CONTROLLER

Leonardo DRS has successfully completed formal interoperability testing of its Link-22 Signal Processing Controller (SPC) within the NATO Improved Link Eleven (NILE) Link-22 Network.

Compliance with this standard allows Leonardo DRS to provide world-class production of the technology and full interoperability with all NATO and allied partners supporting operations and exercises in the INDOPACOM theater.

Leonardo DRS worked closely with the NILE team to successfully complete all cycles and posture for future advancements. The success illustrates that Leonardo DRS SPCs are compliant with Link-22 Block Cycle 9 specifications for current and emerging mission requirements for users around the world.

Link-22 tactical datalinks are used by the U.S. military and other allied military forces to increase joint and coalition communications in the surface, sub-surface, land, and air domains by providing unprecedented situational awareness across the battle space. It is the primary means to exchange data, including radar tracking information beyond line of sight.

With more than 40 years of tactical datalink experience, 1,100 Link-22-capable SPCs and more than 3,000 Link-11 Data Terminal Sets

delivered, deployed, and on order, military services around the globe depend on Leonardo DRS for beyond-line-of-sight communications guaranteeing interoperability across domains, platforms, and nations.

Leonardo DRS' Link-22 SPC solution is well-positioned for current missions and is primed to accept additional missions due to its abundance of spare memory and additional processing power. Using next generation hardware and software architecture, coupled with software-defined radio (SDR) and software-defined modem technologies, the company is able to offer enhanced capabilities while retaining the look, feel, and operational reliability to which the world's operators have grown accustomed. As the trusted supplier of tactical datalink solutions, Leonardo DRS has established itself to deliver leading edge technology to meet customers' requirements and to support their products for decades after delivery.

Leonardo DRS' commonality across hardware and software ensures interoperability between nations during times of long range secured SATCOM, as well as HF/UHF encrypted communications during time of SATCOM-denied operations. With additional, advanced HF waveforms, this solution can expand upon the capabilities inherently found in Link-22.

Larry Ezell, Senior Vice President and General Manager of the Leonardo DRS Airborne and Intelligence Systems business. *"These systems are positioned for current and emerging mission requirements and the signal processor controllers ensure U.S. and allied forces have the best long-haul communications and situational awareness possible."*



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VIASAT RECEIVES TWO DOD CONTRACTS FOR BATTLESPACE 5G IMPLEMENTATION



Viasat Inc. (NASDAQ: VSAT) has received two awards from the U.S. Department of Defense (DoD) through the Information Warfare Research Project (IWRP) to conduct research that will examine the use and implementation of 5G networks on the battlespace. These awards are part of the DoD \$600 million 5G research initiative announced last year to explore how 5G technology can strengthen warfighting capabilities.



Viasat is working with the DoD to solve complex communications problems across multiple network domains—from satellite to cellular to government specific networking waveforms.

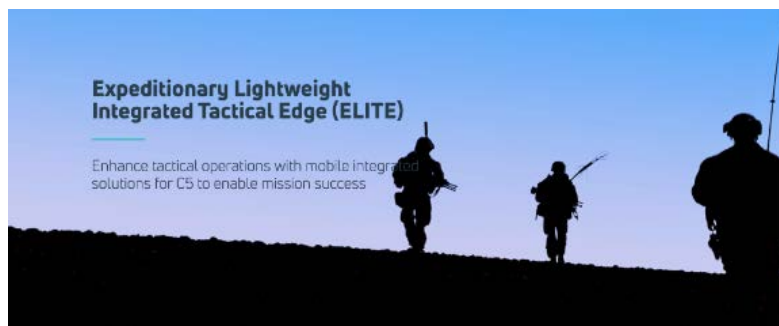
Specific to these contracts, Viasat will tap into its 5G wireless, networking and cybersecurity expertise and help the DoD understand how it can best use 5G technology to enable multi-domain operations in future joint warfighting programs, including **Joint All-Domain Command and Control (JADC2)** capabilities.

The awards focus on two areas:

– **Improving Command and Control (C2) applications and services:** Viasat will provide C2 hardware packages that support **Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)**, networking and cybersecurity software, and integrate those capabilities into tactical networks using 5G to improve visibility across the battlespace. Viasat will also explore how 5G connectivity can support bandwidth-intensive applications (e.g. ISR mapping), be leveraged to share real-time situational awareness information and be used to provide resilient cloud access to the battlefield.

– **5G enhanced network deployment for Agile Combat Employment (ACE) operations in contested environments:** Viasat will look at rapid configuration and deployment of secure 5G nodes at the tactical edge that could be required when operating in unknown battlezones. Viasat's research will focus on understanding of configurations and capabilities for enterprise orchestration and management (how to route network data); tactical network dimensioning and planning (how to optimize network/RF planning tools); and Low Probability of Intercept/Low Probability of Detection (LPI/LPD) capabilities (how to prevent adversaries from finding the network).

For these research experiments, which will be conducted over three years, Viasat aims to use its **Expeditionary Lightweight Integrated Tactical Edge (ELITE) Kit** solution with a 5G gateway to support the C2 application experiments, as well as its System Integration Lab (SIL) to establish an emulation environment for network dimensioning, planning and radio access network modeling.



Additionally, Viasat's **NetAgility™** product will offer the DoD multi-path transport and network management support. Viasat will also create a 5G digital twin model to test rapid network configuration and modification, and use 5G millimeter wave and Free Space Optics links to deliver high bandwidth needs.

"With 5G networks spreading globally and adversaries investing heavily in this capability, it is critical for the U.S. and its allies to understand and explore the potential of 5G technology in supporting warfighting operations," said Craig Miller, president, Viasat Government Systems. "The rapid transport of information and data across domains is critical to advancing multi-domain operations and enabling joint force operations. Enhanced 5G bandwidth and connectivity for bases and mobile platforms at the tactical edge can offer commanders greater visibility to enhance C2 operations and increase situational awareness for the warfighter."

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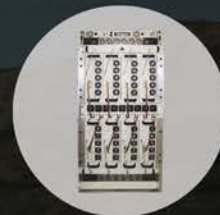
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COMMAND CENTER LT. GEN. MICHAEL A. GUETLEIN

LEADING SPACE SYSTEMS COMMAND (SSC)
TO COUNTER THREATS IN THE SPACE DOMAIN

Author: USSF's Space Systems Command

When Lt. Gen. Michael A. Guetlein received the call that he had been nominated by President Biden to serve as Commander for Space Systems Command (SSC), one of three field commands under the U.S. Space Force (USSF); his first thought was 'This is going to be the most exciting and challenging time of my life.'

Guetlein officially assumed command of SSC on 13 Aug. 2021 upon the field command's date of activation. In this role, he is responsible for SSC's mission to pioneer, develop and deliver sustainable joint space warfighting capabilities to defend the nation and its allies and disrupt adversaries in the contested space domain.

This includes SSC's developmental testing, launch, on-orbit checkout, and sustainment and maintenance of USSF space systems, as well as oversight of USSF science and technology activities. Guetlein oversees more than 10,000 military, government service and contract employees nationwide, while managing SSC's annual Space Acquisition budget of \$11 billion for the Department of Defense (DoD).

A respected expert in the global space landscape and next-gen capabilities, Guetlein is well-positioned for this new role. Previously he served as Deputy Director for the National Reconnaissance Office (NRO) in Chantilly, Virginia, where he assisted the director in managing the strategic and tactical operations of the NRO, and, as Commander of the Space Force Element, managed all Air Force personnel and resources assigned to that agency.

He had a front-row seat observing the unprofessional behavior and challenges being imposed on the United States by the nation's adversaries.

Prior to that, he served as the Program Executive for Programs and Integration for the Missile Defense Agency. Early in his career, he served as the Director of the Remote Sensing Systems Directorate at Space and Missile Systems Center (SMC) one of several units that transitioned into the new SSC field command.

He said, "Our USSF Chief of Space Operations, General Raymond, has been sounding the alarm and talking about direct ascent weapons, directed energy weapons, nesting dolls in space, cyber hacks and even robots in space. These may all sound like fantasy to the layperson, but what's happening in space today is not science fiction.

"Make no doubt about it, the threat is real and this is not a fight we can afford to lose. Every corner of our society is dependent on space and our way of life is directly threatened on a daily basis. It is up to Space Systems Command to counter the rising threat with game-changing capabilities that will drastically change the way we fight."



Lt. Gen. Michael A. Guetlein



DEVELOP • DELIVER • DRIVE

SPACE SYSTEMS COMMAND

COUNTERING THREATS IN THE SPACE DOMAIN

General, what are you most excited to see SSC do that SMC wasn't quite able to do as a Center?

LT. GEN. MICHAEL A. GUETLEIN

While Space Systems Command builds on SMC's legacy as a center of excellence for acquiring and developing military space systems for the national security space enterprise, SSC is a shift in culture that sees us laser focused on the threat while driving a unity of effort across government, industry, academia and our allies.

As a field command, not only do we have a greater voice in highlighting the threats we face in the space environment to our nation's leaders, but we get the opportunity to shift away from focusing on various life cycles of a system to anticipating and being responsive to the challenges presented in the contested space domain.

I'm excited to see how the men and women of SSC innovate, acquire, and field out-of-this-world class capabilities. I am excited to help drive a unity of effort across the national security space enterprise. We must go where innovation is happening, and partnerships with industry is our key to enhancing resiliency in the face of determined competitors.

As your organization expands its focus on identifying commercial technologies and aiding inroads for commercial organizations new to doing business with the federal government, why is this important? Do you see commercial/industry outreach as a significant area of growth in the future?

LT. GEN. MICHAEL A. GUETLEIN

Outreach into the commercial and small business sector and, in particular, those businesses outside of the traditional space and defense industries, is crucial and affords us great opportunities that may otherwise be missed.

From the space industry perspective, DoD contracts can be difficult to navigate and some smaller companies might not even try. Our **Space Enterprise Consortium (SpEC)** was created in 2017 to bridge the cultural gap between military buyers and commercial space startups and small businesses through **Other Transaction Authorities (OTA)**.



To date, we have more than 600 participants in SpEC, the majority being non-traditional companies. That is a huge accomplishment. The OTA's innovative contracting process allows the SpEC to solicit bids from a mix

of member companies, including companies that have not previously done work with the DoD.

Additionally, matching technologies to the warfighter's needs is a key focus of the newly launched **SpaceWERX** organization. We stood up SpaceWERX to expand the space industrial base.



Today, they are forming collaborative partnerships between the military's operational experts and top innovators in industry and academia, as well as leveraging commercial investment that rapidly pursuing new space technologies.

The fact is our industry partners are innovating at unprecedented rates and in many cases, they are outpacing our demand signals. We must harvest that innovation to accelerate the space capabilities we are delivering to the Nation and to our warfighters.

As part of the SSC standup, the 30th Space Launch Delta at Vandenberg and the 45th Space Launch Delta at Patrick are now part of SSC — how does this affect acquisition?

LT. GEN. MICHAEL A. GUETLEIN

Unity of effort is essential for USSF and SSC to carry out our mission. Bringing the **30th** and the **45th Space Launch Deltas** under SSC now gives us oversight of all units involved within the space acquisition lifecycle, under a Field Command and a Deputy Commander.

Our Space Launch mission focuses on guaranteed access to space. Our **National Security Launch** team, led by Colonel **Rob Bongiovi**, has been extremely successful, not only in putting critical new capabilities into our satellites, but also in cutting taxpayer cost through innovative and acquisition approaches.



Colonel Rob Bongiovi

Both China and Russia appear to be developing anti-satellite weapons. How does this affect the kinds of satellite constellations and orbits SSC will be building?

LT. GEN. MICHAEL A. GUETLEIN

We are seeing strategic competition from other nations on the Moon, on Mars and everything between lower orbit and Mars. This isn't something happening in the far-flung future, and it's something the general public simply isn't aware of. The threat is real, it's evolving, and we need to be ready to counter it and protect our space assets and the capabilities they provide for the nation.

Our adversaries understand how vital space is to the economic and national security of a nation. Directed energy weapons, robots in space, and cyber intrusions are just some of the threats that could interfere with, damage or destroy our satellites.

Not only do our adversaries have these capabilities, they have demonstrated the ability to challenge our capabilities and deny our use of space to promote peace and for defense.

SSC is laser-focused on ensuring the U.S. does not fall behind. We're examining whether proliferated *Low Earth Orbit (LEO)* constellations could be a way of making constellations more resilient, more cost-effective and as a way to make sure the newest and most innovative technology gets launched into orbit. At the same time, LEO also is more crowded than Medium Earth or Geostationary Earth orbits and has more space debris. We're looking at a potential role for SSC in developing cislunar space now that NASA as well as other nations are becoming more interested in that area.

We are shifting to a more resilient architecture that is designed for a congested and contested space domain, and an architecture that outpaces the threat. Space Systems Command not only controls \$11 billion Space Acquisition budget, but we also have the heavy responsibility of developing and fielding resilient, integrated and highly capable assets. Instead of building a few large "exquisite" satellites that have limited operational life, we're looking at launching numerous smaller satellites into LEO, a proliferated LEO approach as one way to create more resiliency.

We're looking at ways to update satellite software and hardware after a satellite is on orbit, so that these expensive space assets can adapt with technological advances and changing threats. We're going to be working closely with our space industry and international allies and partners to achieve this, as well as with our sister services across the DoD.

If we do not tackle our mission head on, we will fail, our warfighters will fail and our allies will fail. We will not let that happen.

What advice would you give to new personnel joining or considering career opportunities at SSC?

LT. GEN. MICHAEL A. GUETLEIN

Space is hard. But it's also incredibly exciting, as well as personally and professionally rewarding. There's a tremendous amount of enthusiasm among young people who want to be a part of the Space Force and not only help defend the space capabilities we rely on today, but take them even further.

Whether you're interested in helping to design the next missile-warning satellite or helping to defend against cyber-attacks, we offer amazing career opportunities.

Visit [afciviliancareers.com/space-force](https://www.afciviliancareers.com/space-force) to learn more.

BLUEPRINT FOR SUCCESS IN SPACE

SSC 'SPACE ARCHITECTURE' PROVIDES THE BACKBONE FOR USSF CORE MISSIONS

For the general public, "space architecture" might conjure up visions of Frank Lloyd Wright-designed moon bases, but for the Department of Defense (DoD), the U.S. Space Force (USSF) and space industry providers, it refers to the entire system of systems:

from the satellites in space, to the software that controls them. Space Architecture provides usable data to the warfighter and to the launch vehicles that ensure continued access to space.

UNITED STATES SPACE FORCE OPERATIONAL ARCHITECTURE





D. Jason Cothorn

"We start with understanding the threats that face our nation, and then determine what requirements and architectures can best meet and counter those threats," said Brig. Gen. **D. Jason Cothorn**, deputy commander of Space Systems Command (SSC).

Through its SSC field command, USSF executes five core competencies: **space security; combat power projection; space mobility and logistics; information mobility; and space domain awareness (SDA)**. To execute those competencies,

SSC fields and operates a complex space, ground and command/control/communications (C3) and data architecture for a global and diverse set of users who are increasingly dependent on space capabilities to accomplish their missions. Those capabilities can be considered across four primary functions: **space superiority; strategic effects; theater effects; and command and control (C&C)**.

Space superiority includes space domain awareness and the ability to defend U.S. assets and deny or degrade the activities of any adversary in space. Strategic effects includes missile warning and highly secure communications as well as supplying position, navigation and timing signals via the GPS satellite constellation. Theater effects include tactical applications, including anti-jam tactical communications. Tying all of these together is command and control, the integration of humans and machines on the ground to rapidly assess, decide and execute the actions necessary to succeed. However, the arena of space is changing and SSC is ensuring its architecture is changing, too, to meet new challenges.

"How do we pivot our space architecture?" said Col. **David Learned**, acting director of SSC's Portfolio Architect. *"What we have up there now was designed for a benign space environment so we're pivoting towards resilient and defensible capabilities. That's something we have to be very deliberate about."*

"What we want is an architecture that best supports the warfighter and our allies," said Col. **Richard Kniseley**, Space



Col. David Learned

Systems Command Core Team Lead. *"So when we start talking about architecture, we look to make sure we have good redundancy and resiliency and that we can support the warfighter and our allies at any given time. We also want a shared, integrated architecture with each different group working together."*

"We've stood up SSC with the goal to have that integrated architecture to best plan for what's needed currently, but also to start marking out what are the needs of the future to best protect our warfighter, and how to succeed in the congested - and now contested - space domain," Kniseley explained.

"In traditional acquisition — say, for an aircraft — the majority of the budget is spent on the operations and maintenance side of the house. You have the ability to bring that airplane down and make repairs or modifications. But space acquisition is kind of flipped onto the other side — about 80 percent of our time, money and effort is spent in research and development in producing these resilient capabilities because you know once you launch it and it's on orbit, that's it - and space itself is such a rigorous and dynamic environment."

"That's one reason we put so much rigor into the beginning part of space acquisitions — because we really only have one shot of getting this right," Kniseley said. *"You need to make sure what you're sending up is meeting the intent and the needs of the warfighter and the allies we're supporting. In the past, space architecture relied mainly on large "exquisite" satellites, usually boosted to higher, geosynchronous orbits,"* Kniseley continued.



Col. Richard Kniseley

"And while many of those systems continue to provide critical data despite having long outlasted their design life, today we can accomplish many of our missions with multiple, smaller satellites, using commercial partners to increase resiliency and tap into newer, emerging technologies."

NASA and the military are no longer alone in the business of space, and the increasing number of commercial space industry companies are helping to spur exciting new developments in technology and providing new partners for the USSF, Kniseley said.

Among the initiatives designed to help SSC find those new commercial partners is SpEC, the Space Enterprise Consortium, a group of more than 600 companies, with more than half of them nontraditional. Space Force Pitch Day is another event designed to lower the barrier to entry to work with the DoD by helping companies pitch their technological solutions to specific mission area needs within USSF.

In addition to better leveraging commercial services and capabilities, key international partnerships with allies such as the countries of NATO, Latin America and the Pacific Rim are another way SSC intends to evolve its architecture, providing increased capability, resilience and deterrence.

"We can more collaboratively improve our capabilities by offering and taking advantage of offered hosted payload opportunities," Learned said. *"We can also take advantage of shared launches, infrastructure, data and services, and ground assets. We have been working for the past several years to streamline and improve the acquisitions process, from removing structural "stovepipes" in the organization, to pushing decision-making authority down from the commander level to the program executive officer level."*

Now that SSC has formally been stood up, that process will continue. The USSF will be the first military service to have contracting authority not residing at the Pentagon, but instead at the SSC field command level, eliminating additional layers of coordination just to get approvals.

"The Program Integration Council, launched last year and led by SSC, brings together representatives from the Air Force Rapid Capabilities Office, Space Rapid Capabilities Office, the National Reconnaissance Office, the Space Development Agency, the Missile Defense Agency, and Space Operations Command to facilitate the cooperation and synchronization of space systems acquisition organizations supporting the USSF," Learned said. *"USSF also has its Space Warfighting Analysis Center, serving as its centralized force designer to ensure that SSC's future investment strategy is supported by rigorous, cost-informed analysis."*

"We don't want to have conflicting investment in the overarching enterprise architecture," he added. *"For example, if our force designers are considering a hybrid design incorporating both LEO (low Earth orbit) and MEO (medium Earth orbit), we'd work with all the acquisition organizations on how to leverage existing investments across their portfolios, and how to get after the new elements of the architecture via coordinated integration, demonstrations, services, partnerships, development, etc."*

"We were founded as the Western Development Division in 1954 and we've been developing innovative space capacity for more than 65 years," Brig. Gen. **Cothorn** said. *"If you're looking for the experts -- the people who know how to do space acquisition, it's here."*

Follow Space Systems Command on [LinkedIn](#).

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COMMAND CENTER EYAL ZELINGER

GLOBAL DEFENSE VICE PRESIDENT,
GILAT SATELLITE NETWORKS



Eyal Zelinger is Gilat Satellite Network's Global Defense Vice President. He is a retired Brigadier General (BG) from the Israel Defense Forces (IDF) and leads Gilat's Defense business to expand presence in global markets. He joined the company in 2020.

Mr. Zelinger has more than 30 years of experience in the IDF Signal Corp. During his service, he managed the development and operation of the IT systems, cyber defense, communication infrastructure, and served IDF's highest, strategic

leadership. He retired at the rank of a Brigadier General after serving as the Chief Signal Officer and C4I/J6 Chief of Staff.

Mr. Zelinger, you had an extraordinary career in the Israel Defense Forces (IDF). How did you find yourself in the Signal Corp and what role did satellite communications play in your work?

EYAL ZELINGER

Actually, I started in the Signal Corp on my first day of service. It was 'assigned' to me, but obviously it was the perfect fit, as I stayed in the Signal Corp for more than 30 years and retired at the rank of Brigadier General. For me, the Signal Corp represented the ideal combination of operations and technology, allowing me to effectively implement the latest communication technologies for optimal use and results.

My first exposure to satellite communications came when I was a Signal Battalion Commander. We received a command to implement a SATCOM solution to improve operational efficiency. When I was head of C4I system development, I was responsible for all future development and established critical SATCOM capabilities for the entire IDF.

As a former high-ranking military officer, what do you think are the biggest changes happening in today's modern defense forces?

EYAL ZELINGER

Since World War II, a large portion of defense industry spending have been driven by technology. Throughout the second half of the 20th century, technology-based defense grew more prevalent and became the best approach to solve security challenges — at least for the larger, more developed military spenders.

The quest for technological superiority and innovation makes sense when armed forces are trying to preserve and reinforce their strategic advantage. The digital transformation of the military continues to shape the future of global security. Seamless collaboration and communication are crucial for helping defense agencies realize a more modern way of working and managing themselves more effectively; sharing vast amounts of critical information (including voice, data and video) in real time makes military maneuvers more efficient and effective.

Now we are well into the 21st century; militaries no longer look like they did in the past. Today's modern militaries move faster, smarter and with greater precision than ever before, based on information systems which consume high bandwidth.



What exactly is driving these changes?

EYAL ZELINGER

Modern militaries have embraced the concept of "net-centricity." The theory around net-centricity is fairly simple: by implementing a globally interconnected broadband communication network (including infrastructure, systems, processes, and people) that speeds up 2-way communications and increases situational awareness, the efficiency and effectiveness of military operations will improve.

Vast amounts of data are shared in a timely, seamless and resilient way among warfighters, officers, applications and platforms during all phases of warfighting efforts. This, in turn, allows combat units to be smaller in size, more effective and lethal and allows them to take on a different range of missions than non-networked units.

Net-centricity enables the real-time, free flow of information across the battlespace so that data is shared, processed into information and then provided to the people or systems in need.

Communications networks are being shaped by Big Data and include Wi-Fi, cellular, voice, video and other technologies. In order to achieve



this new level of connectivity and operational continuity, wherever forces may be located and in spite of any enemy efforts to block communication, modern militaries are now using satellite communications (SATCOM) to help ensure the successful completion of land, sea and air missions.

What should defense customers be looking for in Satcom-on-the-Move solutions?

EYAL ZELINGER

Wartime and tactical missions often take forces into unfamiliar territory crawling with unpredictable and unknown threats. Access to real-time intelligence on the ground — where and when troops need it — can make all the difference between a successful and an aborted mission.

Combat troops need fast, reliable and secure communications in areas beyond the bounds of traditional fixed and wireless networks. Satellite-on-the-move (SOTM) communications is a game-changer for today's net-centric battlefield, enabling soldiers and homeland security personnel to gain instant access to critical information while staying in touch with command headquarters.

Defense organizations need quick-to-deploy ruggedized SOTM solutions that can be carried in a backpack or mounted on fighting vehicles. More specifically, they should look for fully integrated VSAT systems that ensure seamless connectivity for both on-the-move and on-the-pause missions and support voice and data communications, military C4I and border patrol activities with full interoperability among land, sea and airborne forces.

Tell us something about Gilat's products and solutions offerings? What is unique about them? What makes Gilat's offering unique compared to others on the market?

EYAL ZELINGER

I must start with the Defense Team here at Gilat. We all came with extensive operational experience from today's modern battlefield. As such, we understand what is needed today and what will be needed in the future and guide product and solution development accordingly.



In another example, ground troops are activated to enter a city in order to remove enemy forces planning a terrorist attack. Historically, warfighters in this situation go in 'blind,' meaning they have no situational awareness as to what is happening behind the closed doors of houses, offices, warehouses, etc. Warfighters have no choice but to go door to door, hoping to avoid injury to the innocent and capturing the fugitives without incident.

However, with the use of SOTM technology, warfighters can enter battlefields with their eyes wide open. In this scenario, data and video are collected via a number of different applications and sent back to HQ and to the forces in real time via Gilat's ruggedized SOTM antennas.

Gilat offers government and defense organizations a set of advanced SOTM solutions for all types of platforms in order to keep assets in the field connected at all times to central operations. Our high-performance and quick-to-deploy systems provide fast and reliable broadband connectivity for any mission, as well as supporting a diverse range of civilian services.

More specifically, Gilat's end-2-end SATCOM solutions have been designed specifically to meet the needs of today's net-centric battlefield, including: flexible, secure platforms for huge amounts of data and high-bandwidth applications to connect soldiers, platforms and terminals across land, sea and air; continuous and resilient connectivity to ensure that information is available when, where and how it is needed; with all necessary technology, equipment, applications, products and solutions under 1 roof.

Gilat's full scale, state of the art SATCOM solutions are fully equipped to provide the constant flow of 2-way secured broadband communication required by today's net-centric battlefield, including intelligence, live video, voice, command and control information and enemy/friendly forces locations and operational commands.

Offering antennas, modems, BUCs, manpacks and unmanned platforms, Gilat supports any SOTM/SOTP use case and any platform.

What are some examples of use cases for Gilat's Defense products?

EYAL ZELINGER

The ability to integrate wide-band communication between air, land and sea is critical for defense operations. I personally experienced this need in 2014 during "Operation Protective Edge" when I was Chief Signal Officer of the IDF.

Terrorists had infiltrated Israel via the beach; however, the Navy didn't have any 'eyes' on what was happening beyond the sand. In these types of cases, HQ can deploy Gilat's **Blackray**, an unmanned aircraft (UAV), to survey the landscape and send back video to be analyzed by the command-and-control center. Tactical unmanned aircraft systems (UAS) are often capable of long endurance times while carrying significant payload weight.

SATCOM fully exploits tactical UAS capabilities, supports intelligence, surveillance and reconnaissance (ISR) missions beyond line of sight (BLOS). Based on the information provided by the UAV, artillery units are safely moved closer to the border and a Navy offshore patrol vessel hugs the coast.

In a completely coordinated mission and based on common situational awareness, the terrorists are caught. All forces involved have a common picture of what is happening and can choreograph their actions as the situation unfolds.

The information is reviewed and analyzed by intelligence officers who, in turn, are able to advise warfighters on the ground exactly which properties to approach and which to avoid.

Another critical use of SATCOM involves paratroopers using Manpacks. Paratroopers are trained to conduct a range of missions, from prevention and pre-emption tasks, to complex, high intensity war fighting. They are often the first on the ground during an incursion and are responsible for a tremendous amount of intelligence gathering.

Using Gilat's fully integrated and lightweight **SatTrooper** manpacks, which provide rapid connectivity to voice, data and telephony, even under the harshest conditions, paratroopers are able to share invaluable information to command and control. The small-size dish antenna can be set up within minutes, with automatic pointing, and does not require any special tools for assembly.

You probably had your choice of private sector job opportunities after you retired from the IDF. How did you decide to work for Gilat?

EYAL ZELINGER

For more than 30 years, Gilat has been a pioneer and leading innovator in SATCOM. I was fortunate to work with Gilat during my service so I knew that the team leverages its commercial technological leadership and innovation to provide SATCOM solutions to governments around the world to answer all of the broadband communication needs required by today's modern battlefield.

In addition, I knew that military SATCOM is in Gilat's DNA. Many members of Gilat's executive team, solution experts and R&D engineers have extensive military experience across a wide range of disciplines and expertise, making Gilat the best choice for serving the needs of today's defense forces that must use the latest in critical SATCOM technology.

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COMMAND CENTER: CRAIG BROWER

VICE PRESIDENT AND GENERAL MANAGER, PUBLIC SECTOR, ORBITAL INSIGHT

Craig Brower is the Vice President and General Manager, Public Sector, at Orbital Insight. He is an accomplished business development strategist with extensive experience in identifying and developing business opportunities, nurturing critical partnerships as well as launching new products and services.

Craig's core competencies include: Strategic Business Planning, Financial and Contract Negotiation, Account Management, Partnership Development, Competitive Analysis, Congressional Relations, New Market Development

Good day, Mr. Brower. Would you please give our readers an idea as to your background and how you became involved with Orbital Insight?

CRAIG BROWER

I began my career with the Federal Government as a photographer for the CIA. Over the course of my 11 years with the agency, I worked as a research analyst as well as a program manager for new and emerging technologies. It was during this time that I found my passion for applying technology to answer critical questions about the world we live in.

After leaving government service, I helped to build what is today the Global Analysis business unit at BAE Systems and then spent several years selling commercial satellite imagery in the IC and DoD markets.

More recently, I was the third U.S. employee for startup Vricon, a joint venture between SAAB AB and DigitalGlobe (now Maxar). At Vricon we created and sold a new 3D technology at global scale to the U.S. government. Vricon was acquired in 2020 and, in January of 2021, I joined the Orbital Insight team as vice president and general manager of

the firm's public sector business. My goal in this role is to accelerate the adoption of AI and ML technologies in the public sector market.

What does Orbital Insight offer and how can the company's technology improve the way analysis is currently done in the defense and intelligence community?

CRAIG BROWER

Orbital Insight's **GO** platform is an AI-powered, geospatial analytics platform designed to simplify the use of location data and allow users to query the world with three basic parameters: the what, where, and when.

Orbital Insight's GO platform uses AI to process multiple sources of geospatial data — satellite images, mobile location, connected cars and other IoT data — into objective answers to critical security questions about what's happening on the ground.

The defense and intelligence community uses Orbital Insight's technology to monitor global activity and proactively address critical situations. The technology supports critical activity-based intelligence by helping spot trends buried within billions of data points—for example, military asset movement, near peer geopolitical activity, economic patterns associated with global ports, airports and energy infrastructure, and government responses to natural disasters.

The automation capabilities of Orbital Insight's technology are particularly transformational for the public sector community. The government has people whose entire jobs are dedicated to monitoring satellite imagery and other data sources, but the volume of data has become too massive to access and analyze at scale. In fact, it would take approximately 8 million people to look at all the satellite imagery produced of the Earth every day.

By using AI and data science we can count and identify cars, trucks, planes, railcars, and new roads and buildings all over the world, aggregate the results and highlight anomalies to the human analysts. What would take



Data Empowering the
World's Decision-Makers



a human analyst hours or even days to decipher, takes only seconds due to the automated analytical technology. Orbital Insight helps the defense and intelligence community monitor the world to detect anomalies, prevent surprises, and respond with the right security policies, communications and aid.

You note that your company's GO platform is a geospatial analytics platform. When you use the term 'geospatial' as such applies to the military /agency/ government market segments, what exactly does that encompass?

CRAIG BROWER

In our view, the goal of geospatial analytics is to understand what's happening on and to the Earth. To do that, geospatial data usually covers location information, attribute information and temporal information.

The term "geospatial" applies to the military and government markets in the same way as the term applies to commercial or personal use. The difference is the absolute importance for the data to be as accurate and complete as possible when applied within a government segment.

The military uses the terms *reliability* and *explainability*; it is all about ensuring that the best and cleanest information possible is accessible by our military and intelligence leaders. That information can include maps, directions, visualizations and especially patterns of life — all of which can tip-and-cue decision-makers to anomalies. If something is not normal or if situations change, our customers need to know it and they need to know it as soon as possible.

What makes Orbital Insight's capability unique? How does Orbital Insight's capability differentiate from the competition?

CRAIG BROWER

Orbital Insight develops geospatial data analytics to help our clients unlock trends at a global scale. While other companies use AI, process big data from multiple sources, and analyze imagery, only Orbital Insight combines them all into a single self-service platform, called GO. Our GO technology ingests satellite imagery, geospatial data, IoT, demographic, advertising data, and other open source data and translates results into explainable, reliable, unclassified and non-proprietary insights. Customers tell us that GO is the most comprehensive yet distillable solution out there.

"Big Data from multiple sources" — would you give us some examples of the sources used by Orbital Insight to formulate their data?

CRAIG BROWER

We use various types of imagery data coming from commercial satellites, drones, and high-altitude balloons. Our platform also ingests mobile phone or AdTech data for geolocation information as well as AIS and ADB data for tracking ships and aircraft. In addition, we partner with other companies to provide our customers with access to RF and SAR data.

How can AI be used to support the analyst? Does AI replace the need for humans?

CRAIG BROWER

AI is an incredibly helpful tool in analytics, but it will never replace the need for humans. Our goal is to augment the performance of the analyst and the vision is to leverage the human-in-the-loop paradigm.

GO does not remove the analyst from the equation — it simply saves them time that can be used to probe intelligence challenges more deeply. By processing large amounts of data, GO's automation can tip-and-cue the analyst to what matters most.

For example, GO users can set alerts and automatically cue follow-up observations upon detection of indications and warnings. GO also enables geospatial and data analysts to automatically monitor thousands of areas of interest, from hyperlocal to global. Analysts benefit from high revisit collection platforms and high-performance analytics — reducing the time from event to analysis.

What's the most interesting finding you've uncovered recently?

CRAIG BROWER

There are so many interesting findings, it's difficult to pick just one. For instance, with our new *Supply Chain Intelligence* feature, we have been able to locate groups moving between China and North Korea and then on to other locations in the region. We've also been able to make sense of Russian military activity in southeastern Ukraine and detected evidence of a major Russian offensive military training event in the Crimea region.

More recently, we've uncovered China's port development in *Djibouti*, as well as China's depredation of the local fish populations off the coast of *Ecuador* and *Peru* that has the deep interest of our maritime partners. Open source intelligence analysts from Stanford's Center for International Security and Cooperation have also been using GO to monitor nuclear proliferation in North Korea and Iran.

Mr. Brower, would you please discuss the ways wherein this crucial intelligence could inform strategic decisions on the battlefield.

CRAIG BROWER

The intelligence that our technology gathers via AI can help decision-makers better understand normal patterns of life and then set alerts when those norms change. It also helps them identify threat indications and warnings, enabling more strategic operational planning and target development.

Is AI already widely adopted within the defense space? How do you see this changing in the next couple of years?

CRAIG BROWER

The defense industry has widely accepted the need for AI but has yet to fully adopt and implement it. The DoD is taking steps to enable adoption of new and advanced data technologies, and between the **Joint Artificial Intelligence Center** and the services, there is a serious effort underway to test AI technologies, prepare data for AI integration, and build tool sets to solve unique military problems.

A clear case has been made for the utility of AI in the defense and intelligence space, and it's also clear that accuracy and reliability of its use is paramount. I'm encouraged by the pace, progress and thoroughness of the effort to implement AI more widely in the defense sector.

An area of deep concern within the intelligence community is that of security, the protection of data from outside 'influences.'

How does Orbital Insight handle this area of your technology?

CRAIG BROWER

Orbital Insight sources our data from multiple industry-leading vendors, and we authenticate all data to ensure we are sourcing from the actual vendors. Much of the data we source is overlapping for the most comprehensive coverage, and we run correlation and correction processes to remove invalid data. We also follow industry best practices regarding cybersecurity.

The data is encrypted within our environment to prevent modification or tampering. Lastly, we follow a strict ethics policy, which goes above and beyond what the law requires to ensure that we never identify individuals with our products.

What are the biggest challenges for adoption of AI in the defense and intel community today?

CRAIG BROWER

Reliability is the biggest challenge. First, AI must be explainable, transparent, and properly trained. There has to be a clear answer to why an algorithm decides one outcome versus another when presented with various data sets.

Second, AI has to be accurate. This is especially important in target development and execution. The data behind it must be protected and free of malign or corrupt influence.

Tremendous progress has been made on all of these fronts, and with any technological innovation there are obstacles to overcome. Overall I'm impressed with the continued developments.

What measures are you taking to ensure that your AI is used ethically?

CRAIG BROWER

All of our data is anonymized to protect the sources or content of the data. Privacy is an extremely important value to us and one we take seriously. We have established an ethics board to review and assess potential ethical questions and operate within our ethics framework which shapes all of our work and decision making.

What may we expect from Orbital Insight over the coming months?

CRAIG BROWER

You can expect a growing, impactful contribution to the U.S. government, building upon a firm foundation of existing defense work. We've

public sector side of the business, you'll see more features designed to support the DoD, specifically in global airfield and ship port monitoring.

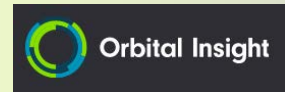
We are in the process of deploying a new open architecture software service that will allow us to integrate many different types of data sets under one roof and on one screen that will provide the analyst with insights derived from Electro-Optical imagery, IoT/Cloud data, AIS, ADB, SAR, RF, and even HSI data. We want to become the single integrator for unique commercial data to support military analysts.

Lastly, Mr. Brower, when you look back upon your career, what missions or projects truly bring a sense of satisfaction to you and a smile to your face?

CRAIG BROWER

Mission success is the most rewarding aspect of my career, and that has been delivered in many different ways. At BAE Systems, I was honored to be able to hire some of the best analysts on the planet and their mission success with our customers was extremely rewarding. When I sold data and software solutions, it was most rewarding to learn of successful missions from our intel and warfighter customers because of our products. Most of those successes cannot be shared publicly, but you might catch a smile from me when that success is reported in the media.

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WHY COOPERATION IS KEY TO SPACE ENDEAVORS

Author: Charlie McGillis, Vice President for Business Development, Slingshot Aerospace Inc.

A space revolution is being realized. Investments in the space economy are astounding and we will continue to see rapid growth in government and commercial sectors. In the U.S., not only was a new Combatant Command reactivated in early 2019 with the mission to protect the interests of the United States in space, but also the stand-up of a sixth service, the United States Space Force.



In some quarters, the militarization of America's operations in space was criticized as an unnecessary move. However, the reality is far more complicated than sending Guardians into orbit. As General John Raymond, the man leading the new DoD branch, correctly argued: the U.S. Space Force is "nationally critical... elevating space commensurate with its importance to our national security and the security of our allies and partners."

That's because our lives are increasingly dependent on assets in space, from GPS systems and financial transactions to the national security infrastructure we rely upon. Developing the ability to deter and respond to threats — both perceived and as yet unknown — is vital to U.S. interests.

However, there is a marked difference between security and confrontation. The story of humans in space is largely one of international cooperation, shared exploration, and collective endeavor. If we are to harness evolving technologies and unlock the potential of space for the future, that same collaborative spirit is required.

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THE VALUE OF DETERRENCE

In a recent interview with **The Washington Post**, General Raymond outlined the threats to US interests in space posed by familiar adversaries.

"Both China and Russia have developed weapons that can disrupt or destroy our satellites from on the ground or in space," he said. "Although it's a warfighting domain, our goal is not to get into a conflict that begins

or extends into space. Our goal is to deter that from happening. The way you do that is from a position of strength."

Strength, in this context, refers to capabilities that can tip the deterrence calculus in US favor; potential actions that would deny adversaries an advantage or opportunity, or impose significant costs, as General Raymond puts it. In theory, these capabilities would work alongside the military might of the US armed forces to prevent conflict from starting or spreading into orbit.

COLLABORATION IN THE FACE OF SHARED THREATS

There's no doubt malevolent space threats are a national security concern. But many of the greatest space-related threats facing the United States are universally shared. Space Debris

Space Debris

Space debris is one example. Left unchecked, cascading collisions in orbit could render the space around Earth unusable, limiting access for commercial, scientific, and exploratory operations

With modern life so dependent upon infrastructure high above, irresponsible actions in orbit could have severe consequences. The anti-satellite tests carried out in recent times by **China**, **Russia**, and **India** are prime examples that risk restricting access to space.





Representatives from all 11 U.S. combat commands participate in the third series of GIDE at North American Aerospace Defense Command and U.S. Northern Command headquarters in July of 2021.

Space Weather

All of the weather we experience here on Earth begins with the sun. On rare occasions, solar activity disrupts the systems that we rely upon.

Different types of space weather, from solar flares to Coronal Mass Ejections (CMEs), can cause geomagnetic storms that damage satellites and electrical infrastructure. In 1989, a solar storm **caused a blackout in Quebec, Canada**. In 1859, a freakishly large “solar superstorm” caused the northern lights to be seen along the equator and destroyed early electronics infrastructure.

Another superstorm is overdue, and the damage it would cause is now far more severe given the modern world’s reliance on electricity.

UNEXPECTED VISITORS

Beyond debris and solar storms, other potential threats exist that most of us assume belong in the world of science-fiction: extraterrestrial life and asteroids.

In 2017, the *NY Times* uncovered a \$22M secret program called the *Advanced Aerospace Threat Identification Program* designed to investigate UFO sightings. Then, in May this year, 60 Minutes did a segment on unidentified aerial phenomena interviewing and this topic will hit the Senate floor in June.

We could come into contact with interstellar objects from **outside our solar system**. And we shouldn’t forget that in our galaxy there are thought to be millions of stars that have planets of the right chemistry and size to support organic evolution.

Quantifying the threat of hypothetical extraterrestrial life is almost impossible. It could be decades, centuries, or millennia before we discover the degree to which we are alone in the universe. But it could also be tomorrow.

Aside from UFOs, the chance of a strike causing an extinction-level event is remote, but ongoing vigilance is vital. NASA’s Near-Earth Object (NEO) Observations Program currently watches the skies in order to track objects that pose a risk to Earth. As recently as 2019, **an asteroid named 2019 OK** came within 40,000 miles of our planet.

That sounds like a huge distance. But in fact, it was the largest asteroid ever known to come so close and, due to its highly elliptical orbit, wasn’t actually noticed until the day it passed by. Had 2019 OK collided with Earth, NASA suggests “*the blast could have devastated an area roughly 50 miles across*”.

All of these uncertainties are indicative of the bigger picture. We are one world among countless worlds, and our success as a spacefaring species will depend on our ability to cooperate, whether that’s keeping Earth’s orbit clear of debris or collectively scanning the skies for solar storms and incoming asteroids.

Currently, that cooperation has been a foundation for scientific progress. The UN General Assembly established a **Committee on the Peaceful Uses of Outer Space (COPUOS)** in 1959 to govern the exploration and use of space for the benefit of all humanity: for peace, security and development. Even astronomers all over the world watch the skies and share information.

For a quarter of a century, **NASA** and the **European Space Agency (ESA)** worked together on the **Solar and Heliospheric Observatory (SOHO)**, studying the Sun to better understand solar activity and weather in space.

The same two agencies are also working together on an ambitious planetary defense experiment, in which NASA plans to alter the trajectory of an asteroid and the ESA will **send a separate probe to study the aftermath**.

And perhaps the best example of all is the **International Space Station**, the most expensive and iconic cross-nation infrastructure project of all time.



On May 9, 2021, the remains of a Chinese rocket crashed into the Indian Ocean after launching a module of a new space station into orbit. The rocket was one of the largest objects in recent decades to dive uncontrolled into Earth's atmosphere and the event led to international outcry.

"Spacefaring nations must minimize the risks to people and property on Earth," US Defense Secretary Lloyd Austin said in a statement. "It is clear that China is failing to meet responsible standards regarding their space debris."

This latest example, alongside [recent anti-satellite tests](#), highlights the need for standards to be developed and enforced around all space operations. The outlaws placing weapons of mass destruction or military bases in space, but other than that, it's what General John Raymond recently described as the "Wild, Wild West." New, internationally-agreed norms of operation in space are required to avoid reckless actions and encourage sustainable space use.

In practical terms, that means fixed engineering standards to ensure satellites break up in a way that's safe when they are no longer in use – standards that ensure the launch of new objects into space doesn't litter LEO with debris – and increased data sharing to help space operators avoid collisions between objects in orbit. Each of those elements requires closer cooperation between satellite owner operators, nations and space agencies, whose interests are closely aligned in the long term.

It could also be argued that the rhetoric around the use of space needs to change. Talk of inevitable conflict only serves to escalate the tension between adversaries. And although the threats in and to space are real, it's far outweighed by the universal risks that necessitate global collaboration.

Ultimately, space is a domain in which cooperation has long been central to our collective success. The simple truth is that all of our space-related ambitions – from planetary defense and space tourism to making humans a multi-planetary species – require combined expertise and mutual collaboration.

Charlie McGillis is Vice President for Business Development at Slingshot Aerospace Inc., a company building world-class space simulation and analytics solutions. The company is driven by its vision of accelerating space sustainability to create a safer, more connected world. McGillis is responsible for leading a team that develops strategy, expands our business and product development activities, and gathers, prioritizes, and integrates product and service requirements for our customers.

McGillis has more than 30 years of defense and executive leadership experience. She served over 26 years in the United States Air Force as an Intelligence Officer, retiring in June 2014, at the rank of Colonel. Following retirement, she served as a Commercial Integration Cell Consultant, representing seven Commercial Satellite Operators to facilitate better coordination and information sharing with the United States Government.

Her broad defense career spanned a wide variety of leadership and staff positions. In her last assignment, she served as the Director of Intelligence at Fourteenth Air Force (Space) where she led all intelligence for Air Force space forces to support operations. In other assignments, she served as Deputy Chief of Staff at USSTRATCOM, Deputy Political Advisor at USSOCOM, and Deputy Director of the Commander's Action Group at NORAD-USNORTHCOM. She commanded at the squadron level at Air Command and Staff College where she led a multiservice and multinational unit.



Slingshot Beacon is the world's first collision avoidance collaboration and communications platform for space, de-risking conjunctions and saving operators time.

A CONVERSATION WITH KEN FLOWERS

VICE PRESIDENT OF GOVERNMENT SOLUTIONS, IRIDIUM
THE IMPORTANCE OF RELIABLE SATCOM IN THE POLAR REGIONS



With increased interest in the Arctic and Antarctic regions, especially for industries like international trade, oil and gas, environmental and scientific research groups and global governments, the need for reliable connectivity is at an all-time high. Currently, satellite communications (SATCOM) is the ideal solution for delivering reliable connectivity in the polar regions, and [Iridium](#) remains the pre-eminent leader of enabling weather-resilient, reliable SATCOM to both Arctic and Antarctic territories.

In June, the company conducted a field demonstration of [Iridium®](#) and [Iridium Connected®](#) technology called [Operation Arctic Lynx \(OAL\)](#). In partnership with 20-plus global organizations ranging from the U.S. Department of Defense to scientific research groups, OAL exhibited Iridium's weather-resilient SATCOM technology on-base, on-the-move and remotely from the field as far as 82 degrees north latitude. Iridium's Vice President of Government Solutions, Ken Flowers explains their important and unique role in enabling polar communications and he shares more regarding the OAL expedition.

Mr. Flowers, why is reliable SATCOM connectivity in the polar regions important?

KEN FLOWERS

From a geopolitical standpoint, as the ice melts and the polar regions become more accessible, there is motivation to create a presence there for a variety of global organizations that include the U.S. government and a number of competing interests.

Since gaining footing in the Arctic has become strategically important, it is critical for all who travel there to have reliable connectivity.

Today the poles remain some of the most difficult places to connect with, due to the regions' extreme latitudes and harsh conditions. Currently, Iridium is the best suited SATCOM provider to deliver connectivity, due to the company's orbital location in *Low Earth Orbit (LEO)*, *L-band spectrum* and crosslinked network architecture enabling reliable, robust and resilient coverage across the entire planet.



Would you tell us more about Iridium's polar capabilities and why they are unique?



Ken Flowers during Iridium's OAL expedition. Image is courtesy of the company.



KEN FLOWERS

For the last 20 years, Iridium has been the leader in polar connectivity, providing our narrowband services to the regions' people and organizations.

Due to the unique architecture of the Iridium network, we are able to deliver a reliable and strong SATCOM connection to the Arctic and Antarctic territories. Our crosslinked satellites in LEO are always in communication with one another, converging at the poles as they rotate around the Earth, delivering a strong signal to locations that typically lack reliable coverage.

Because of this process and the system architecture, unlike alternative satellite networks, we are able to operate above 65 degrees latitude. Of special interest to governments, we support activities as far as 90 degrees north or south latitude.

In addition to our network architecture and polar orbit, our location in LEO delivers a low-latency connection, making real-time communications possible. Our L-band spectrum allocation delivers a weather-resilient connection that is ideal for those operating in the Arctic and Antarctic's harsh conditions.

In addition to delivering our traditional narrowband services, such as messaging and voice calling, we are providing our broadband services to the polar regions with **Iridium Certus**®. The availability of multiple Iridium Certus speed classes brings additional capabilities, such as the ability to enable compressed video, an important tool for search and rescue organizations that rely on **Beyond Line of Sight (BLOS)** technology to conduct both civilian and military rescue missions. Essentially, we can provide the "eyes" that can investigate the most remote areas.

What was the main purpose of OAL and was it a success?

KEN FLOWERS

The main purpose of OAL was to create awareness of our capabilities in the Arctic to all who operate in the region, and in that regard, the exercise was a complete success.

We were able to demonstrate to key military organizations, including the United States Air Force, Coast Guard, Army and National Guard, what our upgraded network is capable of providing clients. During OAL, we spoke with members of the **Canadian Forces Security (CFS) Alert**, who operate at 82.3 degrees north — the most northerly, continually inhabited, location in the Northern Latitudes.

We connected with them over **Iridium Push-to-Talk** technology, telephony and video over Iridium Certus, demonstrating excellent call quality and enabling a strong and reliable connection to analyze data. We also demonstrated as far as 90.0 degrees south at **Amundsen-Scott South Pole Station**.

Can you share any findings or highlights from the expedition?

KEN FLOWERS

In addition to demonstrating the strength of our SATCOM services and solutions within the Arctic region, we were able to show participants the full global scope of our services. During OAL, we not only connected with those in the Arctic, but we were able to facilitate voice, data and video calls with colleagues in Antarctica and Colorado Springs during a variety of weather conditions, truly highlighting the power of our services.

Did any Iridium technologies perform better over others?



KEN FLOWERS

All of our services performed very well, but there were a few standout moments with our tracking capabilities.

For example, our partner **AssetLink Global's** two-way asset tracking device called the **AssetPack™**, was mounted on vehicles traveling a northern route to Fairbanks, Alaska, to track the entire trip. The device plotted each vehicle's location every 15 minutes and used geofences to enable a report rate of every five minutes.

These capabilities really resonated with OAL participants as asset and personnel tracking is a priority for those operating in the Arctic. Additionally, as the device is powered by the Iridium network, it works no matter how remote the route and even in adverse weather conditions, which highlighted the reliability and resiliency of our network.

Are there plans for future Arctic demonstrations similar to OAL?

KEN FLOWERS

Iridium technology is currently being used during a scientific voyage onboard the **U.S. Coast Guard Cutter Healy**. The voyage is circumnavigating North America, which began on August 26th. The cutter departed from Seattle and traveled north to Greenland, then down the East Coast, through the Panama Canal and back to Seattle, while teams conducted various experiments along the way. Iridium data and telephony are the primary Iridium capabilities being used, including auto dialers on the ship.

This expedition is considered Phase 3 of OAL, and we look forward to supporting additional exercises in the future that demonstrate the breadth of our worldwide services.

To learn more about Operation Arctic Lynx, visit:

www.operationarcticlynx.com

More information regarding Iridium services in the polar regions, visit:

www.iridium.com/markets/arctic/