SATCOM for Net-Centric Warfare

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FEATURES

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The President of the United States has signed the 2020 National Defense Authorization Act and, with that signing, directed the establishment of the U.S. Space Force as the sixth branch of the U.S. armed forces.

Secretary of Defense Mark T. Esper

"*We are at the dawn of a new era for our Nation's Armed Forces. The establishment of the U.S. Space Force is an historic event and a strategic imperative for our Nation. Space has become so important to our way of life, our economy, and our national security that we must be prepared as a Nation to protect it from hostile actions*," said Secretary of Defense, *Mark T. Esper*. He continued, "*Our Military Services have created the world's best space capabilities. Now is the time for the U.S. Space Force to lead our Nation in preparing for emerging threats in an evolving space environment. This new service will help ensure we are postured to deter aggression, defend our national interests and outpace potential adversaries.*"

The U.S. military and the commercial sector rely heavily on space-enabled capabilities, and the Defense Department must protect those assets and maintain U.S. superiority in the space domain, the Deputy Assistant Secretary of Defense for Space Policy, *Stephen L. Kitay* said during an AFCEA luncheon last year.

He explained that the Department of Defense (DoD) is no longer viewing space as a support function, but as a warfighting domain –– a domain of potential crisis and conflict. The Space Force unifies space-related activities within DoD.

Kitay added that the nation needs to maintain space superiority and protect freedom of operations in that domain. ''*Future operations will likely start or extend into space and we have to be ready for that eventuality*.''

"*Space is critical to our nation's economic interests, national security, and way of life*," said Chairman of the Joint Chiefs of Staff, General *Mark A. Milley*. "*In military operations, space is not just a place from which we support combat operations in other domains, but a warfighting domain in and of itself. Our adversaries are building and deploying capabilities to threaten us, so we can no longer take space for granted. The U.S. Space Force is the necessary and essential step our Nation will take to defend our national interests in space today and into the future.*"

Chairman of the Joint Chiefs of Staff, General Mark A. Milley

"*The launch of the U.S. Space Force propels the nation into a new era*," said Secretary of the Air Force, *Barbara M. Barrett*. "*An agile, lean and technologically-advanced force of talented professionals will now singularly focus on protecting our U.S. national interests and security in space.*"

"*With the establishment of the Space Force we elevate the organize, train and equip function consistent with the criticality of the space domain*," said General *Jay Raymond*, Chief of Space Operations and Commander, U.S. Space Command. "*The U.S. Space Force will deliver the capabilities U.S. Space Command needs to control and exploit space for national advantage.*"

Much of the new U.S. Space Force will be built from existing structure with the armed services and DoD. Some of the space assets that currently reside in each of the armed services are not going to be incorporated into the Space Force, such as the National Reconnaissance Office. Additionally, U.S. Space Command that was activated in August of 2019 will remain as a combatant command with a focus on warfighting aspects.

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President Donald Trump signs S.1790, the National Defense Authorization Act for Fiscal Year 2020 as senior leaders look on, Friday, December 20, 2019 At Joint Base Andrews. The act authorizes a budget that supports the U.S. Armed Forces and postures the Air Force to meet the requirements of the National Defense Strategy. (U.S. Air Force photo by Airman 1st Class Spencer Slocum)

The U.S. Secretary of Defense released a memorandum on December 20, 2019, that outlined the establishment of the U.S. Space Force.

The Fiscal Year 2020 National Defense Authorization Act establishes the United States Space Force as a new Armed Force within the Department of the Air Force.

The creation of the U.S. Space Force is the most significant reorganization of the Department of Defense (DoD) since the Goldwater-Nichols DoD Reorganization Act of 1986, and the first new Armed Force since the United States Air Force was authorized by the National Security Act of 1947.

Establishing the U.S. Space Force will elevate the role of space in our national defense and transform how DoD organizes, trains, and equips in order to prepare for new security challenges in an era of great power competition.

Standing up the U.S. Space Force as a new Armed Force will require commitment, time, and focus across the entire DoD. Under my guidance, direction, and oversight, the Secretary of the Air Force will lead implementation of this legislation with the support of all DoD Components.

The long-term vision of DoD remains to consolidate the space forces of all Armed Forces into the U.S. Space Force, as appropriate and authorized.

The Secretary of the Air Force will build upon planning efforts to date in order to rapidly and effectively stand up the U.S. Space Force, subject to law. The Department has the opportunity to build a new Armed Force guided by joint principles but with a mission and culture unique to space operations.

First, the U.S. Space Force will cultivate space domain-specific expertise and serve as the DoD proponent of and advocate for space power.

The U.S. Space Force will develop and integrate into the Joint Force the space doctrine, capabilities, and personnel our Nation needs to outpace future threats. Second, the U.S. Space Force must be effective and efficient.

It will remain mission-focused by leveraging infrastructure of the U.S. Air Force, except in performing those functions that are unique to space or central to the independence of the new Armed Force. Third, the U.S. Space Force will not be limited to existing organizational models.

It will be built from the ground up with a focus on speed, agility, and partnerships within DoD, within the U.S. Government, with allies and international partners, and with the private sector.

Finally, the space acquisition enterprise should be rationalized as the U.S. Space Force is established.

I expect the full support of all DoD Components in implementing this historic reorganization of DoD space forces.

The Secretary of the Air Force shall provide me with regular progress reports on the stand-up of the U.S. Space Force and the Deputy Secretary of Defense will lead regular Space Governance Committee meetings. The success of the U.S. Space Force is vital to our Nation's ability to compete, deter, and win.

President Donald Trump speaks during an event at Joint Base Andrews, Md., Dec. 20, 2019. Trump visited Andrews to thank service members before signing the National Defense Authorization Act of 2020, which support the Air Force's advanced capabilities to gain and maintain air superiority and the Airmen that are essential to our nation's success. U.S. Air Force photo by Airman 1st Class Spencer Slocum.

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Secretary of the Air Force, Barbara Barret (l), General Jay Raymond, Chief of Space Operations and Commander, U.S. Space Command (c), Deputy Assistant Secretary of Defense for Space Policy, Stephen L. Kitay (r).

Secretary of the Air Force, *Barbara Barret* and General "*Jay*" *Raymond* conducted a briefing in December regarding the U.S. Space Force. The highlights follow...

Secretary Barret opened the session by saying, "*The U.S. Space Force will protect America's national interests by its singular focus on space. The United States has the best space acumen in the world. Still, now is the time to establish a team, a separate service totally focused on organizing, training and equipping Space Forces.*

"We are moving forward with alacrity and in accordance with presidential direction, congressional legislation and DOD guidance. The Air Force Space Command airmen are today assigned to the U.S. Space Force. Personnel assigned to the initial Space Force headquarters located within the Pentagon will now take over the Space Force planning."

Directing this effort with the secretary is General "*Jay" Raymond*, commander of U.S. Space Command. General Raymond is a career space officer and Barrett said that he is the perfect person to guide this lean, agile, vital Space Force.

General Raymond commented, "*With the establishment of the United States Space Force, we are elevating space commensurate with its importance to our national security and the security of our allies and our partners.*

"In August of 2019, we established the United States Space Command — a warfighting command whose mission is to conduct space operations, to deter conflict from beginning or extending into space, to defend our vital interests in space, to deliver space capabilities to our joint and coalition partners and to develop space warfighters.

"We now elevate the United States Space Force to a separate service. Let there be no mistake, the United States is the best in the world in space today and today, we're even better. Consistent with our National Defense Strategy, the United States Space Force will ensure we compete, deter and win from a position of strength, securing our way of life and our national security.

"I am honored to serve alongside our space professionals who are the source of our great strength. As we stand up this new service, I am committed to taking care of our space professionals and their families and will ensure the uninterrupted execution of ongoing critical space missions.

"Together, the Space Force and the Air Force will control the high ground and — and deliver great advantage for our nation. The establishment of the Space Force truly launches us into a new era."

The press were invited to ask questions of both the Secretary and the General, the highlights of which were:

- *The U.S. Space Force will be comprised of about 16,000 Air Force active duty and civilian personnel and they will immediately become the Space Force.*
- *A phased construction and development of this force revolves around a 30 to 120 day program that will bring additional personnel into the service.*
- *The difference between U.S. Space Command and U.S. Space Force is that the former is the warfighting component and the latter organizes, trains and equips the forces. U.S. Space Command remains solely focused on the warfighting aspects of space and is a major command within the U.S. Air Force, reporting directly to the Secretary of the Air Force.*
- *The newly enacted law provides planning for as many as 18 months to complete the build. In 2022, the budget for Space Force should be completed.*
- *General Raymond said that the U.S. Army, U.S. Navy and the National Guard and service reserves will all be partners in the new service, with the U.S. Air Force starting this work during year one.*
- *The Secretary of Defense, Kitay, noted that the long term vision of the DoD is to consolidate the number of space missions across the services directly into the Space Force.*

www.spaceforce.mil

DISPATCHES

GAO's analysis of DoD's SATCOM processes

The Department of Defense (DoD) has conducted a comprehensive analysis of alternatives (AOA) process for wideband satellite communications, through an assessment of the AOA against relevant GAO best practices.

A comprehensive analysis of alternatives process indicates that the analysis team thoroughly addressed a wide range of possible satellite system alternatives.

DoD used multiple methods to obtain stakeholder input, in accordance with its Wideband AOA study plan. For example, the study team incorporated input from across the military services and operational users, among others. Moreover, the U.S. Air Force and Defense Information Systems Agency (DISA) conducted interrelated studies to provide additional information to the Wideband study team.

DoD's analysis concluded that integrating military and commercial systems into a hybrid architecture would be more cost effective and capable than either acquisition approach alone. However, DoD also found that it needs more information to select its next satellite communications architecture and made recommendations for further study. Examples of these recommendations include:

Develop an enterprise satellite communications terminal strategy – DoD found the magnitude of replacing user terminals to work with new systems was challenging and that more information on emerging technology and possible changes to terminal acquisition approaches would help DoD address this challenge.

Invest in commercial technologies – DoD found that it lacked detailed technical information on commercial systems' cyber protections and that additional information on such protections would help DOD determine the extent to which they would meet DoD's needs.

Such recommendations align with GAO's acquisition best practices for knowledge-based decision-making and have the potential to improve the department's satellite communications acquisitions.

However, DOD stakeholders said there is no formal plan to guide and coordinate implementation of the AOA recommendations. Without such a plan, DOD is at increased risk of not having the information it needs to make timely, knowledge-based decisions on future systems to provide critical communications for military operations.

DoD officials estimate spending an average of $4 billion each year to acquire and sustain wideband satellite communications that provide fast and reliable voice, video, and data transmissions critical to military operations. DoD is considering how to meet its future wideband needs across many different operating environments and scenarios. The National Defense Authorization Act for Fiscal Year 2016 required DoD to conduct a Wideband Communications Services AOA to identify ways to replace current systems as the satellites reach the end of their service lives.

The National Defense Authorization Act for Fiscal Year 2017 contained a provision for GAO to assess DoD's analysis. This report addresses (1) whether the Wideband AOA was comprehensive, (2) how DoD solicited input from stakeholders, and (3) the conclusions DoD reached through the Wideband AOA.

GAO reviewed the Wideband AOA with DOD policies, documentation, and analyses; interviewed DOD officials and commercial stakeholders; and assessed the AOA against best practices for a comprehensive AOA process.

GAO is recommending that DoD develop a plan to guide implementation of the Wideband AOA recommendations. DoD provided technical comments on a draft of this report, which GAO incorporated as appropriate.

For more information, contact Cristina T. Chaplain at chaplainc@gao.gov.

Boeing-built WGS-11 Targets 2024 for delivery to USAF

Artistic rendition of WGS satellites. Image is courtesy of Boeing.

Boeing [NYSE: BA] recently reported that the company has developed a new variant of its 702 satellite for the U.S. Air Force's Wideband Global SATCOM (WGS) constellation, one that offers greater bandwidth efficiency and signal power than previous satellites in the fleet.

The new WGS-11 will be delivered on a recently negotiated contract award from the U.S. Air Force.

Advances in Boeing digital satellite technology mean WGS-11 will deliver hundreds of coverage beams and provide a more flexible and efficient use of bandwidth.

These innovations will enable the spacecraft to support more users in theater and allow dedicated beams to follow aircraft in flight.

WGS provides dedicated high capacity broadband communications connectivity to U.S. and allied forces around the world and Boeing has been the lead contractor on the program since it began in 2001.
Troy Dawson, Boeing Vice President, Government Satellite Systems, said the WGS-11 incorporates the latest advances in Boeing commercial satellite technology combined with a resilient and robust design specifically for military use in contested environments.

The company looks forward to delivering this critically important asset to the U.S. Air Force in 2024.

The mission of the Wideband Global SATCOM (WGS) system is to provide broadband communications connectivity for U.S. and allied warfighters around the world.

WGS is the highest-capacity military communications system in the U.S. Department of Defense arsenal, providing a quantum leap in communications capability for the U.S. military.

Boeing's investments in phased array antennas and digital signal processing, combined with innovations in the commercial satellite market, have resulted in a flexible WGS system that delivers the capacity, coverage, connectivity and control required by the most demanding operational scenarios.

The U.S. Air Force MILSATCOM Systems Directorate at Los Angeles Air Force Base (AFB) is the WGS customer.

WGS is designed for coverage, capacity and connectivity,with each satellite designed for high-data-rate communications providing full-motion video (FMV) and sensor data gathered from remote piloted aircraft; video teleconferencing among military leaders around the world; and critical communications for humanitarian efforts and deployed forces.

Through frequency reuse and digital channelization, each WGS payload provides bandwidth-efficient communications to respond to evolving mission demands.

Operating at X-and Ka-band, the system enable networks for tactical Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR).

The dual-band system allows tens of thousands of users with military wideband terminals to operate seamlessly, anytime, anywhere. WGS is the backbone of U.S. Department of Defense (DoD) satellite communications, providing more than 75 percent of tactical wideband communications.

The WGS design includes 19 independent coverage areas. Ten Ka- and 8 X-band beams can be positioned anywhere in the field of view of each satellite.

Full-Earth coverage in X-band is also provided. Use of phased array technology allows the eight X-band beams to be steered and shaped to apply gain and power exactly where it's needed.

Communications between users are enhanced using the digital channelizer, which allows for very efficient use of a satellite's bandwidth. It divides the uplink bandwidth into nearly 1,900 independently routable sub-channels, providing the connection from any uplink coverage area to any downlink coverage area.

WGS satellites have features to operate in contested environments and updates will include anti-jamming capabilities through two programs currently under development at Boeing in partnership with the U.S. Air Force: the Mitigation and Anti-Jam Enhancement (MAJE) program and the Protected Tactical Enterprise Service (PTES) program.

The MAJE program is a ground-based anti-jam upgrade that will use the existing capabilities of the WGS satellites to geolocate from where interference is coming and shape beams to mitigate the interference.

The PTES program, a new global military satellite communications ground system, will use the wide bandwidth available per beam on WGS satellites to transmit the Protected Tactical Waveform, one of the U.S. Department of Defense's secure, anti-jam waveforms.

PTES will soon also manage Protected Tactical Waveform transmissions over commercial communication satellites and terminals.

BOEING

Sierra Nevada Corp. and Air Force Research Lab one step closer to rocket's reality

Testing the Vortex engine.
Photo is courtesy of Sierra Nevada Corporation.

Sierra Nevada Corporation (SNC) reports they are one step closer to testing the VR35K-A, a commercialized version of the VORTEX engine system, a project that is under development in a combined effort with the Air Force Research Laboratory (AFRL).

With its patented VORTEX™ engine technology, SNC is one step closer to testing a brand new version of its low-cost, high-performance upper stage rocket engine.

The VR35K-A, developed in conjunction with the Air Force Research Laboratory (AFRL), is a commercialized version of the VORTEX engine system.

The team will provide a fully integrated engine, leveraging technologies initially developed under Small Business Innovation Research (SBIR) programs.

SNC's owner and CEO, *Fatih Ozmen*, stated that the company is committed to using technology that is cutting-edge, but also cost-effective, and the VR35K-A is a great example of both.

Ozmen added that this solution shows how small business technologies can be accelerated into valuable applications for commercial and military use.

SNC partners with several other small businesses for components and key subsystems of the engines.

SNC is expanding on its legacy success with the VORTEX technology, using it as the baseline for the next-generation liquid oxygen and liquid hydrogen upper stage class engine.

State-of-the-art technology and a VORTEX flow field to cool the inner walls allows the new engine to be simpler, smaller and lower cost.

The overall size of the engine is also drastically smaller in comparison with traditional combustion upper stage engines, making it as much as 50 percent less expensive to operate.

Tom Crabb, Vice President of SNC's Propulsion and Environmental business unit, added that AFRL has a history of developing and discovering new technology that can be applied in air and space and they are pleased to continue their commercialization effort with them. SNC's VORTEX technology is truly a unique new value to future launches and they are both excited and motivated to see this program move forward.

Testing will continue at SNC's upgraded rocket engine test facilities near Madison, Wisconsin.

Several important commercial, civilian and military applications are planned, including small engines used in orbiting spacecraft and vehicles and larger upper stage engines for final orbit delivery.

Other launch and boost applications will also be tested.

Dr. *Shawn Phillips*, Chief of the Rocket Propulsion Division at AFRL, noted that AFRL is always looking for innovative solutions and SNC's VORTEX technology in the VR35K-A rocket engine adds a new high-performance and low-cost option to the upper stage engine capabilities space for launch providers.

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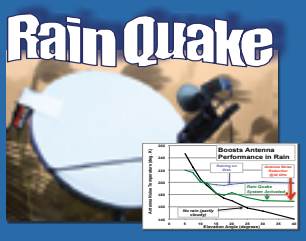

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DISPATCHES

Orbit Communications multi-role aviation terminal ordered by Inmarsat Government

The Multi-Purpose Terminal (MPT) 46WGX terminal. Image is courtesy of Orbit Communications.

Sample UAS preparing for takeoff. Image is courtesy of Wikimedia Commons.

Orbit Communication Systems Ltd. (TASE: ORBI) has announced an initial order from Inmarsat Government for Orbit's Multi-Purpose Terminal (MPT) 46WGX.

Orbit's MPT 46WGX is a 46 cm. (18-inch) modular, multi-role aviation terminal designed to be fully interoperable with military Ka-band systems and optimized for use over Inmarsat's Global Xpress constellation.

The order comes on the heels of a co-development agreement signed between Inmarsat and Orbit Communication Systems, announced on March 20, 2019.

Delivery of the satellite antenna systems is expected in early 2020 from Orbit's U.S.-based production facilities.

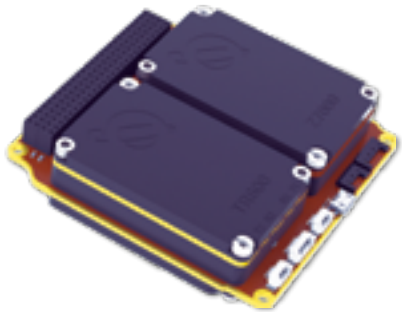
Stav Gizunterman, Vice President of Sales and Marketing at Orbit, said this volume production order, by one of the largest global government satellite service providers, is a strong endorsement of the company's MPT concept and its capabilities. Partnering with Inmarsat has greatly accelerated and enhanced Orbit's development efforts and products.

Steve Gizinski, Chief Technical Officer, Inmarsat Government, added that the company's close work with Orbit Communication Systems has helped ensure rapid development of the innovative new MPT 46WGX terminal.

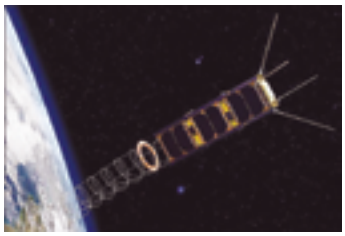
He added that Inmarsat Government looks forward to starting operations with this terminal to expand interoperable connectivity solutions for highly mobile government airborne users.

DISPATCHES

GomSpace to deliver SDRs for geo-intelligence use



The GomSpace SDR platform is used for a high-speed S-band ground link and for inter-satellite links using S- or K-band in a highly miniaturized radio system for long distance communication.



The GOMX-3 spacecraft in deployed configuration (image credit: GomSpace, NASA)

GomSpace has signed a contract with an existing customer on the North American market in the geo-intelligence industry for the delivery of a software defined radio (SDR) modules and antenna systems — the contract is worth 7.9 million SEK and will be fully delivered in 2020.

On GOMX-3, the SDR platform is used for signal sensing with an L-band antenna for spectrum characterization. Significant calculation capacity for advanced signal processing and detection techniques is available in a very compact design.

The FPGA module can be available for other advanced processing requirements such as image processing, etc., using the high capacity of the system.

Software is available for on-orbit programming or applying scripting tools limiting size of program uploads.

GomSpace has, over the years, built a strong product portfolio and on-orbit track record with its SDR modules and antenna modules helping customers to realize many different applications.

GomSpace CEO *Niels Buus* said that this is a significant win accelerating the company's growth in the North American market with a growing number of commercial and institutional customers depending on our products for radio payloads and satellite platforms.

Envistacom receives multi-task order from the U.S. Army

An announcement from the U.S. Army's Product Manager Satellite Communications (PdM SATCOM) stated that Envistacom has been awarded a $47.8 million, three-year award to support the Deployable Ku-Band Earth Terminal (DKET) program.

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

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

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

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

Nelson Santini, Senior Vice President of Sales at Envistacom said Envistacom will help support the Army's PdM SATCOM achieve its modernization goals through the implementation of virtualization, and other new technologies.

The company is pleased to have been selected for such an important program providing satellite transmission capability within the Department of Defense (DoD) global network for almost 20 years.

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

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

ENVISTACOM

Northrop Grumman's customer plans for first flight of OmegA™

Northrop Grumman's OmegA rocket will launch up to two satellites manufactured by Saturn Satellite Networks in the spring of 2021. Image credit: Northrop Grumman

Northrop Grumman Corporation (NYSE: NOC) announced that Saturn Satellite Networks (SSN) has selected the OmegA space launch vehicle to launch up to two satellites on the rocket's inaugural flight scheduled for spring, 2021.

OmegA will launch from Kennedy Space Center's Pad 39B and insert the SSN satellites into a geosynchronous transfer orbit.

Last October, the U.S. Air Force awarded Northrop Grumman a $792 million Launch Services Agreement to complete detailed design and verification of the OmegA launch vehicle and launch sites.

Northrop Grumman's OmegA rocket will launch as many as two satellites manufactured by Saturn Satellite Networks in the spring of 2021. Image credit: Northrop Grumman

Scott Lehr, Vice President and General Manager, Flight Systems, Northrop Grumman stated that the OmegA rocket expands Northrop Grumman's launch capabilities beyond their small and medium class rockets, which have successfully launched nearly 80 missions.

Scott noted that expanding the company's launch capabilities to the intermediate/heavy class with OmegA complements their national security satellite portfolio and enables them to better support their customers.

Jim Simpson, the CEO of Saturn, said the company is excited to launch Saturn's NationSat on Northrop Grumman's OmegA launch vehicle's inaugural mission. OmegA's performance, payload accommodations, and rigorous certification program assures them it is a great fit for NationSats and their customers.

Charlie Precourt, Vice President, propulsion systems, Northrop Grumman added that having Saturn's NationSat on board for this mission further demonstrates the versatility of OmegA to serve other markets including commercial and civil government.

Precourt continued and stated that their customer's mission comes first, whether OmegA is launching a commercial satellite or a national security payload. At the end of the day, they deliver the customer's spacecraft where it needs to go.

Precourt relayed that Northrop Grumman designed OmegA to use the most reliable propulsion available — solid propulsion for the boost stages and flight proven RL10 engines for the upper stage — to ensure exceptional mission assurance for their customers. He added that Northrop Grumman's technical expertise is both broad and deep, and they bring unmatched experience, stability and a strong customer focus to every partnership.

Northrop Grumman's history in space launch includes in 1990, the company developed Pegasus™, the world's first privately developed space launch system.

Additionally, the company's Minotaur launch vehicle has achieved 100 percent success on its 18 space missions and nine suborbital missions.

Northrop Grumman's Antares™ rocket has launched more than 70,000 pounds of food, equipment and supplies to the astronauts aboard the International Space Station.

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Commercial technology leveraged by SMC to enable WGS-11+ to deliver 2x capabilities

Wideband Global SATCOM (WGS)-11+ is a Space and Missile Systems (SMC) Center Pacesetter for the rapid application and fielding of commercial technology.

The SMC Production Corps and Portfolio Architect's Mission System Integration team jointly championed a successful first-ever, cross-corps Systems Requirements Review (SRR) to help the Government and Boeing reach a mutual agreement on a system performance specification to satisfy warfighter needs quickly.

The WGS program office, leveraging enterprise partnerships and a collaborative culture with Army, Navy, and Boeing systems engineers, worked closely together to ensure the system's technical baseline will maximize value to the warfighter on an aggressive 5-year schedule.

The WGS team, embedded at the Boeing facility, has been able to apply lessons learned from extensive testing performed by a similar commercial space program using the same digital payload technologies.

With SRR complete, the WGS-11+ team has initiated production and prototyping of Pathfinder hardware units to reduce risk for the final production build on its "Road to Preliminary Design Review" campaign.

WGS capability evolves significantly with each generation of spacecraft. WGS-11+ adapts innovative technologies to provide more coverage beams, more beam formed bandwidth and more frequency re-use than heritage systems.

WGS-11+ will be capable of forming unique coverage areas anywhere within the field of regard—each sized optimally as mission needs demand. The satellite will have much greater inherent resilience to threats than prior vehicles.

The ability to provide seamless broadband interconnectivity for X-band and Ka-band users, and features to operate in a contested environment—provide the global responsiveness for U.S. and Allied Forces to support missions ranging from warfighting to humanitarian relief efforts.

Additionally, the system remains a viable government host platform for rapid prototyping and additional enhancements with mission partners are being considered.
Colonel *John Dukes*, Chief of the Geosynchronous/Polar Division, SMC Production Corps, said the resilient design will deliver Combatant Commanders twice the mission capability through contested environments—improving capacity and coverage to soldiers, sailors, airmen and marines.

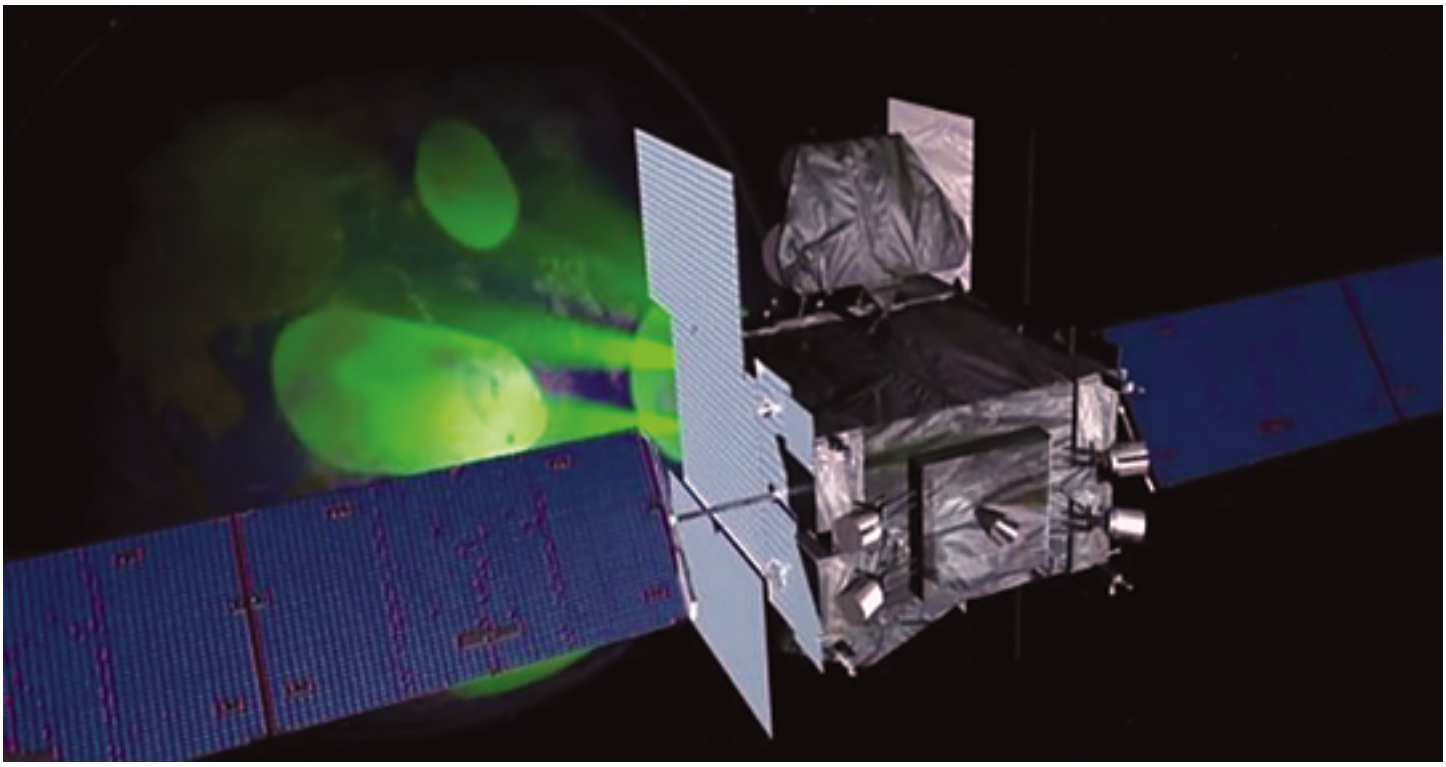
Dr. ***Mark Peterson***, WGS Aerospace Platform lead, noted that WGS-11+ enhances operational flexibility and performance to better serve the warfighter—the system will provide more coverage beams than the entire existing WGS constellation.

Major *Brandon Castillo*, WGS-11+ Program Manager, added that SMC is excited to deliver the warfighter.

Boeing developed a new variant of its 702 satellite for the WGS-11 addition to the constellation, one that offers greater bandwidth efficiency and signal power than previous satellites in the fleet.

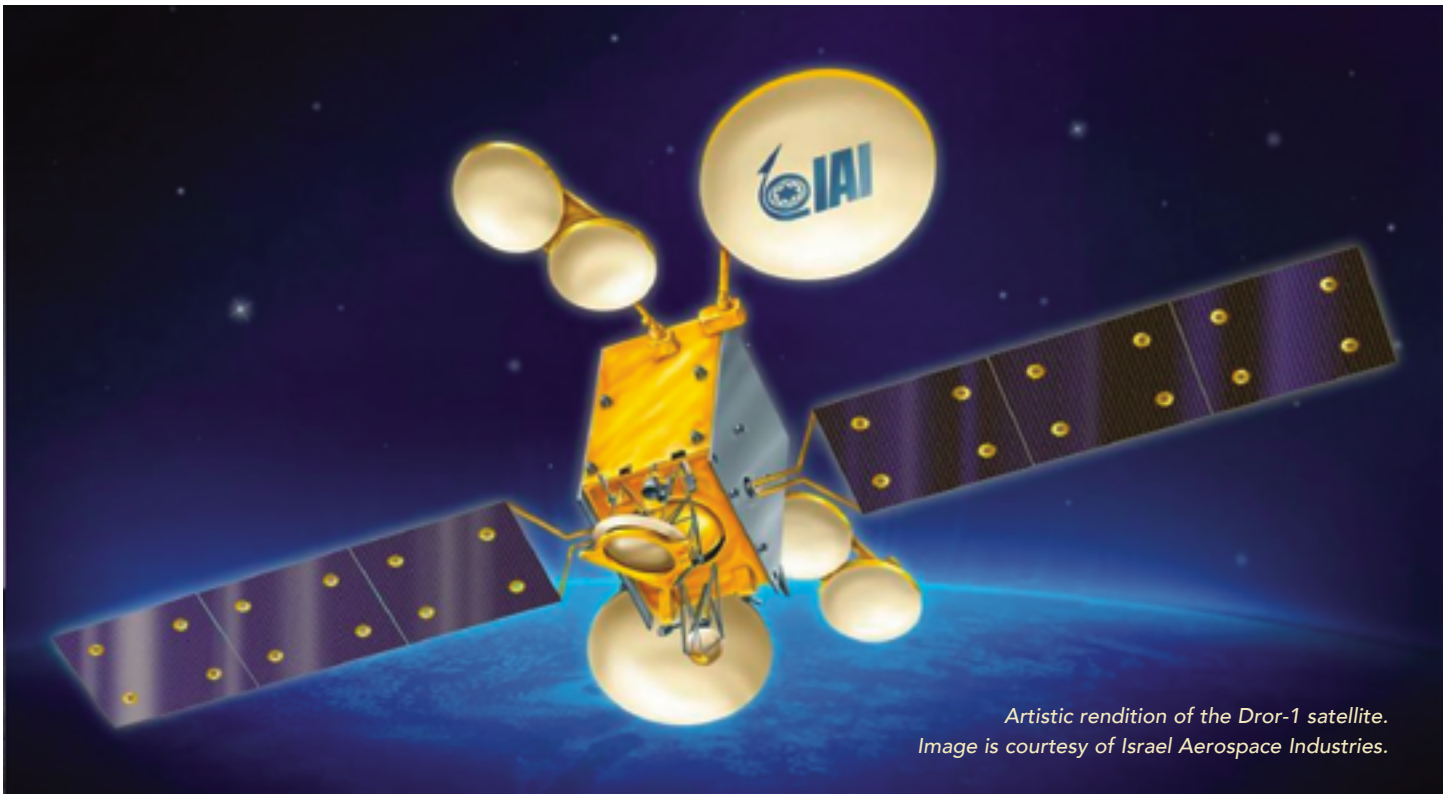
Advances in Boeing digital satellite technology mean WGS-11 will deliver hundreds of coverage beams and provide a more flexible and efficient use of bandwidth. These innovations will enable the spacecraft to support more users in theater and allow dedicated beams to follow aircraft in flight.

Troy Dawson, Boeing VP, Government Satellite Systems, said that WGS-11 incorporates the latest advances in Boeing commercial satellite technology combined with a resilient and robust design specifically for military use in contested environments, with delivery of this critically important asset to the U.S. Air Force in 2024.



Artistic rendition of WGS satellite. Image is courtesy of Boeing.

Israel Aerospace Industries set to build satellite for Israel



Artistic rendition of the Dror-1 satellite.
Image is courtesy of Israel Aerospace Industries.

Israel Aerospace Industries (IAI) will manufacture a highly advanced Dror-1 satellite for the Israeli government and will help to ensure that Israel remains technologically independent.

Dror-1 will be a national communications satellite that has a life expectancy of at least 15 years.

According to the agreement signed between Israel Aerospace Industries and the government, the development of the Dror-1 will require up to four years to complete and will cost approximately NIS 200 million ($58 million) to develop.

IAI is expected to use Israeli-developed technologies, for the most part, to build the satellite. This will include a digital communications payload and "space smartphone" capabilities to enable communication flexibility.

The project was initiated by the Israeli government that has been seeking to appropriately invest in a long-term SATCOM development plan that would also deliver the additional benefits of preserving Israeli knowledge and expertise that has been accumulated over the years.

The CEO of IAI, *Boaz Levi*, said that the company is proud to develop the Dror-1 satellite, the most advanced Israeli communications satellite ever built using various, domestic, developed technologies.

Levi added that this satellite's development will bring to fruition many years of experience and study that will be used in future Israeli satellites. He added that, in recent years, Israel Aerospace Industries has invested considerable research and development budgets and efforts to maintain communications satellite capabilities in Israel and the development of future communications satellites.

The company also developed the SHAVIT launcher, which offers various options for launching smallsats into Low Earth Orbit (LEO).

The launch system is based on flight-proven hardware and software with a unique integration and launch concept. This reduces significantly the launch preparation time, and consequently, offers lower launch costs.

The SHAVIT launcher system includes a mobile launch pad which provides a full testing capability. Unique is that this configuration enables its launch from a customer selected launch site.

The SHAVIT launcher has been operational for 30 years and is used to launch the Israeli OFEQ satellites.

CRUCIAL COMMS SUPPORT FOR HURRICANE DORIAN'S EMERGENCY EFFORTS

By Madison Musgraves, SDG Specialist for the Sustainable Development Practice, Maxar Technologies; Benjamin Kennedy, Customer Technical Solutions for BAE Systems' Geospatial eXploitation Products™ (GXP®) Group; and Lauren Vatier, National Planning Lead, Team Rubicon.

On the Saffi-Simpson Hurricane Wind Scale, the highest ran is a Category 5 storm, which has sustained winds at 157 miles per hour or higher.

When Hurricane Dorian slammed into the Bahamas and stalled for more than a day, it had wind gusts of up to 220 miles per hour. Before the storm, Marsh Harbour was the largest town on Great Abaco Island and served as the commercial hub, according to NPR. After the storm, NPR reported almost every building in Marsh Harbour was damaged or destroyed.

First responders can assess the extent of a disaster's damage prior to arriving on the scene, create plans based on the most recent data and more efficiently help those in need.

Team Rubicon leveraged the geospatial insights provided by Maxar imagery and BAE Systems software to deploy their military veteran volunteers to the hardest hit areas needing assistance after Hurricane Dorian.

As the world waited for damage reports from the Bahamas, Maxar activated its Open Data Program, releasing pre-hurricane and post-hurricane satellite imagery of the Bahamas.

This high-resolution data supported the humanitarian community by providing critical and actionable information to assist response efforts and fulfilling Maxar's purpose, *For a Better World*.

Simultaneously, Team Rubicon started notifying its response teams of military veterans to prepare to go to the Bahamas. They would be treating patients and assessing communities and medical clinics on Abaco Island before transitioning to clearing storm debris to accelerate recovery efforts.

Maxar's GeoEye-1 satellite imaged the downtown area of Marsh Harbour on Great Abaco Island before Hurricane Dorian on October 25, 2018 (left image) and after the hurricane on September 5, 2019.

This image shows part of an imagery product produced by a Team Rubicon GeoVis analyst over the town of Marsh Harbour on Abaco Island. The analyst used a Maxar WorldView-3 image collected after the hurricane hit the town and used GXP WebView to identify and annotate damaged homes and roofs.

Before they deployed teams, Team Rubicon needed to know where in the Bahamas these teams would have the greatest impact. Team Rubicon deployed 555 volunteers to the Bahamas to assist in the Hurricane Dorian disaster response and recovery efforts.

Maxar and BAE Systems have worked together since 2017 to provide Team Rubicon with the geospatial insights they need for planning and executing disaster response missions.

Leveraging Maxar's SecureWatch platform, BAE Systems integrates high-resolution satellite imagery of the affected area into a comprehensive

Team Rubicon deployed 555 volunteers to the Bahamas to assist in the Hurricane Dorian disaster response and recovery efforts.

This visual shows part of an imagery product produced by a Team Rubicon GeoVis analyst that identifies buildings of good structural status and high elevation on Abaco Island, The Bahamas. This was used for contingency planning and identified hardened locations for our deployed teams to evacuate to should a storm threaten the island.

ecosystem of software solutions developed by its Geospatial eXploitation Products (GXP) technology.

GXP Xplorer® provides Team Rubicon personnel with data discovery and management applications to quickly access Maxar imagery, as well as other types of data, from a web browser anywhere in the world.

With a direct connection to Maxar imagery, Team Rubicon's Geospatial Visualization (GeoVis) analysts can then stream those files in GXP WebView®, a web-based geospatial exploitation tool. This allowed analysts to determine heights, distances, and other measurements; create informative annotations; and publish imagery-based products to assist decision makers in the field.

Both GXP Xplorer and GXP WebView are deployed in the Amazon Web Service (AWS) cloud, allowing the GeoVis team to support operations from anywhere in the world, including their own home.

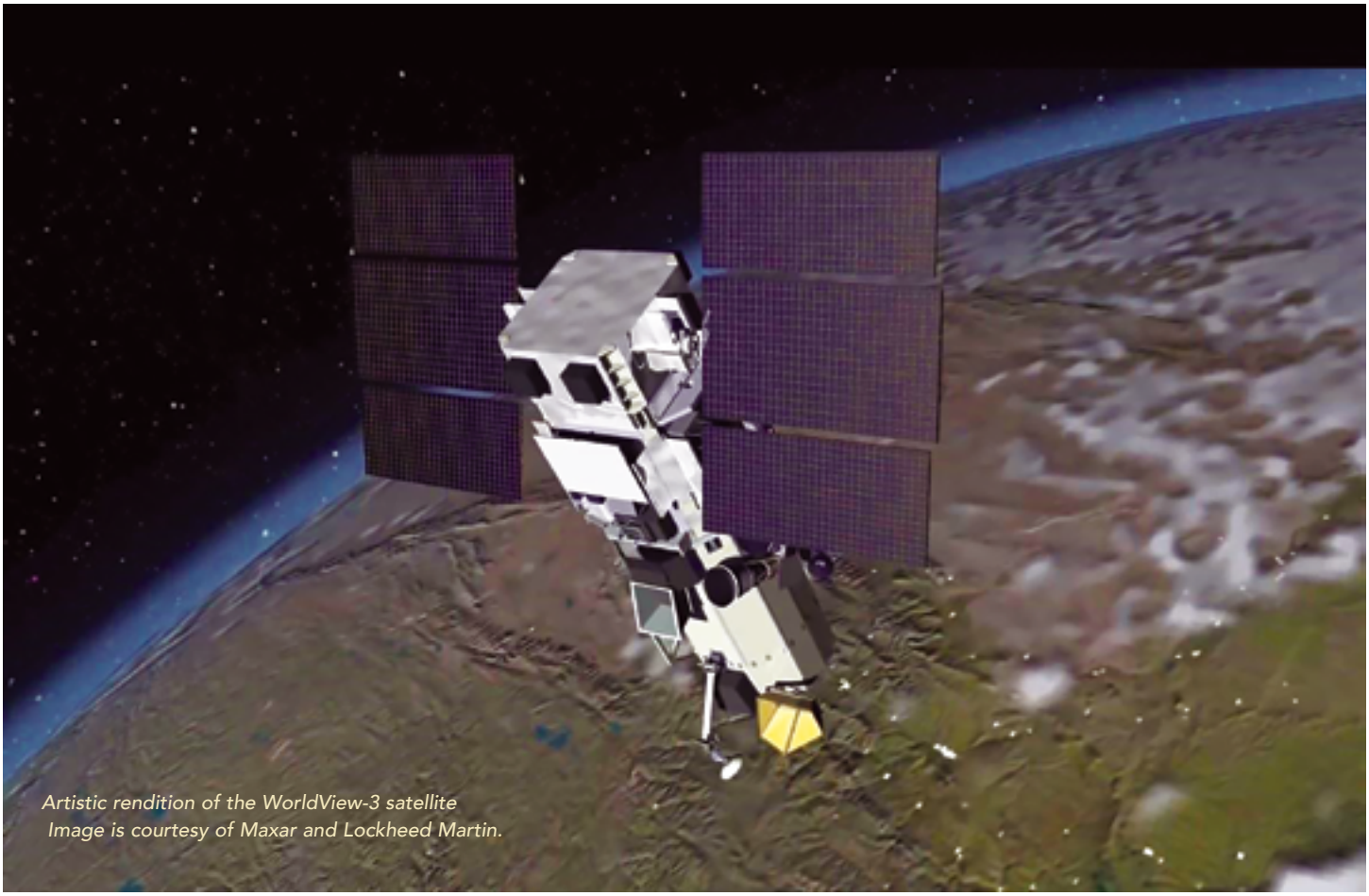
The analyst used a Maxar WorldView-3 image collected after the hurricane hit the town and used GXP WebView to identify and annotate damaged homes and roofs.

This integration of Maxar and BAE Systems capabilities allows Team Rubicon's GeoVis team to create geospatial situational awareness reports for the Planning and Operations Team at Team Rubicon.

These reports informed the deployments of medical teams and debris clearing teams.

The GeoVis team has been training for two years on how to create these reports based on Maxar imagery and BAE Systems' GXP software. Team Rubicon's GeoVis team encompasses approximately 100 volunteers, who typically build products and support mission planning teams remotely.

Over the last two years, the GeoVis training has been conducted as part of the PATRIOT North and South exercises, which are annual training exercises with the National Guard that prepare civilian and military entities to work together during a disaster.



Artistic rendition of the WorldView-3 satellite
Image is courtesy of Maxar and Lockheed Martin.

The first day is dedicated to learning how to use the software and build products, followed by three days of actioning requests injected into the exercise. This allows the volunteer to immediately apply the skills learned.

After the training, Team Rubicon will initiate the GeoVis team during large-scale disasters to provide situational awareness and help Team Rubicon make informed decisions after a disaster or humanitarian crisis.

The team is led by the National Planning Team and is now operating nearly independently. Team Rubicon volunteers muck out a community-focused facility in Abaco that would eventually be used to house a large number of returning survivors.

In the wake of Hurricane Dorian, the GeoVis team created more than 50 reports detailing things like concentration of damaged vs. destroyed properties, identification of potential locations our teams could stay, confirmation of roads blocked and identification of high-ground evacuation locations.

Team Rubicon leverages these reports to:

- *Deploy 555 volunteers to the Bahamas*
- *Provided medical care to 93 people and assessed 11 communities and medical clinics*
- *Cleared debris from over 375 homes/structures/roadways*

Team Rubicon puts Maxar and BAE Systems capabilities to work on the ground, exemplifying the power of geospatial data in disaster planning and response.

First responders can assess the extent of a disaster's damage prior to arriving on the scene, create plans based on the most recent data and more efficiently help those in need. This partnership is just one example of the work that Maxar and non-profit organizations can do together to make a positive difference in the world.

Maxar empowers non-profit organizations that uniquely benefit from the company's geospatial data and analytics to advance their global development efforts. These Purpose Partners, including Team Rubicon, reflect Maxar's purpose, ***For a Better World***. These organizations receive donations of imagery, analytics and service.

Article by Madison Musgraves, SDG Specialist for the Sustainable Development Practice, Maxar Technologies; Benjamin Kennedy, Customer Technical Solutions for BAE Systems' Geospatial eXploitation Products™ (GXP®) Group; and Lauren Vatier, National Planning Lead, Team Rubicon.

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DISASTER RESPONSE

THE GOVERNMENT SATELLITE REPORT

By Ryan Schradin, Executive Editor, GSR, and MilsatMagazine Senior Contributor

U.S. ARMY MODERNIZATION REQUIRES NEXT-GENERATION MILSATCOM TECHNOLOGY

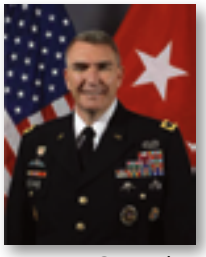
The network increasingly underlies all aspects of the modern battlespace. Whether it's because strategic concerns require forces to be more distributed or the increasing complexity of naval systems, it's undeniable that innovative ways of getting data to the edge are of paramount importance.

The Army is no exception — especially with the introduction of the IVAS system. This new system has the ability to immerse deployed soldiers in a bevy of data — from targeting information, navigational waypoints, or augmented reality inputs. The network that delivers the IVAS systems will be a key factor in achieving overmatch in land warfare in the near future.

The problem is, the U.S. Army is often deployed across the world, and many of those locations either don't have available terrestrial networks, or the networks that exist are denied or untrustworthy. This means the Army often lacks the trusted communications infrastructure necessary to power next generation applications. For these reasons, alternative means of connectivity in austere environments need to be considered as part of Army modernization initiatives.

Case in point — during the recent annual meeting of the Association of the U.S. Army (AUSA), Major General *Peter Gallagher*, who is leading the Army's drive to modernize its network infrastructure, shared a clear example why high-throughput MEO satellites need to be part of that solution.

Traditionally, the time it takes the military to design, develop, build and launch a new satellite means that, by the time they launch a new satellite, the technologies on it are no longer cutting edge.



Major General Peter A. Gallagher.

"*When I was at CENTCOM, we were selecting middle-earth orbit satellite constellations for certain heavy demand data exfil requirements from northern Iraq and Syria where we had to get a lot of data off target and transmit back. We didn't have access to fiber optic cable, so we leveraged commercial MEO constellations*," the General said.

Commercial operators have put the infrastructure in place, have proved it out, and are utilizing that capability across the globe.

This is the beauty of MEO satellite constellations like O3b mPOWER. Critical advancements in commercial satellite technology make it possible to beam incredible amounts of data to anywhere in the world, and that opens up previously inconceivable capabilities: live, 4K HD video; 3D printing in-theater; and real-time augmented reality to name a few, all without the latency associated with constellations in higher, geostationary orbit.

In Maj. Gen. Gallagher's example, this capability is already a boon to warfighters and is being deployed in one of today's most crucial

conflict zones — it's only going to be more important that the military can provide that level of network connectivity the world over.

When talking about how the force of the future will operate and laying out the roadmap for Army modernization, Lieutenant General *Stephen Fogarty*, the commander of U.S. Army Cyber Command (ARCYBER), made it clear that "*the network is the foundational weapons system.*"

That's because so many of the most exciting capabilities that will come out of Army modernization and that will grant the individual soldier unprecedented amounts of intelligence, surveillance, and reconnaissance (ISR) data — such as unmanned combat vehicles and helicopter-launched drones — need to send and receive huge amounts of data in real time order to be effective.

Before their data can be delivered to soldiers on the move, the personnel controlling these remote platforms need to retain control and literally keep them flying, and the drones themselves need to offload the incredible amount of ISR data that their ever-increasing number of sensors are picking up.

As SES Government Solutions' *Eric Gunzelman* said in a recent interview, "*When you combine the data generated from airframe sensors and the data generated by ISR sensors, it's easy to see why the amount of bandwidth needed to and from the aircraft has jumped significantly. In fact, I recently read an Avascent industry briefing that showed the total number of UAVs and the total data rate from those UAVs will both double between 2015 and 2025. That's going to require a lot more bandwidth.*"
This point also highlights an implication of what both Generals *Gallagher* and *Fogharty* alluded to in their AUSA remarks. Two of the men entrusted with the task of Army modernization expect the role of network connectivity to grow, which may very well mean that they'll need more bandwidth than what the current purpose-built, military satellite infrastructure can provide.

That may be a challenge given the process of building and deploying government satellites.

Traditionally, the time it takes the military to design, develop, build and launch a new satellite means that, by the time they launch a new satellite, the technologies on it are no longer cutting edge.

By contrast, commercial satellite operators are constantly launching new satellites and replacing their older constellations, so the volume of satellites they're launching simply gives them more of an opportunity to deploy breakthrough technology than what the government can do by its own devices.

Consequently, if the government takes advantage of this satellite renaissance, it may mean more secure bandwidth and less latency at a faster rate.

As cases such as the one Maj. Gen. *Gallagher* described continue to arise, making use of already-trusted, still-expanding commercial resources like high throughput MEO satellite constellations may be one more way that our military can guarantee its technical overmatch against any potential adversary.

The post U.S. Army modernization requires next-generation satellite technology appeared first on GovSat.

INTEGRATED SATELLITE ARCHITECTURE ESSENTIAL FOR MULTI-DOMAIN OPERATIONS

General David Goldfein, Chief of Staff, U.S. Air Force. Image is courtesy of the Air Force Association.

The vignette presented by Chief of Staff of the U.S. Air Force Gen. David Goldfein at the recent Air Force Association Air, Space and Cyber Conference was meant to illustrate an awe-inspiring military of the future — one capable of operating in multiple domains simultaneously to overwhelm an opponent with an incredible show of coordinated military force.

As Gen. Goldfein explained, his vision for future multi-domain operations, "*…isn't just about the domains…nor is it just about executing operations across these domains, we already do that now. Where we're going is to use dominance in one domain or many, blending a few capabilities or many, to produce multiple dilemmas for our adversaries in a way that will overwhelm them. This is where we're going.*"

A video presentation offered a fictional military situation being responded to by the military that Gen. Goldfein claimed we'd need in 2030 — and the force that he and his contemporaries are prepared to create for the nation. From my seat in the National Harbor's Gaylord resort, this presentation was certainly impressive.

The vignette illustrated an integrated and collaborative approach to multi-domain operations that showcased how sea, air, land, space and cyber operations could be pressed into service to quickly respond to escalating aggressions from an adversary and almost immediately repel a fictional invasion of an imaginary allied nation. While the vignette and presentation was impressive and aspirational, some in the room were also frustrated. That's because, while it incorporated coalition forces in practically every domain, it was obviously missing something that the U.S. Air Force (USAF) has claimed it would increasingly rely upon in the future — commercial satellites.

Why Commercial Satellite Matters

While there are many things that commercial satellite services could deliver to the military, there are two specific benefits that I really consider the most important — innovation and resiliency, both of which could have been used by the fictional force in Gen. *Goldfein*'s vignette.

USAF senior leadership has admitted on numerous occasions that the commercial satellite industry is the clear leader in space today. It's the leader because it moves quickly and must satiate the world's enormous appetite for satellite capacity. Commercial satellite providers are constantly building and launching new satellites to replace aging spacecraft and to fill the capacity requirements of their customers. With the nearly constant and rapid pace of satellite development, construction and launch, the commercial satellite industry gets frequent opportunities to incorporate the latest and greatest technology advancements into their satellites.

Compare this to how the military has traditionally operated. The military has been building and launching similar WGS satellites for a decade. The time it takes the military to design, develop, build and launch a new satellite means that, by the time they launch a new satellite, the technologies on it are no longer cutting edge.

When it comes to resiliency, commercial satellite providers have been long fighting against the misconception that their services are in some way less

resilient and secure than military satellites. There is a good reason why that misconception exists, there are demonstrated benefits to operating in the X band frequency, as satellite expert, *Phil Harlow*, recently articulated in another article on the *Government Satellite Report*:

"*With only ten [X band] WGS satellites in orbit, there is less chance of adjacent satellite interference. This means that more power can be put down from each satellite without fear of interfering with other, adjacent satellites (or being interfered with by other satellites). This higher power results in a stronger signal on the ground that further overcomes attenuation from environmental factors, increases throughputs and improves link reliability.*"

However, the small number of WGS satellites creates a resiliency problem itself. If a near-peer adversary is looking to deny the military's satellite services – which have long been a strategic edge for our military — they only have ten potential satellites to target. This lack of diversity makes it easier for enemies to target and deny satellite capabilities, which is why *Kimberly Morris*, satellite communications operations division head at the U.S. Naval Network Warfare Command, recently called for an increase in satellite options when she said, "*We need diversity – we need a wide range of diversity*," at the Milsatcom USA Conference.

By using commercial satellites in conjunction with military satellites, the ecosystem of potential satellites that could be carrying military signals increases from ten to more than 150. This can help to disrupt an adversary's targeting calculus as well as provide back-ups, should military satellites be denied.

As Morris said at that same event, "*You go after our [military-owned] systems, I've got something else that I can get to. Historically, with a lot of the weapon systems that are brought to bear in the modern age, it's not the primary system that has been a hero, it's the secondary system, because the enemy puts so much effort into taking out that primary system.*"

With the potential to increase resiliency and bring new, innovative solutions to bear, it's clear that commercial satellite needs to be a part of military plans in the future. Why wasn't this presented in the vignette, especially as it could have been so beneficial?

What Could Have Been — and What Will Be

During Gen. *Goldfein*'s vignette, the two coalition military satellites being relied upon for communications in every other domain were jammed by adversary space assets.

The response of the coalition forces in the vignette were to bomb targets deep in enemy territory and relocate military spacecraft — which is an extremely time-consuming and risky response.

How would that have played out if this futuristic force was using a combined commercial and military satellite architecture?

First, the adversary would have struggled mightily to target the correct satellites. Today's commercial satellite industry operates innovative new satellites in more orbits than just the traditional geostationary orbit.

With more than 150 satellites in multiple different orbits — including GEO, MEO and LEO — that could have been transmitting military communications in theater, the adversary would have struggled mightily to identify which satellite to target for jamming or even kinetic attacks.

Should the adversary jammed or denied the correct satellites, the coalition forces in the vignette would have had an even easier, far less risky response should they have been using an integrated commercial and military satellite architecture.

They simply could have relocated a digitally-steered beam from a different commercial satellite —possibly even one in a different orbit — to deliver high-throughput, low-latency connectivity to the battlefield.

No jets would have needed to be scrambled, no military satellites would have needed to expend precious fuel to be repositioned, and no pilots' lives would have needed to be risked.

Ken Peterman

This is why *Ken Peterman*, the President of Government Systems at Viasat, recently told attendees at a recent panel discussion, "*… within government circles, support continues to build for a DoD, hybrid, multi-network adaptive enterprise so that the DoD has the improved resiliency, improved mobility and improved flexibility to take full advantage of commercial innovation.*"

Where do we stand with that "*hybrid, multi-network adaptive enterprise*," or integrated commercial and military satellite architecture?

I asked Gen. *John Raymond*, the Commander of United States Space Command, during a media roundtable at the Air, Space and Cyber Conference and he assured all that it's still on the table — even if not in vignettes.

General John Raymond.

When queried about the potential to use satellites of different sizes and in different orbits, General Raymond responded, "*I think what we'll see in the future is a more hybrid architecture which would provide us with more resiliency.*"

Adding commercial satellite to the military's network architecture and infrastructure was also a priority for Gen. *Raymond* moving forward.

When asked about the timing and roadmap toward this combined architecture, the General responded, "*[The Air Force] had several meetings with the commercial industry to partner with them on a vision going forward. I expect to publish a vision document towards that end in the coming months. We're here to work with industry and I think that the relationships that we have and that were provided to us by the National Defense Authorization Act will provide us great advantage.*"

Both the military and the satellite industry see the potential that an integrated commercial and military satellite architecture could have for our nation's multi-domain operations in the future.

If we're going to truly win the battle for space and use satellites as part of a military response that will, "*produce multiple dilemmas for our adversaries in a way that will overwhelm them*," then commercial satellite needs to be an integral part of the Air Force's plans now and into the future.

These articles first appeared at the GovSat infosite. To read additional, informative articles, please visit ***ses-gs.com/govsat/#***

Ryan Schradin is the Executive Editor of GovSat Report. A communications expert and journalist with more than a decade of experience, Ryan has edited and contributed to multiple popular online trade publications focused on the satellite, unified communications and network infrastructure industries.

Ryan also contributes articles about satellite news and trends and conducts written and podcast interviews for the GovSat Report. He also contributes to the publication's industry event and conference coverage, providing in-depth reporting from leading satellite shows. Ryan is a Senior Columnist for MilsatMagazine.

COTS PROCESSING EVOLUTION

By Scott Anderson, President and Co-Founder,SEAKR Engineering, Inc.

Since the company's first contract in 1983, SEAKR has won, developed, and delivered hundreds of processing based subsystems for spacecraft payload applications leveraging Commercial-Off-the-Shelf (COTS) technology. Almost 300 company units have launched and properly performed or are currently performing their mission today.

SEAKR's systems have found their way into critical, cannot fail subsystems for NASA, DoD and commercial satellites. SEAKR has been a pioneer pushing state-of-the-art solutions using COTS Central Processing Units (CPUs) and Field Programmable Arrays (FPGAs) to leapfrog traditional spacecraft systems. With 35 years fielding high performance systems, SEAKR has achieved invaluable insight to enable future applications requiring vast performance increase.

In the early 1990's, SEAKR's first flight systems were truly revolutionary and employed the commercial Motorola 68302 communication processor. At the time, this CPU was an enormous jump in performance over the leading rad hard MIL-STD-1750 CPU.

The success of this COTS processor led SEAKR to expand our portfolio to include the commercial Texas Instruments TMS320C40 CPUs for mission critical Digital Signal Processing (DSP) applications and a line of Power PC Single Board Computers including, the Motorola Power PC 603s, G4 and Freescale 8548. Needless to say, these COTS based processors crushed the standard issue rad hard CPU generations of their time period.

Jumping forward to the late 2000's and state-of-the-practice today, some systems and applications are shown below in ***Figure 1***. SEAKR's architecture approach over the years intentionally evolved to achieve flexibility and adaptability. SEAKR's Internet Router-In-Space (IRIS) launched the Application Independent Processor (AIP) architecture, and its implementation paved a milestone for coupling multiple Ku- and

Artificial Intelligence and machine learning is key to achieving the full promise of evolving new constellations. This requires unique, on board processing that has never previously been flown.

C-band transponders into a true layer-three-router. Quality of service, delay tolerant networking and other IP features were demonstrated.

As the name implies, the AIP processing system is highly adaptable to a wide range of On-Board Processing (OBP) applications such as image processing, data compression, communications processing, hyper-spectral processing, autonomous docking and high-speed switching. More than a half-dozen AIP based systems with vastly different missions and sensor types have been delivered and flown. Subsequently, the AIP architecture evolved into SEAKR's Cronus architecture, improving modularity, redundancy schema and upset mitigation through a centralized, switched fabric system configuration and control.

IridiumNext represents SEAKR's flagship program using Cronos Architecture with 81 Flight units delivered, 75 successfully launched into orbit and are performing brilliantly as the architecture network's core communication system. With this constellation, SEAKR now has over 900 SIRF V5 FPGAs and 225 MPC8548 PowerPC CPUs on-orbit.

With Cronus architecture as its foundation, the IridiumNext On-Board-Processor (OBP — s*ee Figure 2*) is a reconfigurable processor providing all necessary hardware, DSP firmware and software for inter-satellite communication, L-band subscriber links and Ka-band gateway and feeder links.

Re-programmability was a critical enabler for Iridium as they deployed the NEXT constellation and orchestrated transition from legacy

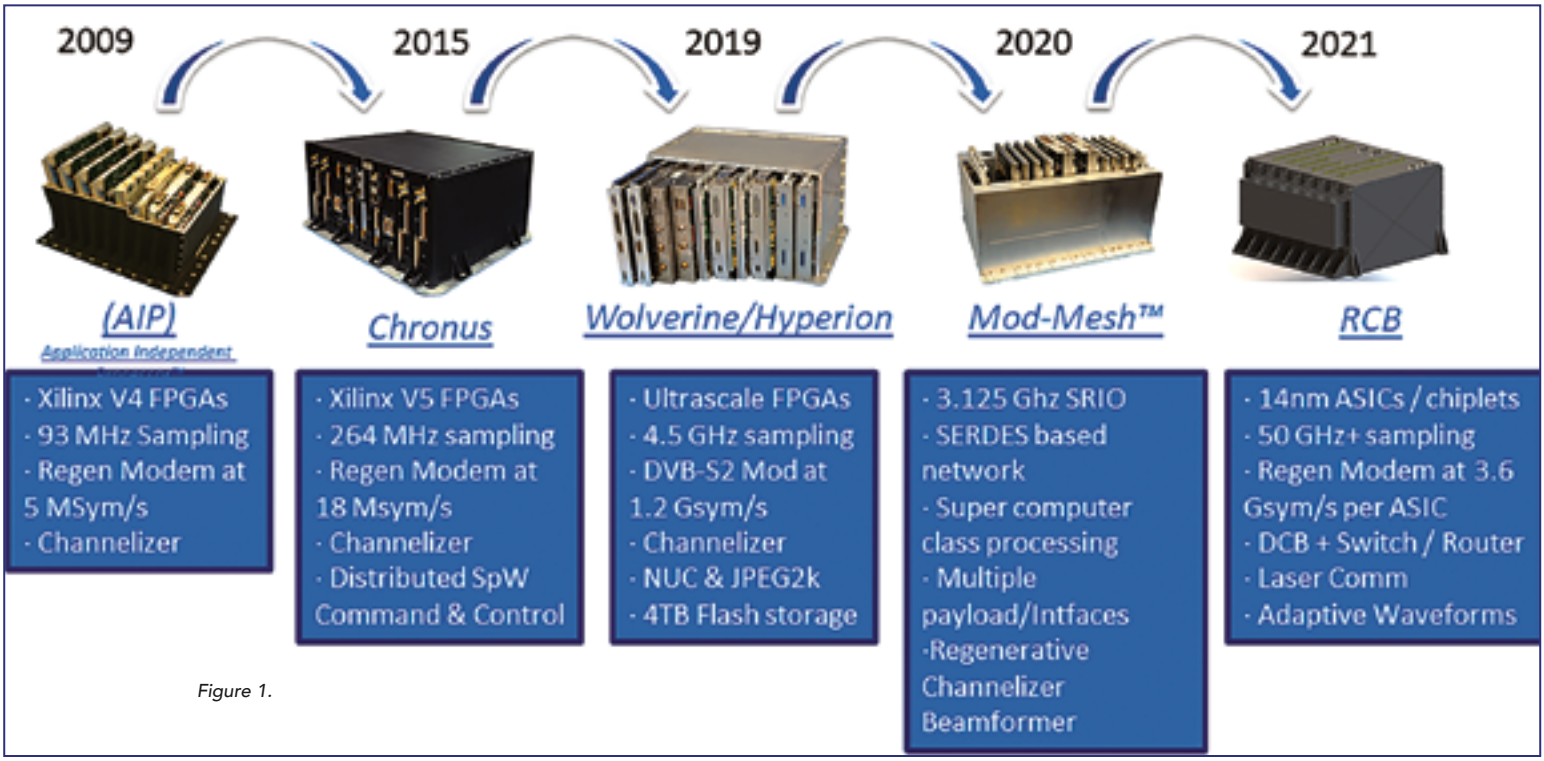


Figure 1.

Figure 2. Flight Iridium Next OBP.

functionality to enhanced NEXT features, while retaining backward compatibility. Further, the modular architecture provides enhanced redundancy management affording expanded processing capacity.

Wolverine (***see Figure 3***), a new RF processor, pushes the Cronos architecture to next generation Ultrascale FPGAs and employs dramatically higher sample rate Analog-to-Digital Converter/ Digital to Analog Converters (ADCs/DACs).

This RF processor provides approximately 10 Ghz of fully processed Ka- functionality and is baselined on four communication satellites — 2 GEO and 2 MEO.

With the architecture fully reconfigurable, SEAKR adapted it to be an image processor called Hyperion (***see Figure 4***).

The Hyperion system provides Non-Uniformity Correction (NUC), bad pixel replacement, binning, and multiple Gbps of image compression. Combined with high-capacity data storage, the same architecture can be applied to on-orbit feature detection for indications, targeting and tracking against threats. The Hyperion system will be used on eight different imaging spacecraft for two different customers.

Evolving further, SEAKR's newest qualified architecture is Mod-Mesh™ which leveraged and improved the VITA-78 (SpaceVPX) standard and provides a high-speed Serial Rapid I/O (SRIO) switch fabric with SpaceWire command plane.

The result is a modular and open systems architecture providing substantial flexibility in application instantiation, data management and movement, interface compatibility and 3rd party module integration.

This is achieved by SEAKR's open Interface Control Document (ICD) and 3rd party software or firmware implementation through Application Programing Interfaces (APIs) and wrappers respectively. In all architectures, agility is achieved through commonality, standard and mezzanine interfaces, base platform reuse, software modularity, logic design and verification reuse libraries and switched connectivity fabrics.

This network architecture can be and has been propagated throughout an entire spacecraft tying all payloads into one fully networked construct.

More than a half dozen spacecraft and multiple customers have adapted this state-of-the-art network for their spacecraft central nervous system and data flow.

Lastly, during the last 20 years, commercial communication satellites have increasing embraced digital processing rather than purely bent pipe architectures. SEAKR's contribution to next generation RF processing technology leverages commercial ultra-high sample, wide-bandwidth ADC/ DACs with digital beamforming, channelization, MODEM functionality, and multi Terabytes per second of network data flow to facilitate Terabit per second hybrid lasercom/HTS payloads.

New systems under development will start fielding two years from now.

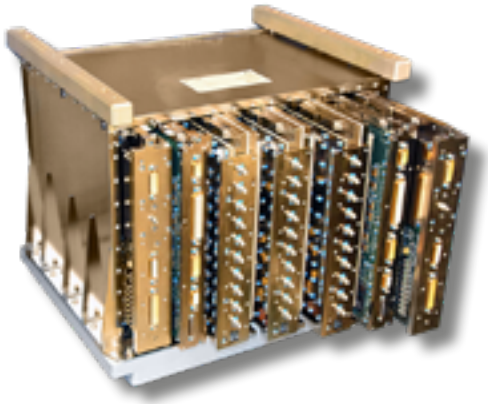
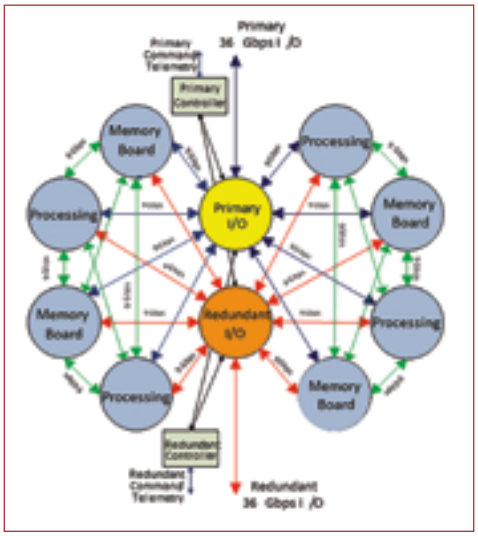


Figure 3. Wolverine Waterfall.



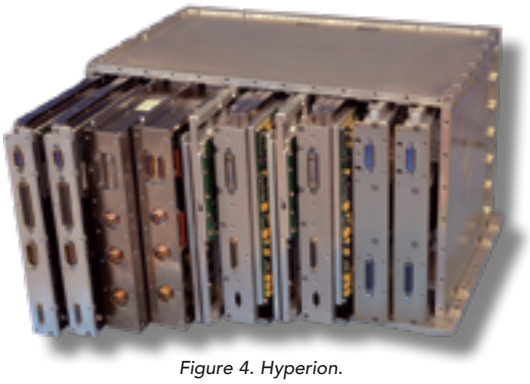


Figure 4. Hyperion.

What Next? The Future is AI

With multi-hundreds, if not thousands, of satellites in proposed constellations, how does one control and operation such systems? What if autonomous operation such as tip and queuing, fault isolation and autonomous spacecraft repair and/or replacements are required?

Artificial Intelligence and machine learning is key to achieving the full promise of evolving new constellations. This requires unique, on board processing that has never previously been flown. State-of-the-art 7nm electronics common in internet cloud computing centers and terrestrial edge computing will have to be used.

Toward this revolutionary processing capability for future constellations, SEAKR has recently been selected by DARPA to develop the Pit Boss processor for the BlackJack constellation. SEAKR will be bringing forward unprecedented autonomy and capabilities for this crucial USG program.

Scott Anderson is the President and Co-Founder of SEAKR Engineering, Inc..

PROTECTING SPACE ASSETS

By Rebecca Cowen-Hirsch, Senior Vice President, Government Strategy and Policy, Inmarsat Government

As a person who has always found space technology endlessly fascinating, I often think about how broadly satellite advancements touch upon the wide range of human experiences. In our blogs, we have frequently conveyed how satellite communications (SATCOM) supports the military mission.

However, we must also recognize that SATCOM helps us — governments, corporations, communities and citizens — forecast weather, use GPS applications, watch television programs, make phone calls, supply electrical power and respond to disasters, among many other use cases. The outcomes from space effect all aspects of our daily lives.

That is why we are growing increasingly watchful over the sustainability of the space domain across all orbits, including threats in geosynchronous (GEO) orbit. Risks to this domain from debris, other satellites and behaviors — unintentional or not —are increasing.

As a result, the space-operating environment has become more contested, degraded and operationally-limited, which drives the need for enhanced space situational awareness (SSA) to better protect assets in space.

It is about more than just data and more than just cataloging objects — it is about maintaining custody of data and supporting the command and control of these assets. Increased knowledge of the space domain and sufficient information to make informed and timely operational decisions for safe operation of satellites is required.

As more and more objects enter space, we will always seek improved information from this data to safely navigate this ever-changing and increasingly complex environment.

At the 8th Annual Space & Satellite Regulatory Colloquium in Washington, D.C., I had the opportunity to expand upon this topic during a panel discussion on space situational awareness (SSA). During the session, the question of "*Who is responsible to fix this*?" came up. Is it the government? Is it industry? My reply is, "***Both***."

Our satellite industry plays an essential and driving role in today's national security strategy rather than a secondary or reactive one. Across all domains and capabilities, the commercial industry continues to innovate and advance comparably and even beyond what governments can do. We pursue these accomplishments not as competitors to agencies, but as collaborators for assured, protected access to space.

SSA sharing proves critical for a safe and secure space domain. It fosters the openness, predictability and transparency of space operations. Our unprecedented SSA and supporting architecture provides timely indications and warnings of potential threats operating in orbit. As trusted operators, we have an obligation to operate responsibly in space and demand similar behavior from others.

The collection and analysis of data remains a critical component of SSA. We need data that tells us where our assets are, and how to operate in space in a way that does not put these assets at risk, *i.e.*, collision avoidance. We need data that pinpoints the presence and volume of debris. As more and more objects enter space, we will always seek improved information from this data to safely navigate this ever-changing and increasingly complex environment.

Toward this goal, Inmarsat is proud to be one of the founding members of the Space Data Association (SDA), an international coalition that brings together satellite operators to support the controlled, reliable and efficient sharing of data critical to the safety and integrity of the space environment and the radio frequency (RF) spectrum.

We all know the time-tested dogma, "*Rubbish in/rubbish out*" … If the data is not good enough, then the system is highly flawed. Through ongoing education and collaboration, the SDA seeks to inform our industry and government partners with an understanding that improving the data that goes into the system, the better our knowledge of the space catalog.

This is just one role that we as a trusted industry leader take on, so that the space environment is sustained for the long-term future. But, as indicated, we need government to step up as well, to federate the problem by leveraging industry-generated data and analysis. With this, the government can appropriate funding and develop a regulatory framework that incentivizes responsible activity while increasing costs for irresponsible operators.

However, this framework must be elastic as innovation continues to change the playbook. For example, the U.S. President's Space Policy Directive-3 (SPD-3) acknowledged that new debris mitigation rules are needed to adjust to changes in the environment, requiring greater agility.

"*Emerging commercial ventures … are increasingly outpacing efforts to develop and implement government policies and processes to address these new activities,*" states the directive. "*To maintain U.S. leadership in space, we must develop a new approach to space traffic management (STM) that addresses current and future operational risks. This new approach must set priorities for space situational awareness (SSA) and STM innovation in science and technology (S&T), incorporate national security considerations, encourage growth of the U.S. commercial space sector, establish an updated STM architecture and promote space safety standards and best practices across the international community.*"

With the Department of Defense (DoD) tracking more than 20,000 objects in space — a number that will rise dramatically as new, more capable sensors detect smaller objects — the "*volume and location of orbital debris are growing threats to space activities,*" the directive states. "*It is in the interest of all to minimize new debris and mitigate effects of existing debris. This fact, along with increasing numbers of active satellites, highlights the need to update existing orbital debris mitigation guidelines and practices to enable more efficient and effective compliance, and establish standards that can be adopted internationally.*"

Inmarsat wholeheartedly agrees and believes in responsible stewardship — it is in our collective interest to enhance the overall safety and sustainability of space. We are far past the time of simply "*admiring the problem*" and saying "*this is too difficult.*"

As President Kennedy told us in the immortal words of his "*We choose to go to the Moon*" speech, "*we do these things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win.*"

In addition, we as industry should shine a light on the challenges we face to the general public at large, while illuminating how satellites benefit our daily lives.

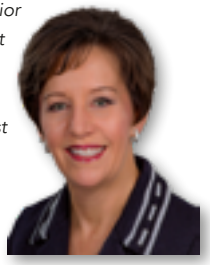
People respond to things that they care about and their support can help fuel forward momentum for continued progress among industry and government leaders.

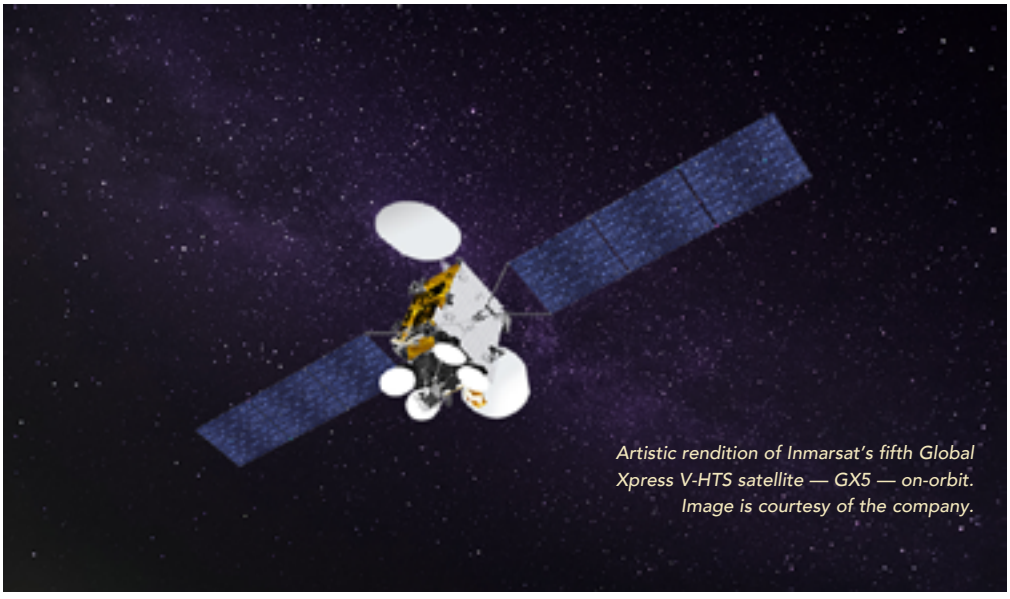
With that, we can ensure the protection of the space assets that impact us so greatly and positively, in so many ways.

This article first appeared at the Inmarsat Government blog infosite. To read additional, informative articles, please visit

www.inmarsatgov.com/news-events/news/?cat=blog

Rebecca M. Cowen-Hirsch is Senior Vice President for Government Strategy and Policy of Inmarsat's Government Business Unit and she is also a Senior Columnist to MilsatMagazine.





Artistic rendition of Inmarsat's fifth Global Xpress V-HTS satellite — GX5 — on-orbit. Image is courtesy of the company.

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