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5G MILITARY COMMUNICATIONS

5G will influence voice, video, text, and image communications to create data on demand for the battlefield. PAGE 12

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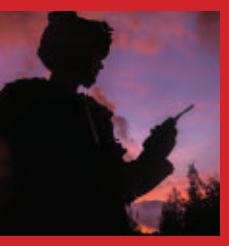

COVER STORY

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BY **JOHN KELLER**, EDITOR IN CHIEF

Future 5G capabilities for the military: the only limit is the imagination

One of the most intriguing aspects of next-generation military technology involves emerging fifth-generation wireless communications — better-known as 5G. While many of us see 5G as a slick and fast new cell phone technology, its potential for the military truly stretches the imagination.

What's exciting about 5G isn't what today's cell phone companies are touting — far from it. While the 5G cell phone services being rolled out offer incremental improvements in speeds and latency, the real promise of 5G for military civil applications will come later with millimeter wave 5G that will operate on frequencies between 24 and 300 GHz.

It is in this frequency range where military and civil authorities can start to use 5G for applications like control of swarming unmanned aerial vehicles (UAVs); augmented- and virtual reality for simulation, training and mission rehearsal; real-time intelligence, surveillance, and reconnaissance (ISR); distributed command and control; smart warehousing and logistics; and dynamic RF spectrum use.

Add artificial intelligence (AI), machine learning, and mobile ad-hoc networking (MANET) technologies, and the military capabilities really start to grow. The fast throughput of millimeter wave 5G has the potential to keep superfast microprocessors, general-purpose graphics processing units (GPGPU), field-programmable gate arrays (FPGAs), and other data-processing architectures fed — even when exchanging information from the tactical cloud.

MANET technology offers to switch communications channels quickly to other available RF frequencies when and if 5G signals are blocked, jammed, or out of range. All this would be transparent to the user, which will increase reliability for military and civil users alike.

5G capabilities will involve three frequency bands: low band, which operates at frequencies lower than 1 GHz; mid band, which operates at frequencies between 1 GHz and 6 GHz; and high band, or millimeter wave, which operates at frequencies between 24 and 300 GHz. Low band and mid band collectively also are called sub-6, and this is where all of today's so-called 5G cell phone services operate, with limited millimeter wave cell phone service rolling out in a handful of large cities.

There's a downside to fast 5G, however, and the biggest stumbling block is range. Millimeter wave signals can travel perhaps a mile under the best conditions, and usually a lot less in the presence of rain, tall buildings, mountains and hills, dense foliage, and any kind of electronic interference or electronic warfare jamming.

As a result, the military will need vastly more transmit-and-receive towers at fixed-site and mobile locations. This will mean substantial investment and additional time necessary to get military 5G services up and running — particularly in difficult terrain at the leading edge of the battlefield where commanders can anticipate enemy jamming or other kinds of interference.

Fortunately the U.S. military places a big priority on developing and deploying 5G capabilities. The Pentagon has designated several military bases as 5G test beds to try out enabling technologies and to device new 5G military applications. In October the military announced $600 million in contracts for 5G experimentation and testing at five military test sites, which represents the largest full-scale 5G tests for dual-use applications in the world.

More experiments are planned, which should reveal possibilities for bringing 5G capabilities to the edge of the battlefield, how to share 5G RF spectrum with civil communications networks, how to fold-in AI and machine learning to 5G applications, using augmented- and virtual-reality for simulation, training, and command and control, and for supplying forward-deployed warfighters in the field.

For now, however, 5G for the military remains in its infancy, with another couple of years necessary to mature today's 5G enabling technologies sufficiently to start deploying 5G where it's needed most. The military is on its way realizing this promising future; it just won't come as quickly as most military leaders would like.

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the E-4B Advanced Airborne Command Post for nuclear weapons command and control will receive an SSHF satellite communications upgrade from L3Harris.

L3Harris to upgrade SSHF satellite communications for E-4B airborne command post

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio — U.S. Air Force strategic communications experts needed a company to upgrade the survivable super high frequency (SSHF) satellite communications systems aboard the E-4B Advanced Airborne Command Post. They found their solution from the L3Harris Technologies Communications Systems West segment in Salt Lake City.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, announced a $23.8 million contract to L3Harris to perform survivable super high frequency (SSHF) satellite communications (SATCOM) upgrades to the E-4B aircraft.

The Air Force E-4B represents a fleet of four modified Boeing 747-200 jumbo jets that serve as survivable mobile command posts for the president of the United States, the U.S. secretary of defense, and other U.S. national command authorities.

When airborne, the E-4B operates as a national airborne operations center to enable national command authorities to maintain control over military conventional and nuclear forces if more conventional means of command and control have been destroyed or disabled from war damage or other disasters.

The E-4B's SSHF upgrades will improve and replace portions of the E-4B's SHF system to ensure continued connectivity and interoperability as satellite and communications infrastructure evolves.

Expected modifications include component and subsystem upgrades and replacement of portions of the current SHF system that are obsolete or near end of service life.

A replacement to the E-4B's SSHF system eventually will be necessary as secure and survivable communications capability switches from the Defense Satellite Communications System (DSCS) to the future Wideband Global (WGS) SATCOM system.

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While DSCS provides data transmission speeds as fast as 200 megabits per second, the WGS features data rates ranging from 2.1 to 3.6 gigabytes per second. Fourteen DSCS satellites were launched between 1982 and 2003, with eight of them still working. Ten WGS satellites have been launched between 2007 and 2019.

The E-4B aircraft is a survivable, command, control, and communications center to direct U.S. forces, execute emergency war orders, and coordinate civil authorities' activities, including national contingency plans.

The E-4B aircraft also has a low-frequency transmit system (LFTS) to send instructions to submerged ballistic missile submarines. The LFTS can transmit signals as strong as 100 kilowatts over low frequencies of 28 to 60 kHz — lower frequencies than commercial AM broadcast radio — to send encrypted text messages to submerged submarines.

The E-4B also maintains contact with other nuclear forces via advanced extremely high frequency (AEHF) SATCOM and other secure communications systems.

On this contract L3Harris will do the work in Salt Lake City and Offutt Air Force Base, Neb., and should be finished by April 2022. For more information contact L3Harris online at www.l3harris.com.

MDA wants enabling technologies for sea-based defense against hypersonic weapons

BY **John Keller**

HUNTSVILLE, Ala. — U.S. missile-defense experts are reaching out to industry for enabling technologies for future sea-based terminal defenses against hypersonic glide vehicles and other hypersonic missile threats.

Officials of the U.S. Missile Defense Agency (MDA) in Huntsville, Ala., have issued a broad agency announcement (HQ0851-20-S-0001) to define concepts for the Sea-Based Terminal Future Interceptor.

MDA officials want industry to submit concepts to maintain a layered defense based on a multi-mission terminal-phase interceptor that works together with all other midcourse weapons to engage and defeat future hypersonic threats.

The Missile Defense Agency is reaching out to industry to find enabling technologies for sea-based hypersonic missile defense.

Those responding should describe weapon system concepts, component maturity, missile defense integration approaches, estimated achievable performance, and technologies that require risk reduction.

Companies responding should describe the interceptor concept design, to include details counter-missile munitions hardware configuration, kinematic performance, rocket motor staging, inter-pulse delays, firing doctrine, fire-control methodology, guidance phases, homing sensor operation, and communications.

Companies also should describe all critical component technology maturity levels; a defended area performance assessment; weapon system concept support; terminal homing performance via multi-mode seeker; missile sizing to accommodate several packs in the Navy's shipboard Mk 41 Vertical Launch System (VLS); flexible warhead design with submunition concepts; Use of certified components; missile-to-missile communications ability; structural designs that accommodate maneuverability; and key Aegis Weapon System integration requirements or needs.

MDA officials say they expect ultimately to award several contracts that will be worth as much as $5 million each.

Companies interested were asked to email 35-page white papers, submitted at the secret level, by 13 Nov. 2020 to Contracting Officer, Jennifer Elkins at jennifer.elkins@mda.mil and to Contract Specialist Majesta Hartley at majesta.hartley@mda.mil.

MDA officials may issue a formal request for proposals based on responses to this solicitation by 13 May 2021. More information is online at https://beta.sam.gov/opp/1b315686fc674e6bbd86b39087adb551/view.

Military to hasten 5G adoption with large group of 5G wireless contracts

The U.S. Department of Defense (DOD) has awarded $600 million in 5G wireless experiment contracts as a part of the U.S.'s strategy to catch up in the development of the next-generation communications technology. The DOD has awarded smaller pilot contracts for 5G testing before, but this round of contracts represents the largest scale of testing done to date. The bases that will feature the 5G wireless communications test beds are Joint Base Lewis-McChord, Wash.; Naval Base San Diego; Marine Corps Logistics Base, Ga.; Nellis Air Force Base, Nev.; and Hill Air Force Base, Utah. The companies receiving 5G awards in this latest round of testing include AT&T, Ericsson, Nokia, KPMG, GE Research, Deloitte, Booz Allen Hamilton, General Dynamics Mission Systems, and many others. Using military bases to test technology enables companies to circumvent complex regulations.

Air Force sends software code updates in real time to flying aircraft

For the first time, the U.S. Air Force updated the software code on one of its aircraft while it was in flight. The service tested the technology aboard the U-2 spy plane, one of the oldest and most iconic aircraft in the Air Force's inventory. The U-2 Federal Laboratory provided updates to the software of a U-2 last month from the 9th Reconnaissance Wing during a training flight near Beale Air Force Base, Calif. To push the software code from the developer on the ground to the U-2 in flight, the Air Force used Kubernetes, a containerized system that enables users to automate software deployment and management. For the demonstration, the U-2 lab employed Kubernetes to run advanced machine-learning algorithms to the four flight-certified computers onboard the U-2, modifying the software in real time without hurting the aircraft's flight or mission computers.

Army to issue lucrative contracts for enterprise information systems

The U.S. Army's enterprise information systems office expects to release requests for proposals for several lucrative contracts in the next

Continued on page 11

Raytheon to provide air-to-ground smart munitions with tri-mode seekers

BY **John Keller**

The GBU-54/B StormBreaker smart munition uses millimeter wave active radar, semi-active laser guidance, infrared homing, and GPS-coupled inertial guidance to guide the weapon to its target.

EGLIN AIR FORCE BASE, Fla. — Smart munitions designers at Raytheon Technologies Corp. will provide the U.S. Air Force with more than 1,000 radar- and infrared-guided air-to-ground munitions under terms of a $239.1 million order.

Officials of the Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., to provide product lot six of the GBU-54/B StormBreaker — also known as the Small Diameter Bomb (SDB) II.

Like the GPS-guided GBU-39 SDB I already integrated on the F-35 joint strike fighter, the 208-pound StormBreaker is six to seven inches in diameter. This size can fit eight StormBreaker munitions in the F-35's confined internal weapon bays. If stealth is not a factor, about 16 more can fit on the F-35's wings.

The StormBreaker air-to-ground smart weapon can hit moving targets in bad weather. The winged munition autonomously detects and classifies moving targets in darkness, rain, fog, smoke or dust.

The smart munition for guidance uses millimeter wave active radar homing, semi-active laser guidance, infrared homing with an uncooled imaging infrared camera, GPS-coupled inertial guidance, and radio data-links back to the aircraft.

Its millimeter wave radar detects and tracks targets through weather; imaging infrared provides enhanced target discrimination; and its semi-active laser enables the weapon to track a laser designator on the aircraft, or on the ground.

The tri-mode seekers share targeting information among all three modes to engage fixed or moving targets any time, and in any weather. The weapon can also fly more than 45 miles to strike mobile targets.

The StormBreaker can launch from the F-35, as well as from the Navy the F/A-18E/F Super Hornet carrier-based jet fighter-bomber. It also is officially approved for operational use on the Air Force F-15E jet fighter-bomber.

On this order Raytheon will do the work in Tucson, Ariz., and should be finished by November 2023. For more information contact Raytheon Missiles & Defense online at www.rtx.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

Five companies to provide military machine learning and artificial intelligence software

BY **John Keller**

JOINT BASE ANDREWS, Md. — U.S. military information technology experts are asking five software companies to provide software engineering and machine learning expertise to the U.S. Department of Defense Joint Artificial Intelligence Center (JAIC) Missions Directorate in Washington.

Officials of the Air Force District of Washington at Joint Base Andrews, Md., announced separate contracts, each potentially worth $100 million, to the five companies, which

will provide JAIC with services in software development, machine learning expertise, cognitive and systems engineering, and user experience design.

The companies are:

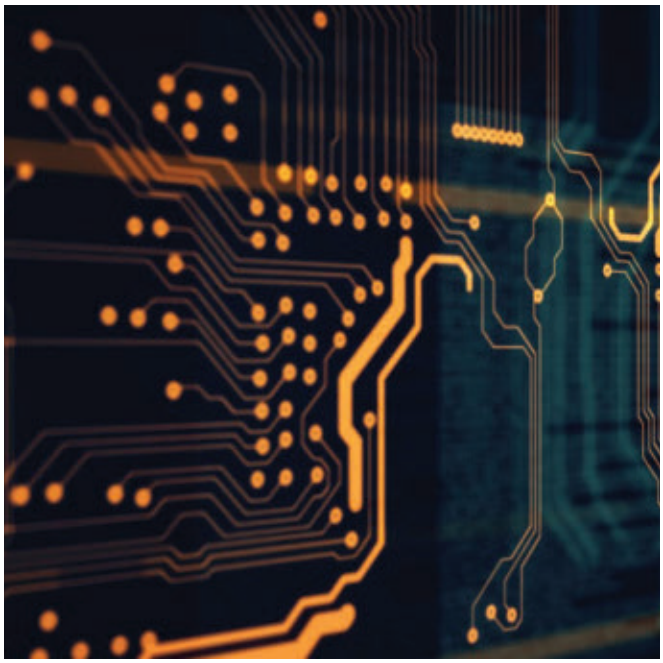
- Redhorse Corp. in San Diego;
- Cyber Point International LLC in Baltimore;
- Elder Research Inc. in Charlottesville, Va.;
- Barbaricum LLC in Washington; and
- Enterprise Resource Performance Inc. (ERPi) in Fairfax, Va.

The JAIC is the Pentagon's artificial intelligence (AI) center of excellence that helps the military harness AI for defense applications.

JAIC is in place to accelerate AI adoption for large and complex military systems and help defend military infrastructure from cyber attacks.

The center helps the U.S. military services apply AI technologies to military operations; warfighter health; threat reduction; logistics; and information warfare.

For more information contact the Air Force District of Washington online at www.afdw.af.mil, or the Joint Artificial Intelligence Center at www.ai.mil.



Five companies will provide software engineering and machine learning services to the Pentagon's artificial intelligence center of excellence.

Three information companies to provide special-ops computers and surveillance hardware

BY **John Keller**

Photo (above): Barbaricum LLC; iGov Technologies; and NexTech Solutions will provide the U.S. Air Force with intelligence, surveillance, reconnaissance, command, control, communications, computers, and services.

McDILL AIR FORCE BASE, Fla. — U.S. special operations experts are asking three information technology companies to provide intelligence, surveillance, reconnaissance, command, control, communications, computers, and services as part of a $780 million program.

Officials of U.S. Special Operations Command (SOCOM) at McDill Air Force, Base, Fla., announced three contracts collectively worth as much as $780 million on Friday for the Targeted Requirement Execution (T-REX) computers and surveillance equipment program.

Companies chosen are:

- Barbaricum LLC in Washington;
- iGov Technologies Inc. in Reston, Va.; and
- NexTech Solutions LLC in Orange Park, Fla.

These companies, acting as systems integrators and coordinators, will provide intelligence, surveillance, and reconnaissance (ISR) and command, control, communication, and computers (C4) related hardware and services to SOCOM.

These three companies will take over T-REX work from four contractors that were chosen in 2015 for the first T-REX project contract. Contracts for the original four contractors will expire at the end of this year.

The original T-REX contractors are:

- Advanced Technology Solutions Inc. in Oakhurst, N.J.;
- Barbaricum LLC in Washington;
- Leidos in Reston, Va.; and
- OSGSystems in Chantilly, Va.

The three latest T-REX contractors will provide equipment and services related to systems integration; hardware and modifications; specialized communications solutions and networks; and signal-processing capabilities.

The contractors will supply brand-name equipment in these four categories, as well as continuous increased capability and new technology insertions.

For more information contact U.S. Special Operations Command online at www.socom.mil.

Continued from page 7

few months. Ross Guckert, program executive officer at Program Executive Office Enterprise Information Systems, has laid out the office's top four highest-value contracts for the upcoming quarter, including multi-award contract for IT services worth as much as $10 billion. That contract, called Information Technology Enterprise Solutions-4 Hardware, has a base period of five years with five one-year options. According to industry day slides from July, the office plans for 17 awardees. A draft RFP will be released by the end of December. The final RFP is slated for release this spring. ITES-4H will provide the Army with IT services such as client, servers, storage and network environment, as well as maintenance of legacy platforms. ITES-4H is a follow-on for ITES-3H, which has 17 incumbents.

L3Harris Chesapeake to build TB-29X advanced submarine towed-array sonar systems

Undersea sonar designers at L3Harris Chesapeake Sciences Corp. in Millersville, Md., will build addition versions of the U.S. Navy's next-generation towed-array sonar to enable Navy submarines to detect, track, and classify quiet, modern submarine threats in open ocean and littoral waters. Officials of the Naval Sea Systems Command in Washington announced a $31.1 million order to L3Harris Chesapeake to build TB-29X towed arrays for Navy submarines. The TB-29X is the future-generation reliability improvement to the TB-29A. It is a 416 channel thin line towed array with an equivalent acoustic performance capability to TB-29A. The TB-29X is a thin line towed array passive sonar receiver that has the same form factor as the TB-29 array, yet offers increased capability, greater reliability and reduced obsolescence. Towed array sonar uses hydrophones towed on a cable trailing behind a submarine or a surface ship; it can be miles long. It's designed to keep the array's sensors away from tow vessel noise to improve its signal-to-noise ratio and its ability to detect and track faint contacts like quiet nuclear- and diesel-powered submarines and seismic signals.

What 5G means to the military

5G wireless communications is expected to move voice, video, text, and image data with bandwidth as fast as 300 GHz to create data on demand for the battlefield.

BY **John Keller**

Emerging fifth-generation wireless communications — better-known as 5G — will be far more than quick-connect phone calls and fast movie downloads, particularly for the U.S. military. 5G, in fact, could make reality of what military leaders as far back as the 1980s referred to as the "infosphere," where access to data from video, voice, sensors, targeting, reconnaissance, and even the sights on infantry weapons are easy and instantaneous for anyone who needs it.

5G holds the promise of ubiquitous high-speed data connectivity: vastly improved intelligence, surveillance, and reconnaissance (ISR); fast and secure command and control; more efficient logistics; swarming unmanned vehicles; and wide use of virtual reality and augmented reality for simulation, training, and mission rehearsal. The promise of 5G is for instant situational awareness anywhere on Earth, smart hypersonic weapons with re-targeting on-the-fly, rich access to mission-critical data on the leading edge of the battlefield, and unmanned aircraft that can fly safely alongside passenger aircraft in commercial airspace.

5G, however, will not come easily, quickly, or inexpensively. When compared to the overall 5G vision for the military, commercial interests, and for the consumer, the technology today is only in its infancy — despite the advertising we see on TV from cell phone providers. Bringing the 5G future to fruition will require time, much testing, experimentation, investment — and a whole lot more cell towers than we have today.

Photo (above): 5G telecommunications technology offers far more to the military than today's voice and data radio. It has the potential to create a ubiquitous infosphere where data from sensors, targeting, surveillance, and signals intelligence are instantly available.

What is 5G?

5G is to increase the speed, reduce the latency, and improve reliability of data transfer compared to existing 4G technologies, and support interconnected or autonomous devices like smart

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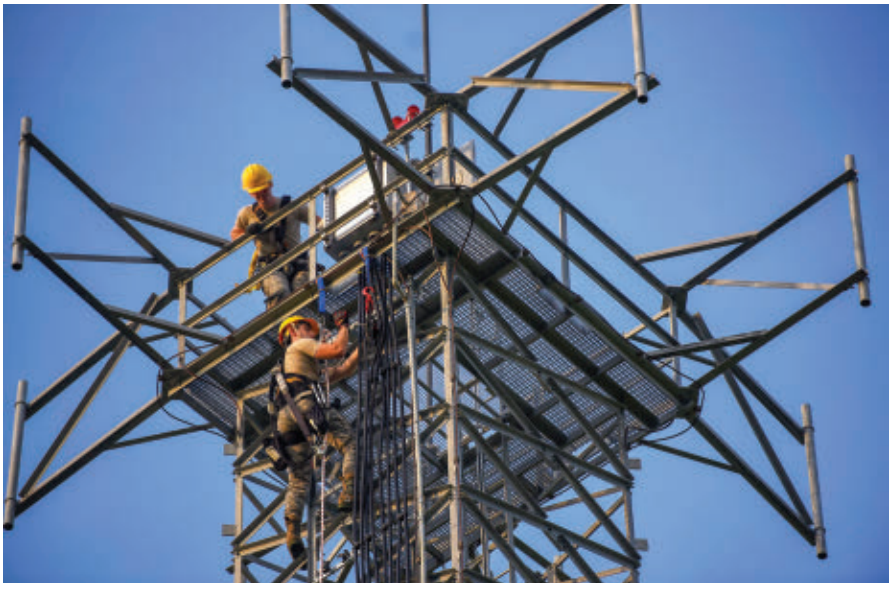


Although 5G has the potential for lightning-fast military data communications, its higher frequencies have relatively short ranges, which will require building large numbers of fixed-site and mobile towers.

homes, self-driving vehicles, precision agriculture and industrial machinery, and advanced robotics, according to the U.S. Congressional Research Service in Washington, in an October report titled National Security Implications of Fifth Generation (5G) Mobile Technologies.

For the military, 5G could improve ISR systems and signal processing, enable new command-and-control applications, and streamline logistics. 5G also could give the military broad access to augmented and virtual reality, 5G smart warehousing, distributed command and control, and dynamic spectrum use.

A big priority for military communications experts is to bring 5G technology to the leading edge of the battlefield to bring high-speed sensor, targeting, and intelligence data to front-line warfighters.

To do all this, 5G will operate on three segments of the electromagnetic spectrum:

- low band, which operates at frequencies lower than 1 GHz;
- mid band, which operates at frequencies between 1 GHz and 6 GHz; and
- high band, or millimeter wave, which operates at frequencies between 24 and 300 GHz.

Low band and mid band collectively also are called sub-6, and this is where all of today's so-called 5G cell phone services operate. Although sub-6 frequencies can offer faster service than cellular 3G and 4G, the sub-6 frequencies offer capabilities that will lag far behind most future high-band systems.

High bands's use of millimeter waves will enable faster data transfer rates, which some telecommunications companies argue is necessary for autonomous vehicles, virtual reality, and other data-intensive applications like smart cities, according to the Congressional Research Service report.

Yet there are substantial technology tradeoffs when moving to the high band's millimeter waves. RF signals in the 24-to-300-GHz bands can be absorbed by rain or disrupted by physical objects like buildings and vehicles. As a result, 5G millimeter wave technologies require installing many more cell sites than those operating in the lower bands. This move to a larger number of cell sites will come at much higher cost and on a much slower deployment schedule than the sub-6 approach. 5G deployment will rely on millimeter wave technology for high-speed, high-bandwidth communications, and on sub-6 signals for nationwide coverage.

"Unlike 3G, the 5G technologies represent more than a radio capabil-

ity," says Ian Dunn, vice president of advanced development and chief scientist at embedded computing and electronic warfare (EW) specialist Mercury Systems in Andover, Mass. "It is a mobile infrastructure as a service, mobile computing as a service, and can be tailored and provisioned for each user."

The military faces even stronger technological challenges because of the need to deploy 5G capabilities on the leading edge of the battlefield, where little, if any, 5G infrastructure exists, and where intentional RF jamming or other kinds of interference from enemies is likely.

High-band signals "have a lot of different characteristics than sub-6," explains Rodger Hosking, vice president of embedded computing and signals intelligence expert Pentek Inc. in Upper Saddle River, N.J. "Those signals don't travel very far and are very easily absorbed. You would need more cell towers and smaller cells. the advantage is you get these tremendous data rates and capabilities. The high band is much faster and can carry more information on those signals."

A chief military goal of 5G technology is to provide data-on-the-move to military vehicles operating on the battlefield to provide video, voice, images, and maps on-demand.

5G military capabilities

The U.S. Department of Defense (DOD) 5G Strategy report, published last May, says 5G has the potential to transform military capabilities. "Ubiquitous high-speed connectivity will also transform the way militaries operate," according to the report. "Tomorrow's warfighters will use local and expeditionary 5G networks to move massive amounts of data to connect distant sensors and weapons into a dense, resilient battlefield network.

"This data-rich environment will fuel powerful algorithms that will allow commanders to better understand, shape, and adapt to complex and contested physical and information environments," the report continues. "Low-latency communications will enable new generations of unmanned and autonomous weapons systems across all domains. The warfighter will be empowered with far richer access to data at the tactical edge, so that even small units can achieve strategic effects."

Persistent Systems in New York City specializes in mobile ad-hoc networking (MANET) technology for a variety of applications such as controlling groups of unmanned vehicles in difficult terrain. Persistent has expertise in real-time switching between different RF frequencies to find the most reliable pathways in a given set of conditions. Company engineers make use of satellite communications (SATCOM) channels, land mobile radio, and RF repeaters mounted on unmanned aircraft and even on other handheld radios to sample the RF environment constantly and adapt in real time to changing conditions.

As such, the company will not be an exclusive user of 5G networking, but instead will use 5G as the technology matures to enhance the reliability of ad-hoc networks.

"We are excited about the opportunity to network with another technology beyond military tactical radio, which is old and somewhat limited," explains Adrien Robenhymer, Persistent's vice president of business development for Air Force and intelligence community applications. "5G offers the military another network pathway."

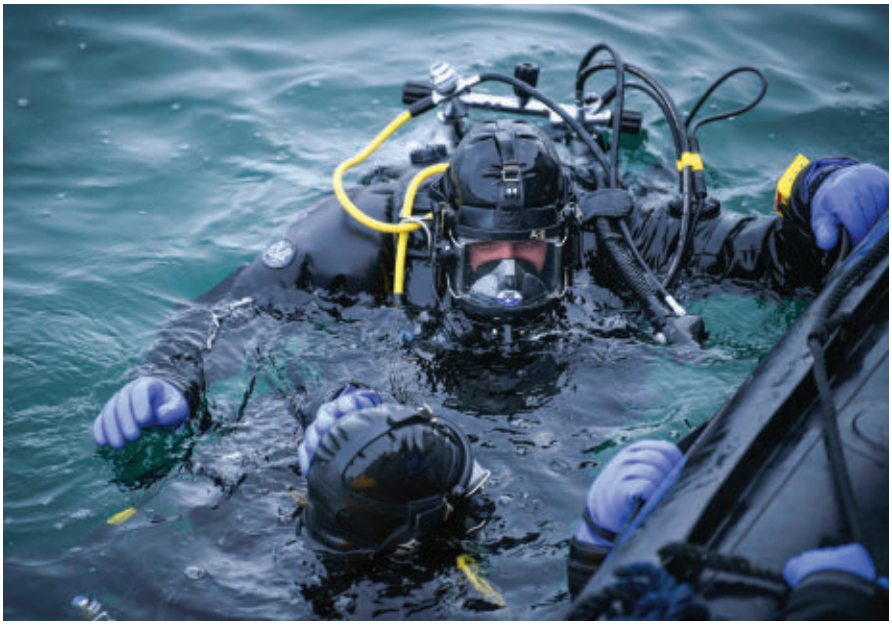
Adding 5G as another communications layer also offers to enhance the reliability of military networks — particularly when they operate in contested environments. "In the DOD space, being able to transition between networks is very critical," Robenhymer says, explaining that Persistent Systems experts have demonstrated the ability to use 5G and 4G wireless technologies together with the company's MANET technology, with the addition of SATCOM systems.

Providing 5G connectivity to warfighters on the front lines could provide new capabilities in situational awareness, the locations friendly forces and enemies, and instant access to video from overhead unmanned aircraft.

"From virtual reality, to robots, to the simple logistics of flight-line operations, to counter-unmanned systems where threats are flying into military bases. Having some additional communications layers to leverage widens the aperture."

The speed of data

The speed of data throughput is among the biggest enablers that 5G offers. "You are going from kilobits to megabits, but with 5G you see hundreds of megabits," Robenhymer says. "You are breaking down the walls that have been architected in communications. We no longer will be constrained to the legacy interoperability of systems at the radio level; we can do that at a network level. How can I do my logistics faster, make bar code readers more technology-focused, and how can I automate the pen and paper work of locating where people are on military installations?"



Millimeter wave 5G signals present many challenges to the military operating in hostile environments. Millimeter waves cannot penetrate water, and can be absorbed by rain and fog.

Backward-compatibility of 5G with its 4G and 3G predecessors also will be an important consideration for systems designers — particularly in MANET-like architectures that hop to different bands based on spectrum availability.

"Our customers are seeing the base stations for 5G that will operate at significantly higher speed," says Mike Southworth, senior product manager at the Curtiss-Wright Corp. Defense Solutions division in Salt Lake City. "4G and 3G devices are there today, so 5G base stations should be able also to support 4G and 3G."

Southworth says he envisions many new military applications that 5G throughput could provide. "Warfighters in an aircraft could use augmented-reality goggles to control drones launched off the aircraft; you are gaming, yet with an actual drone."

Enabling unmanned aerial vehicles (UAVs) to operate safely in congested commercial air space with commercial passenger aircraft, business jets, and commercial helicopters also lends itself to 5G, Southworth says. "Commercial drones operating in commercial air space — 5G was the infrastructure they were thinking of using for the drones to communicate. Not crashing into something else, and collision-avoidance, 5G could help enable that."

Networking separate infantry warfighters also is a potential application of 5G, says Pentek's Hosking. "The military increasingly relies on data-connected

warfighters. That means connecting soldiers, vehicles, command posts, ships, satellites, and planes with information that consists of everything that you know, using voice, data, imagery, and signals-intelligence information. 5G gives the military the potential for boosting the data rate capabilities between the links of these operations by 20 to 100 times faster than the current state of the art of LTE or 4G wireless speeds."

Couple 5G networking with artificial intelligence (AI) and machine learning, and potential new applications start to expand exponentially, Hosking points out.

"Machine learning and AI are extremely important to the military because it will dictate how we conduct warfighting and go head-to-head with an enemy that has his own AI and machine learning," Hosking says. "We could have unmanned vehicles and smart munitions that are attacking, evading, targeting, and re-targeting."

Real-time command and control is another possibility, he says. The number of network-connected sensors on manned and unmanned platforms is likely to grow quickly once advanced 5G technologies sees broad deployment. "How do you put all that stuff together for actionable intelligence?" Hosking asks. "It is a hugely complex problem, and that's where AI and machine learning come in. 5G is the connection, and its bandwidth will support these information channels. The AI and machine learning need a faster interface to sort all this out."

Such high data throughput also could enable several uses of military systems that originally were designed for just one use. "Software-defined radio was focused on software-defined recongigurability," says Mercury's Dunn. "Now we're talking about software-defined functionality. Think of how you could re-invigorate military platforms."

U.S. military forces are coming to grips with the infrastructure necessary to implement 5G communications in challenging environments. In addition, questions arise concerning military control of commercial towers.

High throughput also could enable new uses of tactical cloud computing as systems designers no longer have to worry about the latency of sending and receiving data from the cloud. "Cloud-native is the notion of taking an application built for the cloud and deploy it to the edge just as easily as it can be part of the core of the cloud," Dunn says. "The application is defined in software and seamlessly moved to the edge."

Drawbacks and tradeoffs

High-band 5G signals, which will operate in the millimeter wave range, hold the brightest potential for new military capabilities, but the ability to operate in these frequencies will come at a price — namely the need to build many more fixed-site and mobile antennas and towers than today's 3G and 4G cell services require.

"5G frequency bands do not penetrate walls very well, or rain or foliage very well," says Persistent Systems's Robenhymer. "The way it is architected you need a lot of towers, or radiators, in your office or home. It adds to the complexity of 5G, but it is still a limiting factor in coverage and the number

Military 5G communications at the edge may require warfighters to set up mobile or temporary communications on or near the battlefield to content with the relatively short range of millimeter wave 5G signals.

of towers you would need."

The stationary nature of most of the cell tower infrastructure may necessitate sizable investments in building new 5G towers — especially for the military, which must operate in challenging environments, such as the leading edge of the battlefield, in urban areas with terrain masking and multipath interference, in the air at various altitudes, and in the world's oceans.

"Our customers are seeing the base stations for 5G that will operate at a significantly higher speed, but at shorter ranges," says Curtiss-Wright's Southworth. "The military will have to implement many more base stations to get the coverage they need."

The military, especially, ultimately will need a new kind of mobile 5G infrastructure to ensure that the next-generation infosphere will be available wherever the military operates. "It's a question of the reliance on these systems," points out Persistent Systems's Robenhymer. "That could be a problem unless we can cut the cord and really start moving these systems around."

5G antennas must be complex designs. "All the 5G bands use multiple-element antennas," says Pentek's Hosking. "Each antenna is connected to its own transceiver; there are 64 elements — each of which is a small antenna itself, but arranged in a grid so they act in a phased array for beam steering."

Designing the 5G antennas themselves in the small size and rugged packaging that the military needs also will be a challenge. "One of the key things in 5G is the ability to manage these antennas," Hosking says. "You have to think about the dimensions of these 64-element antennas, because the space between the elements gets tighter as you go up in frequency. You could have an array in a fairly small area, but the electronics still must fit in that area. Getting the electronics of the transmit/receive antennas integrated into that space is a challenge."

The Pentek model 5903 can synchronize as many as eight RF systems-on-chip (RFSoC) products to support 64 elements of a 5G phased-array communications antenna.

Moving to 5G also confronts the military with complicated new requirements for technology development and procurement. "If you adopt this 5G deployment paradigm, it necessitates a change in the software-engineering culture," says Mercury's Dunn. "If my users subscribe to resources throughout a network, like surveillance and characterization of new signals, then I need the software and engineering methodology to be different from ever before?

The need for these kinds of changes comes from the expected rapid tempo of technology development, upgrades, and technology insertion that 5G will provide to the military. "It's a paradigm shift, that to achieve the subscription of new capabilities, you need new capabilities, and you need to speed up engineering to speed up the software engineering that you already have. Software development must be faster than it's ever been before," Dunn says.

Then comes the question of 5G spectrum, who controls it, and when. "Does the military 5G use the same spectrum as commercial 5G users, and if so, what happens in a crisis?" asks Persistent Systems's Robenhymer. "Does the military take over commercial cellular telecommunications, or do they use a separate spectrum? That issue is a really big deal."

Data security

5G communications must have data security built-in. "Because 5G networks will transport massive amounts of sensitive personal, corporate, and government information, they are particularly attractive targets for potential U.S. adversaries," states the DOD 5G Strategy document. "With persistent access to an ally's 5G network, an adversary could potentially engage in widespread espionage, threaten the privacy rights of citizens globally, prepare the operational environment to provide an advantage in armed conflict, conduct information operations, and/or protections. The U.S. government also encourages allies and partners to prioritize security considerations by avoiding untrusted and unreliable suppliers for their 5G networks, even as DOD seeks to be prepared to operate in all network environments."

Pentek's Hosking points out that the relatively short range of millimeter wave 5G signals provides some

inherent security, much the same as the short range of some of today's wireless signals helps keep users safe. "Take Bluetooth, which is a very small cell," Hosking says. "No one farther away from about 30 feet can pick up that signal or interfere with it."

Electronic eavesdropping, electronic warfare jamming, and inadvertent electronic interference from nearby transmitters all are threats to the reliability and integrity of 5G, and experts must deal with these issues sooner rather than later.

"The vulnerability of any cell system is if you jam it or cut power to any tower, then all the handsets in that footprint are useless," points out Persistent Systems's Robenhymer. In any 5G design, engineers must as the question, what are the vulnerabilities.

The DOD 5G Strategy document puts a priority on 5G security. "DOD must assess 5G vulnerabilities and develop security principles for equipment, architecture, and operations," the document states. "In-depth protection also requires adoption of compliance standards for 5G design, cyber security for 5G infrastructure, and implementation of a 'zero-trust' security model."

The notion of zero-trust requires all users — even those inside the organization's enterprise network — to be authenticated, authorized, and continuously validated before getting access to applications and data. This approach capitalizes on advanced technologies like multifactor authentication, identity and access management, and next-generation endpoint security to verify the user's identity and maintain system security.

5G enabling technologies

So what kinds of enabling technologies does it take to put reliable 5G networking in the military's hands? Embedded computing companies are particularly well positioned to contribute high-performance computing, embedded parallel processing, artificial intelligence and machine learning, high-speed networking, digital signal processing, and a variety of other technologies vital to military operations.

Curtiss-Wright, for example, offers high-performance embedded computing components — which company officials refer to as building blocks — to help control and process data from 5G signals. "At Curtiss-Wright we consider ourselves a hardware provider, and not a solutions provider," Southworth says. "We will provide building blocks that will become part of the 5G architecture."

Curtiss-Wright specializes in small-form-factor rugged 3U VPX computer boards that are optimized for small size, weight, and power consumption that are suitable for military uses. "We are developing our first software-defined radio card," Southworth says. "By nature of being software-defined, it means what frequency do you want to operate on? It could be a fundamental building block for 5G."

Although embedded computer designers have technologies that could benefit 5G, this technology path is not a one-way street. The 5G vision also is helping direct embedded computing suppliers toward future products and applications.

"What wireless communications have brought to the DOD and the embedded community is a distributed architecture, which is different from the cloud," explains Mercury's Dunn. "Wireless is mobile, is on all the time, and its quality of service adjusts as you move around. It is a good example of a distributed communications infrastructure. We now have an infrastructure as a service in the mobility model. There is a real-time need for voice, data, and beyond, and 5G is just another increment of this model that likely will be useful to the C4ISR industry, where mobility is one of the most important aspects of the tactical edge."

Radio technology for cell phone communications "is maturing very quickly, creating opportunities for the

Curtiss-Wright Defense Solutions is offering the TCG Battlefield Operations Support System (BOSS) TDL testing, simulation, and platform integration solution, which supports a wide range of radio RF to support tactical communications using deployed Combat Net Radio (CNR) networks.

embedded world in general," Dunn says. "We are now in another wave where those technologies are starting to push into defense, such as wideband radio communications." RF cell phone technology, from analog RF, to field-programmable gate arrays FPGAs), to monolithic microwave integrated circuits (MMICs) "are chasing the opportunity to provide to defense," Dunn says.

Advanced 5G technologies such as millimeter wave signals, still have much development work to become viable to military and commercial users, Dunn says, adding "We are incorporating some of these technologies into our products, and I expect another one to two years of maturity before we see widespread adoption."

5G military programs

The U.S. Department of Defense has designated several military bases as 5G test beds to try out enabling technologies and to device new 5G military applications. Just last month DOD announced $600 million in contracts for 5G experimentation and testing at five military test sites, which represents the largest full-scale 5G tests for dual-use applications in the world.

Those five sites are Joint Base Lewis-McChord, Wash.; Naval Base San Diego, Calif.; Marine Corps Logistics Base Albany, Ga.; Nellis Air Force Base, Nev.; and Hill Air Force Base, Utah.

5G tests and experiments at Joint Base Lewis-McChord will sponsor testing of augmented reality and virtual reality training. Contractors involved at this site are GBL Systems Corp. in Camarillo, Calif.; AT&T Corp. in Bedminster, N.J.; Vectrus Mission Solutions Corp. in Alexandria, Va.; and Deloitte Consulting LLP in New York City.

These contractors will work with military experts to field a scalable, resilient, and secure 5G network to provide a test bed for 5G-enabled virtual reality and augmented reality for mission planning, distributed training, and operational use.

Experiments at Naval Base San Diego will involve 5G smart warehouse transshipment. Contractors are AT&T; GE Global Research in Niskayuna, N.Y.; Vectrus Mission Solutions; and Deloitte Consulting. These tests seek to develop a 5G-enabled smart warehouse that focuses on transshipment between shore facilities and naval units to increase the efficiency and fidelity of naval logistic operations like identification, recording, organization, storage, retrieval, and transportation of materiel and supplies.

Albany Marine Corps Base will focus on 5G vehicular smart warehousing. Contractors are Federated Wireless Inc. in Arlington, Va.; GE Research; KPMG LLP in Amstelveen, the Netherlands; and Scientific Research Corp. (SRC) in Atlanta. These tests will develop a 5G-enabled smart warehouse that focuses on vehicular storage and maintenance.

The Nellis Air Force Base tests involve distributed command and control. The primary contractor is AT&T, which will develop a testbed for applying 5G technologies to air, space, and cyberspace lethality, while enhancing command and control survivability. A 5G network will help disaggregate and mobilize existing command-and-control architectures in an agile combat employment scenario.

The Hill Air Force Base tests will involve dynamic spectrum utilization. Contractors are Nokia Corp. in Espoo, Finland; General Dynamics Mission Systems in Fairfax, Va.; Booz-Allen Hamilton in McLean, Va.; Key Bridge Wireless LLC in McLean, Va.; Shared Spectrum Co. (SSC) in Vienna, Va.; and Ericsson in Stockholm, Sweden.

WHO'S WHO IN 5G ENABLING TECHNOLOGIES

AT&T Corp.
Bedminster, N.J.
www.att.com

Booz-Allen Hamilton
McLean, Va.
www.boozallen.com

Curtiss-Wright Defense Solutions
Ashburn, Va.
www.curtisswrightds.com

Deloitte Consulting LLP
New York City
www2.deloitte.com/us/en.html

Ericsson
Stockholm, Sweden
www.ericsson.com

Federated Wireless Inc.
Arlington, Va.
www.federatedwireless.com

GBL Systems Corp.
Camarillo, Calif.
www.gblsys.com

GE Global Research
Niskayuna, N.Y.
www.ge.com/research/

General Dynamics Mission Systems
Fairfax, Va.
https://gdmissionsystems.com

Key Bridge Wireless LLC
McLean, Va.
https://keybridgewireless.com

KPMG LLP
Amstelveen, Netherlands
www.kpmg.us

Mercury Systems
Andover, Mass.
www.curtisswrightds.com

Nokia Corp.
Espoo, Finland
www.nokia.com

nVidia Corp.
Santa Clara, Calif.
www.nvidia.com/en-us

Oceus Networks
Reston, Va.
www.oceusnetworks.com

Persistent Systems
New York City
www.persistent.com

Scientific Research Corp. (SRC)
Atlanta
www.scires.com

Shared Spectrum Co. (SSC)
Vienna, Va.
www.sharedspectrum.com

Vectrus Mission Solutions Corp.
Alexandria, Va.
www.vectrus.com

An MQ-9A Reaper sits on the ramp at Creech Air Force Base, Nev., in the first flight test of the MQ-9 carrying eight Hellfire missiles.

High-performance test and measurement equipment hits the flight line

Avionics technicians make use of oscilloscopes, spectrum analyzers, and other high-performance test and measurement instruments to ensure that sensitive RF and microwave systems are working properly

BY **Jamie Whitney**

When commercial and military flightline crews ready equipment and pilots take to the skies, they want the sense of safety born out of rigorous testing of systems with trustworthy equipment. With modern flightline crews being asked to do more with fewer crew members on equipment packed with more technology than ever, reliable and accurate test and measurement has become even more vital.

Retired U.S. Air Force Maj. Gen. Stephen Sargeant, who is the CEO of Marvin Test Solutions in Irvine, Calif. says that robust test and measurement equipment, "is all about mission readiness, but frankly, that's the key to being successful as a military, and it requires comprehensive and accurate testing of very complex systems that the warfighters rely on to accomplish their objectives across the target the first time, and that's very, very important."

Marvin Test's Sargeant says that ensuring the munitions being carried onboard today's military aircraft are sufficiently tested to hit their target keeps warfighters on the move and in less danger.

"So, they don't have to go back a second time if things don't work properly. That just ups the odds that things don't go well for the people involved either on the ground that or our folks are flying in support of those folks that are flying across the target a second or

third unnecessary time because things didn't work the first time," Sargeant says. "So, it's very important that we send people into battle with fully tested equipment that is fully mission capable."

He continues, "So you need the very accurate, comprehensive test equipment to check out that aircraft and its systems, and then over time, precision guided munitions have really become the weapon of choice for militaries around the world ... They've got much more electronics both on board and on and off for guidance, which makes the testing much more complex. And so, the test sets have to be up to the challenge of today's weapons."

Eyes on cost

Test and measurement can bring monumental expenses to getting an aircraft into service in civilian and military capabilities, says Patrick Quinn, senior product line manager for data acquisition at Curtiss-Wright Corp. based in Davidson, N.C.

"Flight test is a very expensive process," Quinn says. "So, the more and more flights you have to do, the more expensive it is. So, you're unsure of your results if you have to repeat tests at longer times. You want to be sure to minimize interference like that — your equipment is gathering the data correctly, and you need confidence in your equipment."

Accuracy in test equipment is one major component in minimizing flight test time, says Farhad Daghigh, also of Curtiss-Wright, who is the company's vice president of sales in aerospace instrumentation.

"There is one other factor that we should also mention that makes it different than a lot of other testing in general that taking place in this country

Curtiss-Wright's next generation MnACQ-2700 TTC data-acquisition system.

— but what's crucial about flight testing is the timing of having a fully synchronized data system that's accurate within not just microseconds in the latest technology or in the latest offerings that we're providing to our customers," Daghigh says. "Having a nanosecond accuracy and synchronized data is very important, because if a specific event happens, let's say in an unlikely event that the wing splits open, they want to know based on thousands of measurements what exactly happened at that instant in time.

He continues, "What [happened] when they did this very hard banking that created a rupture in the skin or the structural integrity of that specific aircraft. Another very important aspect of that is when you're looking at the data during a test flight, you want to make sure that you've successfully completed each of your tests, your test operations in particular, a maneuver like thank you for certain degree or something like that is what you're looking for."

While Daghigh says flight test equipment is invaluable in the commercial and military aviation sectors, the latter has additional stresses that need to be considered when choosing test equipment.

"Military aircraft have to go faster — commercial aircraft don't go to the sound barrier," says Curtiss-Wright's Daghigh. "The equipment we provide has to withstand that type of environment. It's very challenging to make sure it can survive that environment and provide that high-temp solution that can withstand a lot more rigorous environment that a commercial aircraft will."

High-speed data

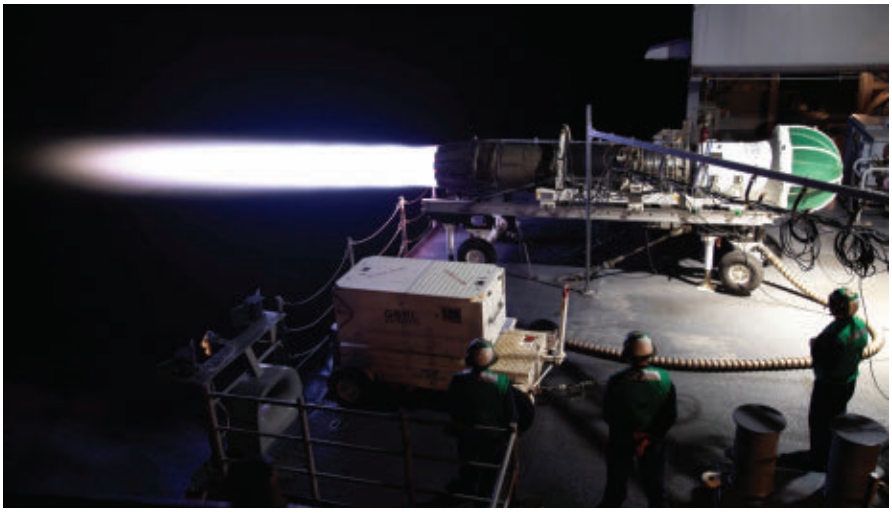
With blazing-fast systems enabling the most technology-packed aircraft yet, Ben Kupferschmidt, senior manager of desktop software at Curtiss-Wright Corp., says that transmission of data from the sky to the ground is more important than ever.

"So, one of the biggest trends is that end users are collecting more data than they ever have in the past and the data they're collecting is running at higher speeds," Kupferschmidt says. "They're collecting more data ... quicker. So, you're getting exponentially more data than you did in the past. And that creates a number of challenges because that means you have to continue your transmission. Bandwidth from the aircraft to the ground is relatively limited. You know, there there's not that much bandwidth that's allocated to flight test."

Kupferschmidt says that because so

much data is collected, it is easy to isolate it very specific parameters.

"Show me all the maneuvers — a certain type when the speed was greater than 500 miles-per-hour and the altitude was greater than 10,000 feet," Kupferschmidt says. "And you can then show you all the data that matches that criteria and that would allow you to find things you want to analyze in more detail very quickly."



Sailors aboard the aircraft carrier USS Gerald R. Ford perform jet engine test instrumentation on an F/A-18 jet engine to verify the engine's ability to deliver sufficient fuel flow for the jet afterburner.

Proactive and reactive

While having a massive amount of data can be fantastic, Marvin Test's Sargeant says that it also can be a risk. "Now what's happening is all this data is coming in and people are realizing there's a liability with having that much data," Sargeant says. "And especially some of that data is being stored in the cloud and that brings cyber security right to the forefront. We need to secure this data so it cannot be used maliciously. And so cyber security features are being mandated to be brought forward with any test systems that are going to be connected to the airplane, to the armament or to the weapons."

Sargeant continues, "There's a massive amount of data that is collected every day when tests are run. In the past it just wasn't used unless there was a problem; somebody might go back and look at it. Now it's going to be used a lot because there's the drive toward predictive maintenance which could lower costs. And that is something very, very attractive across the board."

By analyzing data, Sargeant says the lifespan of components can be monitored and replaced before they become a liability to mission readiness.

"Maybe the engine that will drive from reactive maintenance of fixing things when they break or preventive maintenance fix it when there's a scheduled course based on historical data, which may or may not actually be right for the part you're fixing. We're going to go with that, because that's ... predictive maintenance."

He continues, "And it won't typically be a specific point, but it will be a range. And now you can you can make the risk assessment and change that part, which always costs money in terms of time and actual funding of the pieces and parts of aircraft. Then you can actually reduce the cost by having that level of analytics brought into the test the measurement world. There's a huge push toward that."

Checking components

Marvin's Sargeant explains that line-re-

An aviation electronics technician aboard the aircraft carrier USS Dwight D. Eisenhower tests the electronic countermeasures of an F/A-18F Super Hornet.

WHO-S WHO IN FLIGHT-LINE TEST AND MEASUREMENT

Abaco Systems
Huntsville, Ala.
www.abaco.com

Astronics Corp.
East Aurora, N.Y.
www.astronics.com

Behlman Electronics
Hauppauge, N.Y.
www.behlman.com

Curtiss-Wright Corp.
Davidson, N.C.
www.curtisswright.com

Curtiss-Wright Defense Solutions
Ashburn, Va.
www.curtisswrightds.com

Data Device Corp. (DDC)
Bohemia, N.Y.
www.ddc-web.com

Diversified Technical Systems Inc. (DTS)
Seal Beach, Calif.
www.dtsweb.com

Great River Technologies
Albuquerque, N.M.
www.greatrivertech.com

Kaman Precision Products
Middletown, Conn.
www.kamansensors.com

Keysight Technologies
Santa Rosa, Calif.
www.keysight.com

Marvin Test Solutions
Irvine, Calif.
www.marvintest.com

Meggitt Sensing Systems
Irvine, Calif.
www.meggitt.com

National Instruments
Austin, Texas
www.ni.com

Rohde & Schwarz
Columbia, Md.
www.rohde-schwarz.com

Saelig Co. Ltd.
Fairport, N.Y.
www.saelig.com

Tektronix
Beaverton, Ore.
www.tek.com

VIAVI Solutions Inc.
San Jose, Calif.
www.viavisolutions.com

Vishay Precision Group
Malvern, Pa.
https://vpgsensors.com

placeable technology components need to be tested before they make it into the fleet.

"The reality is, all military electronics — whether it's circuit cards, subassemblies, line replaceable units — they all require a certain amount of functional test to show that they're operating properly before being issued out to the fleet."

Sargeant says that customers are asking for test and measurement technologies that can do multiple functions across different aircraft.

"Even during COVID, the move toward smaller, rugged, and multi-capable test technology is definitely happening because it's being funded in many ways," Sargeant says. "So, the other thing that we see there is not only do they want to see maintenance and sustainment activities to be able to be accomplished faster, but with fewer people, and they want that same test equipment to be used across a multitude of aircraft."

An aviation machinist's mate aboard the aircraft carrier USS Abraham Lincoln performs a liquid crystal test to reveal possible delamination of an engine run trailer.

On the line

This fall, Military & Aerospace Electronics recognized Marvin Test Solutions as a platinum-level winner in its 2020 Innovators Awards for its Marvin Test-3060A SmartCan Gen2 universal O-level aircraft armament test set.

The Marvin Test-3060A SmartCan Universal O-Level Armament Test Set from Marvin Test Solutions Inc. addresses the challenges of performing flightline test activities with an existing generation of armament test sets that limit the ability to verify armament system functionality, failures, and readiness.

The system can perform flightline test and measurement of all fighter aircraft armament and gun systems. The SmartCan weighs 4.2 pounds, and incorporates more than 30 measurement channels, electronic loads, communications interfaces, a switch matrix, and video/audio signal generators, and cable ID.

The test set for combat aircraft uses the Marvin Test Solutions ATEasy test executive and test development software.

Today's flightline armament maintainer faces the challenging task of performing O-Level flightline activities with an existing legacy generation of armament test sets that greatly limit the ability to verify armament systems.

Northrop Grumman to build electronic warfare (EW) for ship missile defense

BY **John Keller**

WASHINGTON — U.S. Navy surface warfare experts are ordering advanced electronic warfare (EW) systems for aircraft carriers and amphibious assault ships under terms of a $100.8 million contract.

Officials of the Naval Sea Systems Command in Washington are asking engineers at the Northrop Grumman Corp. Mission Systems segment in Linthicum Heights, Md., to build the Surface Electronic Warfare Improvement Program (SEWIP) Block 3 electronic attack systems and hardware design modifications for aircraft carriers and amphibious assault ships.

SEWIP is an evolutionary acquisition program to upgrade the existing out-of-production AN/SLQ-32(V) shipboard EW system and provide improved anti-ship missile defense and situational awareness.

Northrop Grumman won $267 million Navy contract in 2015 to develop and build SEWIP Block 3 to make further upgrades to the AN/SLQ-32 with new technologies for early detection, signal analysis, threat warning, and protection from anti-ship missiles. There are three established SEWIP block upgrades and a fourth is planned.

The Lockheed Martin Rotary and Mission Systems segment in Liverpool, N.Y., is building the SEWIP Block 2 surface warfare EW system, which provides improved electronic support receivers and combat system interface and expands the receiver and antenna group to help surface electronic warfare capabilities keep pace with growing threats.

Since the SEWIP program started in 2002, General Dynamics Advanced Information Systems (AIS) in Fairfax, Va., acted as prime contractor for SEWIP blocks 1A, 1B1, 1B2, and 1B3.

Developed by Raytheon in the 1970s, the original AN/SLQ-32 systems employed passive radar technology for early warning, identification and tracking of enemy threats. Subsequent upgrades provided an additional active capability for simultaneous jamming of several different threats.

On this contract Northrop Grumman will do the work in Baltimore and White Marsh, Md.; Tampa, Fla.; Andover and Chelmsford, Mass.; Rochester, N.Y.; San Diego, El Cajon, Los Angeles, and Glendale, Calif.; Winona and Minneapolis, Minn.; Stafford Springs, Conn; Glendale, Ariz.; Nashua, N.H.; Elk Grove Village and Woodridge, Ill.; Tucson and Chandler, Ariz.; Washington, N.C.; Richardson, Texas; Hiawatha, Iowa; Littleton, Colo., and other U.S. locations, and should be finished by May 2023.

For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com.

SEWIP Block 3 electronic attack systems will help defend Navy aircraft carriers and amphibious assault ships from enemy missile attack.

General Atomics to provide Gray Eagle unmanned combat aircraft and communications

BY **John Keller**

REDSTONE ARSENAL, Ala. — U.S. Army aviation experts are ordering MQ-1C Gray Eagle unmanned combat aircraft for reconnaissance and attack, as well as satellite communications air data terminals, maintenance, repair, and support services under terms of a $131.6 million order.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking General Atomics Aeronautical Systems Inc. in Poway, Calif., for the Gray Eagle attack unmanned aerial vehicles (UAVs), communications terminals, and support.

The General Atomics MQ-1C Gray Eagle is a medium-altitude, long-endurance UAV that is an upgraded MQ-1 Predator for extended-range, multi-purpose unmanned operations. The aircraft can be fitted with the AGM-114 Hellfire missile or GBU-44/B Viper Strike guided bomb for attack missions.

Compared with its predecessor, the MQ-1 Predator, the Gray Eagle has an increased wingspan, and a Thielert Centurion 1.7 heavy-fuel engine that can burn jet and diesel fuel. The UAV can fly for as long as 36 hours at altitudes to 25,000 feet. It has an operating range of 200 nautical miles.

The Gray Eagle UAV has a synthetic aperture radar and ground moving target indicator system, and targeting capability from an AN/AAS-52 multi-spectral targeting system under the nose. The aircraft can carry payloads as heavy as 800 pounds.

Army commanders deploy the Gray Eagle UAV in platoons, each with four aircraft, support equipment, and payloads like electro-optical and infrared/laser range finder, laser designator, communications relay, and as many as

Boeing to help develop secure communications satellites for U.S. Space Force

The Boeing Co. received a $298 million contract to build a satellite payload prototype and develop a secure communications architecture for the U.S. Space Force's Evolved Strategic SATCOM (ESS) program. The ESS will replace the existing Advanced Extremely High Frequency (AEHF) satellites made by Lockheed Martin. Boeing, Northrop Grumman and Lockheed Martin will be developing competing designs for the ESS program. Each company is building prototypes to be completed by 2025. Like AEHF, the new ESS program is intended to provide secure, jam-resistant communications for high-priority military operations and national command authorities. Boeing is a longtime supplier of military communications satellites. It is the prime contractor for the Wideband Global SATCOM (WGS) constellation, and is also working on the Protected Tactical Enterprise Service and Protected Tactical SATCOM programs. These programs are developing survivable, secure and resilient tactical-level communications for the U.S. military.

four hellfire missiles.

The common sensor payload and synthetic aperture radar ground moving target indicator are one per aircraft. Ground equipment per platoon includes two universal ground control stations; three universal ground data terminals; one satellite communication ground data terminal; and one mobile ground control station per company.

Gray Eagle platoons also have an automated takeoff and landing system two tactical automatic landing systems and ground support equipment to include ground-based sense and avoid.

On this order General Atomics will do the work in Poway, Calif., and should be finished by December 2022. For more information contact General Atomics Aeronautical Systems online at www.ga-asi.com.

General Atomics will provide the U.S. Army with satellite communications air terminals for the MQ-1C Gray Eagle unmanned aircraft.

Skyborg is to be an inexpensive, quick-turnaround, autonomous unmanned combat aircraft that can take on increasingly complex technologies and tasking to support the warfighter.

Nine companies to provide enabling technologies for Skyborg unmanned combat aircraft

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio — U.S. Air Force unmanned vehicles experts are asking nine companies to provide mature enabling technologies to prototype a low-cost unmanned combat aircraft called Skyborg, which will have artificial intelligence (AI) and modular payloads for a wide variety of fighter and ground-attack capabilities.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, have announced that the nine companies will share as much as $400 million develop technologies for a prototype Skyborg Autonomous Unmanned Combat Air Vehicle (UCAV).

The Skyborg unmanned combat aircraft is to be an inexpensive, quick-turnaround, autonomous UCAV that will be a modular, fighter-like aircraft that can take on increasingly complex technologies and tasking to support the warfighter.

The nine companies that will share the $400 million for the Skyborg Vanguard project budget are:

— AeroVironment Inc. in Simi Valley, Calif.;

— the BAE Systems Controls & Avionics Solutions segment in Endicott, N.Y.;

— Blue Force Technologies in Morrisville, N.C.;

— Fregata Systems LLC in St. Louis;

— the Lockheed Martin Corp. Aeronautics segment in Fort Worth, Texas;

— Wichita State University in Wichita, Kan.;

— Autonodyne LLC in Boston;

— NextGen Aeronautics in Torrance, Calif.; and

— Sierra Technical Services Inc. in Tehachapi, Calif.

These contracts provide for Skyborg prototyping, experimentation, and autonomy development to deliver mission-ized prototypes in support of operational experimentation, Air Force officials say.

Once fielded, the Skyborg unmanned combat aircraft will enable warfighters to adjust Skyborg's payload and autonomy modularly to support an array of missions. Researchers are interested only in technologies that quickly can move to operational use.

Advanced autonomy and artificial intelligence (AI) are poised to change the character of the international battlefield substantially in the near future, Air Force researchers explain. Researchers want to field an autonomous system that meets an immediate operational need, as well as that can jump-start complex AI development, prototyping, experimentation, and fielding.

Skyborg will be attritable, meaning it will have a lost enough cost to sacrifice it in combat to attack high-value targets. It also will be reusable after flying routine missions. It also have the ability of an intelligent system to compose and select independently among different courses of action.

Its AI embedded computing will have modular components and protocols that conform to open-systems standards, which integrate easily with third-party products. Open systems mitigate risks associated with technology obsolescence, vender-unique technology, and single sources of supply and maintenance, Air Force researchers explain.

Skyborg will have an open AI software architecture and toolkits that enable timely modifications and upgrades of complex autonomous behaviors; have modular open-systems mission hardware; and meet military certification and acquisition requirements.

Air Force researchers are interested in the ability autonomously to avoid other aircraft, terrain, obstacles, and hazardous weather; conduct autonomous takeoffs and returns; have separate sensor payloads and flight computers to allow for modular adjustments and adaptability; and have mission-planning software that integrates with next-generation Air Force mission planning tools that emphasize modularity and openness.

Researchers also want Skyborg to be an autonomous aircraft that can operate with personnel who have limited engineering or pilot experience. On these contracts, the nine companies will do the work at various locations around the U.S., and should be finished by July 2026.

Wearable controller for unmanned vehicles and sensors introduced by Persistent Systems

Persistent Systems LLC in New York is introducing the Rugged Display and Controller (RDC) for the MPU5 mobile ad hoc networking (MANET) device to enable users to interact with other users, unmanned systems, and sensors. The wearable RDC offers improved ruggedness, ergonomics, and enterprise-class management in one of the few Android end-user devices made in America. The controller enables the operator to receive voice, video, and situational awareness data from every user, unmanned systems, and sensor on the network. Designed for tactical users who wear gloves, the RDC has buttons that include the Android standard Home, Back, and app overview buttons. When connected, the RDC appears to Android as a game pad input device with two joysticks, rocker-switches, A-B-X-Y buttons, and an emulated D-Pad. Joysticks on the wearable device

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Boeing to develop new payloads for Orca large long-range unmanned submarines

BY **John Keller**

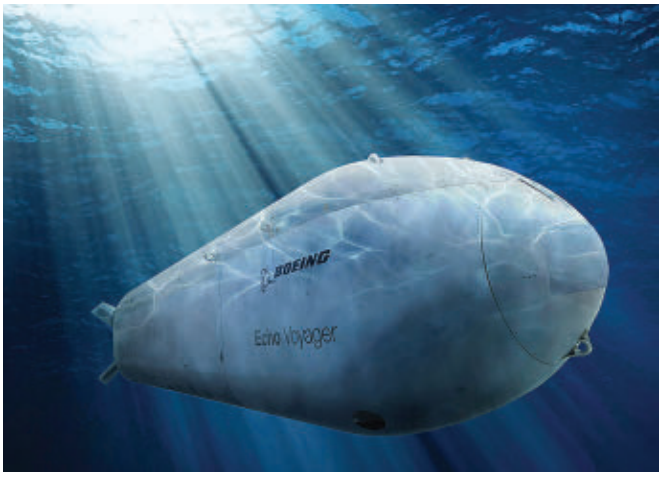
WASHINGTON — Undersea warfare experts at the Boeing Co. will develop new capabilities, payloads, and applications for the Orca Extra-Large Unmanned Undersea Vehicle (XLUUV) under terms of an $11.1 million order announced in late September.

Officials of the U.S. Naval Sea Systems Command in Washington announced are asking the Boeing Defense, Space & Security segment in Huntington Beach, Calif., for engineering services to expand the XLUUV's role in future naval operations.

The modular-construction Boeing Orca XLUUV is to be an open-architecture reconfigurable unmanned underwater vehicle (UUV) with the core vehicle providing guidance and control, navigation, autonomy, situational awareness, core communications, power distribution, energy and power, propulsion and maneuvering, and mission sensors, Navy officials say.

Boeing won a $43 million Navy contract in early 2019 to build four XLUUVs, which are autonomous mini-submarines based on the Boeing-designed Echo Voyager large UUV. Echo Voyager's advanced autonomy enables it to operate in clear and congested waters without physical human contact.

The Echo Voyager has a range of 6,500 nautical miles on one fuel module, can reach depths of 11,000 feet, and can operate independently for months underwater. It is 51 feet long, with a modular payload section as long as 34 feet and a volume of 2,000 cubic feet. Boeing unveiled the Echo Voyager in early 2016 and began sea trials of the unmanned undersea craft in summer 2017.



Boeing is developing new payloads and applications for the Orca extra-large unmanned underwater vehicle, shown above.

The large UUV's navigation system uses a Kalman-filtered inertial navigation unit supported by Doppler velocity logs and depth sensors. Powering the vessel is a hybrid combination of batteries and marine diesel generators. It can launch from shore or from large military ships with well decks, or from large civil vessels with moon pools.

The Lockheed Martin Rotary and Mission Systems segment in Riviera Beach, Fla., also has been involved in designing prototype XLUUV systems.

The Boeing Orca XLUUV will have well-defined interfaces for future upgrades to capitalize on advances in technology and respond to threat changes. The Orca XLUUV will have a modular payload bay, with defined interfaces to support current and future UUV payloads.

XLUUVs, which are among the largest unmanned submersibles ever conceived, will be for long-endurance surveillance missions or undersea cargo vessels to deliver other sensor payloads and other UUVs.

These large unmanned undersea vehicles eventually could be used as motherships to deploy and recover smaller surveillance UUVs on far-flung reconnaissance, surveillance, or special warfare missions in the open ocean or along coastlines and inside harbors.

The Navy's XLUUV project is moving enabling technologies forward that were developed originally in other projects such as the DARPA Hydra program to develop an unmanned submersible large enough to transport and deploy UAVs and UUVs stealthily in enemy territory to respond quickly to situations around the world.

On this order Boeing will do the work in Huntington Beach, Calif.; and Cockeysville, Md., and should be finished by September 2021. For more information contact Boeing Defense, Space & Security online at www.boeing.com/company/about-bds, or Naval Sea Systems Command at www.navsea.navy.mil.

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enable users to navigate their applications to zoom in, and hot keys help users switch between functions. The unit's accelerometer, gyroscope, magnetometer, thermometer, pressure, light sensors, and rear-facing camera incorporate motion, orientation, and environmental data. For more information contact Persistent Systems online at www.persistentsystems.com.

Air Force to test high-power microwave weapon to destroy unmanned swarms

The U.S. Air Force Research Laboratory at Kirtland Air Force Base, N.M., is investing $16 million in further field assessment of Raytheon's Phaser High Power Microwave System outside the continental U.S. The testing phase will span over 12 months in which the Phaser will engage simulated and real unmanned aerial vehicle (UAV) threats. The evaluation will explore the effectiveness of Phaser's counter-drone engagement without disrupting the necessary installation operations. The effectiveness of Phaser against drone swarms already has been demonstrated at the Army MFIX exercise in 2018, when the system eliminated 33 drones, two to three at a time. Currently mounted on a shipping container-like box, Raytheon plans to reduce the size significantly in future versions. AFRL already evaluates two other high-power microwave systems — the Tactical High-Power Operational Responder (THOR), that deploys as a means to provide base defense against drones, and 'Counter-Electronic High-Power Microwave Extended-Range Air Base Air Defense' system, or CHIMERA, designed to engage multiple targets over a larger area.

General Dynamics to begin producing Stryker IM-SHORAD UAV defense system

Officials of General Dynamics Land Systems in Sterling Heights, Mich., say their company received a $1.2 billion U.S. Army contract to provide systems that defend forces against drones and other aircraft. The Army's initial order calls for producing 28 Stryker Interim Maneuver Short-Range Air Defense (IM-SHORAD) air-defense vehicles for $230 million. IM-SHORAD is designed to counter threats from unmanned aerial vehicles (UAVs), helicopters, and fixed-wing aircraft. The IM-SHORAD Stryker combat vehicle included a mission equipment package designed by Leonardo DRS, which includes the Raytheon Stinger vehicle missile launcher.

Military could treat artificial intelligence as any intelligence

The U.S. military is rolling out artificial intelligence (AI)-enabled projects like the Air Force's Airborne Battle Management System or the Army's Project Convergence. The novelty of these demonstrations and the effort required to pull them off suggest that unlike Silicon Valley, the U.S. Department of Defense (DOD) is struggling to incorporate AI into its combat systems, aircraft, ships, and other equipment. DOD promulgated an Artificial Intelligence Strategy, established the Joint Artificial Intelligence Center, and the services all stood up their own AI offices, so we know they're trying hard. The problem is these initiatives treat AI as a tool rather than a method for using a tool. The model of AI as technique suggests a new way to think about its use by the military. Warfighters should treat AI as just another form of military intelligence. Officers don't need to be experts in biology to lead a division or squad; they need to understand their subordinates' knowledge, motivations, and strengths or limitations.

Arete to build multispectral sensors for Marine Corps unmanned mine detection

BY **John Keller**

PANAMA CITY, Fla. — Electro-optics experts at Arete Associates in Northridge, Calif., are building additional multispectral unmanned aircraft sensor payloads to help unmanned helicopters detect and pinpoint enemy mines and obstacles in beach surf zones to help keep Marines safe during amphibious landings.

Officials of the Naval Surface Warfare Center Panama City Division in Panama City, Fla., announced an $18 million order for Arete to build AN/DVS-1 Coastal Battlefield Reconnaissance and Analysis (COBRA) Block I systems.

Carried on the Navy Northrop Grumman MQ-8 Fire Scout unmanned helicopter, the sensor system has limited detection capability in the surf zone. It enables operators and personnel to remain at safe distances for mine detection. COBRA will be deployed from the littoral combat ship and is an integral part of the ship's mine countermeasures mission package.

COBRA uses multispectral sensors to conduct unmanned aerial tactical reconnaissance to detect and localize mine fields and obstacles in the surf zone and beach zone prior to amphibious assault.

A multispectral image contains data within specific wavelength ranges to extract information the human eye fails to capture with its receptors for red, green, and blue. It measures light in 3 to 15 spectral bands to help detect otherwise-invisible mines.

The AN/DVS-1 COBRA passive multispectral sensor system is for unmanned helicopters to perform daytime surface-laid mine line and obstacle detection in the beach zone, and has off-board processing, Arete experts say.

The COBRA payload includes stabilized step stare digital gimbal, high-resolution multispectral imaging digital camera with spinning six-color filter wheel, a processing unit, and a solid-state data storage unit.

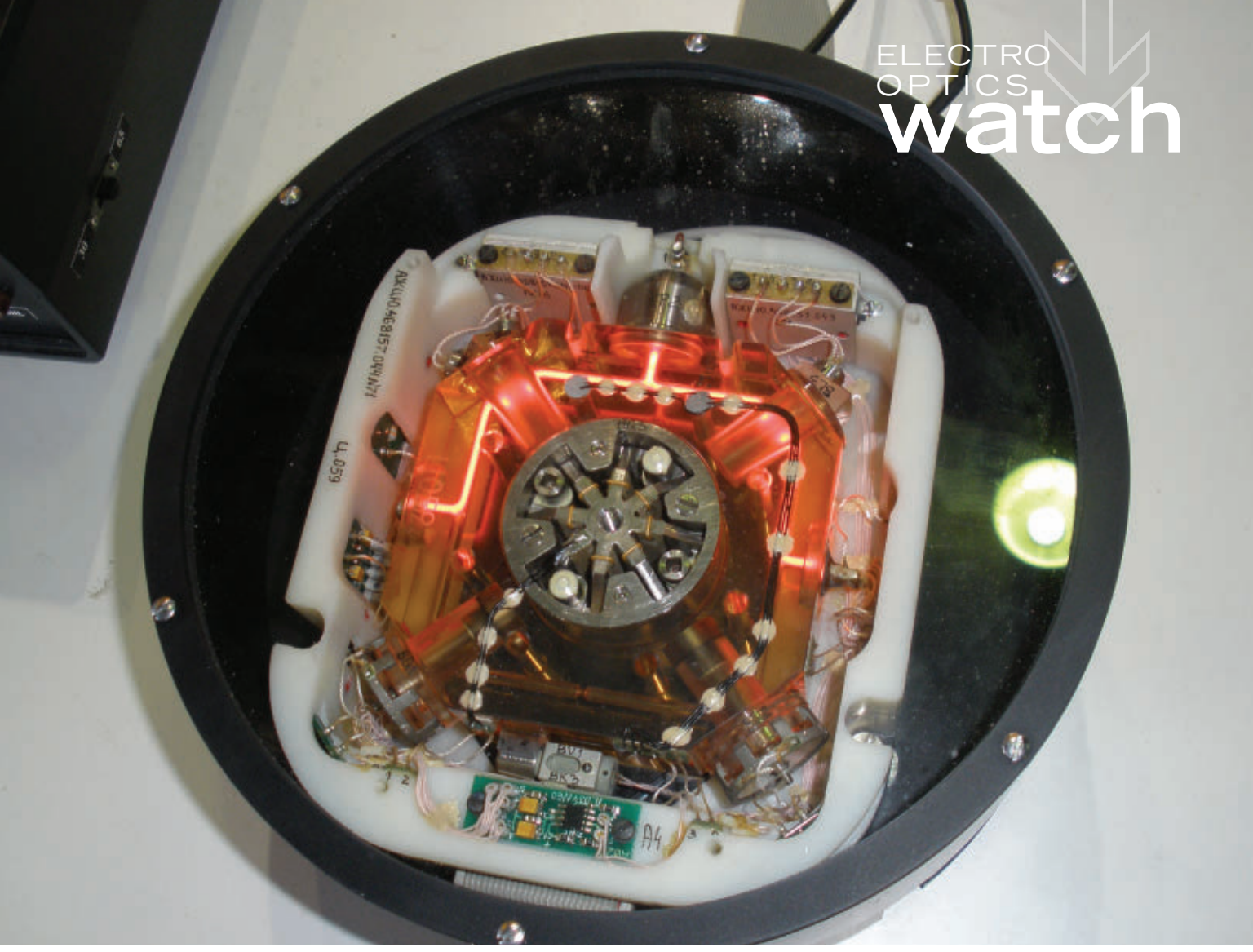
The gimbal is about 19 inches long and 11 inches in diameter, and collects six different color-band images across a large area using a step-stare pattern. At the mission, personnel load its data storage unit into a post mission analysis station.

The COBRA Block I system has two airborne payloads, the post mission analysis station, and the tactical control system segment for the UAV ground control station to plan the flight tracks for the COBRA mission, monitor the mission, and reprogram the flight path if necessary.

COBRA began as a U.S. Marine Corps advanced technology program in the 1990s. The system uses incremental development, with three initial blocks of development planned with each introducing new or enhanced capabilities. COBRA Blocks II and III are in concept refinement and technology development.

The U.S. Marine Corps will use multispectral sensors aboard the MQ-8 Fire Scout unmanned helicopter to detect and pinpoint buried mines on invasion beaches.

On this order Arete Associates will do the work in Tucson, Ariz.; Destin, Fla.; and Santa Rosa, Calif., and should be finished by September 2021. For more information contact Arete Associates online at https://arete.com, or the Naval Surface Warfare Center Panama City Division at www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Panama-City.



Northrop Grumman to build AN/WSN-7 ring laser gyro shipboard navigation

BY **John Keller**

WASHINGTON — U.S. Navy shipboard navigation and guidance specialists are continuing their efforts to squeeze all the life they can out of the AN/WSN-7 ring laser gyro navigation system for Navy surface vessels and submarines.

Officials of the Naval Sea Systems Command in Washington have announced a $210.1 million order to the Northrop Grumman Corp. Sperry Marine segment in Charlottesville, Va., to build more of the company's AN/WSN-7 navigation systems.

The AN/WSN-7 is a self-contained, ring laser gyro inertial navigation system that senses ship motions, computes the ship's precise position, velocity, attitude, heading, and rates in digital and analog formats, and forwards the data to other vital ship systems.

The WSN-7 has been in service with the Navy for decades, and was designed as a replacement for spinning-mass gyro navigation equipment aboard Navy warships. The system is as a more reliable strapdown ring laser gyro-based replacement for the old WSN-2 navigation system.

The AN/WSN-7 offers accuracy of one nautical mile deviation over 24 hours. Navy officials are extending the

Photo (above): Northrop Grumman Sperry Marine will build ring laser gyros for the U.S. Navy's AN/WSN-7 ring laser gyro navigation system for surface vessels and submarines.

life of the WSN-7 as long as possible as they develop a WSN-7 replacement.

Sperry Marine is developing the Inertial Navigation Systems Replacement (INS-R) Inertial Sensor Module (ISM) as a replacement for the WSN-7, to enable surface vessels to navigate accurately without GPS satellite navigation. This new system will be called the AN/WSN-12.

Sperry Marine reported completion of the ISM's preliminary design review in May 2016. The ISM will be a critical component on the INS-R WSN-12 replacement for the WSN-7. Preliminary design review means a system is operationally effective, and clears the way for detail design. First deliveries of WSN-12 engineering development models are schedule for later this year.

The INS-R will provide mission critical ship positioning, velocity, and altitude data to shipboard sensors, combat systems, guns, and missile systems. It will use an open-systems architecture using a modular design, standards-based interfaces, and widely supported consensus-based standards.

The AN/WSN-7, meanwhile, uses 25-year-old technology based on the NATO MK49 inertial navigation system deployed in the late 1980s. The INS-R will provide improved real-time navigation for Navy surface warships, and enable future technology growth.

The standard WSN-7 shipboard configuration consists of two independent cabinets for redundancy and survivability. It is not be susceptible to jamming or detection by enemy forces.

The ring laser gyro uses two counter-propagating laser beams operating on different frequencies with the difference dependent on rotation rate. Measurement of this difference provides the rotation angle or rotation rate about the device's sensitive axis.

Compared with older spinning-mass gyro navigation systems, ring laser gyros are much smaller, do not resist changes in direction, are frictionless, have low power consumption, and feature almost no moving parts to enhance reliability while still providing adequate accuracy.

On this order Sperry Marine will do the work in Charlottesville, Va., and should be finished by December 2022. For more information contact Northrop Grumman Sperry Marine online at www.northropgrumman.com, or Naval Sea Systems Command at www.navsea.navy.mil.

NASA reveals plans for Landsat Next Earth-observation satellite with advanced imaging sensors

BY **John Keller**

GREENBELT, Md. — U.S. space experts are asking industry to weigh-in on plans to build and launch a next-generation Landsat Earth-observation imaging satellite in the late 2020s with enhanced sensor capabilities.

Officials of the U.S. National Aeronautics and Space Administration (NASA) Goddard Space Flight Center in Greenbelt, Md., have issued a request for information (RFI2020LandsatNext) for the Landsat Next project, which by late this decade is expected to offer sensors for superspectral land observations with high-spectral and high-resolution imagery of the Earth's surface.

These improved Earth images are to be for agricultural monitoring, ecological monitoring, urban studies, water resources management, and related applications. Sharing a role in the Landsat Next project is the U.S. Geological Survey (USGS) in Reston, Va.

In addition to enhanced imaging capability, the Landsat Next project also is expected to offer users more frequent satellite coverage — at least once every eight days, NASA officials say.

For the past 48 years, Landsat satellites and ground sites have made available global multispectral Earth images of 15-to-120-meter resolution for research on land use change, forest health, carbon inventories, and changes to Earth's environment, climate, and natural resources.

Researchers in government, academia, and industry use Landsat data for resource issues like water resource management, wildfires, agricultural productivity, rangeland management, and understanding impacts of climate variability on ecosystems.

The USGS today operates two spacecraft, Landsat 7 and 8, which NASA developed. Landsat 9, a near copy of Landsat 8, is under development, and is expected to begin operations in 2021. Together these satellites can cover the entire Earth's surface every 16 days.

Landsat 8 and 9 each host two instruments: the Operational Land

The next-generation Landsat spacecraft will have enhanced sensor capabilities able to make superspectral land observations with high-spectral and high-resolution imagery of the Earth's surface.

Imager (OLI) that provides multispectral imaging in the visible-light to shortwave infrared spectral; and the Thermal Infrared Sensor (TIRS) that gathers long-wave infrared imagery.

Now government experts are looking forward to the next satellite, Landsat Next, which will operate during the 2030s, which should gather images of the Earth's surface cloud-free. The future satellite should enable the merging of its data with those of other spacecraft to achieve near-daily coverage for many applications.

Landsat Next also should enable new applications like monitoring surface water quality, cryospheric science, geology, agricultural crop water consumption, and improved estimation of surface temperatures.

Landsat Next may use just one spacecraft, or a constellation of three to five satellites with relatively narrow fields of view. Using a constellation of satellites, instead of just one spacecraft, would improve system resiliency, enable use of on-orbit spares, increase revisit frequency, save costs of Earth-observation sensors, and enable quick technology infusion.

Enabling technologies envisioned for Landsat Next include a new generation of focal planes and free-form optics to help acquire more spectral bands with relatively small instruments. Experts predict that each Landsat Next satellite will have either a single instrument that acquires all visible-through-shortwave infrared and thermal infrared spectral bands, or two instruments that acquire these spectral bands separately.

The Landsat Next spacecraft is expected to operate in a polar, frozen, sun-synchronous orbit with repeating ground track by using propulsive maneuvers for orbit maintenance.

The Landsat Next ground station may continue using the existing Landsat Multi-mission Operations Center at NASA Goddard Space Flight Center in Greenbelt, Md., or may pursue a commercial service-based mission operations center.

The future satellite also may use increased machine autonomy decrease the frequency of command and fault-management uplinks.

From industry, NASA and USGS experts want comments on potential instrumentation approaches; mission architecture approaches. Of interest are comments on the technical viability of using compact instrumentation suitable for a constellation approach.

Experts also want industry opinions on necessary payload size, weight, power consumption, and cost (SWaP-C). Companies interested should email 12-page white papers to NASA at gsfc-landsatnext-rfi2020a@lists.nasa.gov. Email questions or concerns to the same address.

More information is online at https://beta.sam.gov/opp/09a18f980f67449fa10608ecb0924883/view.

Wanted: electro-optical sensors with machine learning algorithms for defense applications

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking industry to develop a new kind of camera and digital signal processing to enable intelligent electro-optical sensors for tactical military applications.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a broad agency announcement (HR001121S0001) for the Fast Event-based Neuromorphic Camera and Electronics (FENCE) program.

DARPA FENCE seeks to develop and demonstrate a low-latency, low-power, event-based camera and a new class of digital signal processing and machine learning algorithms that use combined spatial and temporal information to enable intelligent sensors for tactical military applications.

Neuromorphic describes silicon circuits that mimic brain operation; it exhibits low latency, sparse output, and extreme energy efficiency. Neuromorphic cameras offer sparse output, and respond only to changes in the scene, with accompanying low latency and low power for small-format cameras in sparse scenes.

Event-based imaging sensors operate asynchronously, and only transmit data from pixels that have changed, so they produce 100 times less data in sparse scenes than traditional focal plane arrays (FPAs). This leads to 100x lower latency at 100x lower power.

The DARPA FENCE program seeks to develop a fast, low-power event-based camera digital signal processing algorithms, and machine learning for intelligent sensors in tactical military applications.

Despite their inherent advantages, existing event-based cameras are not compatible with military applications because military images are cluttered and dynamic. The FENCE program seeks to develop an integrated event-based infrared focal plan array with embedded processing to overcome these challenges.

The FENCE program's primary focus is on developing an asynchronous read-out integrated circuit (ROIC) capable of very low latency and power operation, and a new, low-latency event-based infrared sensor with in-pixel processing.

The project also will develop a low-power processing layer that integrates with the ROIC to identify relevant spatial and temporal signals. The ROIC and the processing layer together will enable an integrated FENCE sensor that can operate on less power than 1.5 Watts.

The FENCE program will last for four years. Contractors must have personnel with collateral SECRET clearances and access to an accredited facility and secure communications to support classified development.

DARPA researchers are not interested in proposals that produce spiking event-driven cameras that are not cryogenically cooled or have cutoff wavelengths less than 3 microns; that use low technology readiness level (TRL) detector materials not fielded in military systems; or have amalgamations of existing imagers that are neuromorphic but that are not using the event-driven asynchronous methodology.

DARPA officials say they plan to award contracts to several companies. Companies interested were asked to submit unclassified abstracts by 1 Nov. 2020, and full proposals no later than 16 Dec. 2020 to the DARPA BAA website at https://baa.darpa.mil.

Classified abstracts and proposals should be submitted by post or by messenger to DARPA, attn. Program Security Officer, MTO, 675 North Randolph St., Arlington, VA 22203-2114.

Email questions or concerns to Whitney Mason, the FENCE program manager, at HR001121S0001@darpa.mil. More information is online at https://beta.sam.gov/opp/dd33f3e8d0104290a42f74d8a07e99a3/view.

Industrial-grade camera for computer vision introduced by Teledyne e2v

Teledyne e2v, a Teledyne Technologies company in Grenoble, France, is introducing the 2 Megapixel (2MP) compact camera module for computer vision applications like scanning and embedded vision. The 2MP has a pre-focused industrial-grade scanning optic. This MIPI interfaced module includes a small state-of-the-art Snappy 2MP CMOS sensor with a 2.8-micron low-noise global shutter pixel. Designed for scanning and embedded vision applications, the sensor includes the patented Fast Self-Exposure mode for correct exposure and fast decoding and image processing by the downstream digital system, even in rapidly changing light conditions. The module has a 20-by-20-by-16-millimeter mechanical outline and has a high-depth-of-field lens for applications that typically require a wide working range. For more information contact Teledyne e2v online at www.teledyne-e2v.com.

Maritime sensor with night-vision for surveillance introduced by FLIR

FLIR Systems Inc. in Wilsonville, Ore., is introducing the SeaFLIR 280-HDEP high-performance maritime surveillance sensor system to identify and track smugglers, terrorists, or any other threat, day and night, on rough seas. Designed for full-time, all-weather maritime duty, SeaFLIR 280-HDEP provides long-range target detection, identification, and tracking for intelligence, surveillance and reconnaissance (ISR); maritime search and rescue; interdiction; covert operations; exclusive economic zone constabulary; and disaster recovery. Qualified to MIL-STD-461 and MIL-STD-810, SeaFLIR 280-HDEP has several near-infrared and shortwave infrared sensors, and laser illuminator and pointer options light up targets for personnel with night-vision capability. The maritime sensor system has a thermal-imaging camera, daylight camera, low-light camera, spotter scope, and laser payloads. It measures 14.25 by 16 inches and weighs 60.2 pounds. The open-architecture SeaFLIR 280-HDEP offers a modular, scalable control electronics unit able to host high-power video processing and trained convolutional neural networks from FLIR and third-party solutions. For more information contact FLIR Systems online at www.flir.com.

Optical imaging cameras for machine vision introduced by Teledyne DALSA

Teledyne DALSA in Waterloo, Ontario, is introducing the Falcon4-CLHS M4480 and M4400 cameras for industrial imaging applications that require high-speed data transfer such as aerial imaging, machine vision, industrial automation, and semiconductor inspection. Based on the Teledyne e2v Lince 11.2M monochrome sensors, the Falcon4-CLHS models deliver easy-to-use, CLHS interface cameras that can reach speeds of multiple thousands of frames per second in partial scan mode, and when using the sensor's binning mode, can reach a very large pixel full well capacity of over 160Ke. The Falcon4-CLHS optical sensor system leverages standard cabling such as CX4 and fiber optic (AOC) cables to make the most of length and speed. Features include two models in 11.2M monochrome versions; large full well capacity when using in-sensor binning more than 160Ke; thousands of frames per second in partial scan mode (ROI); and an all-metal body with three-year warranty. For more information contact Teledyne DALSA online at www.teledynedalsa.com.

High-temp infrared light-emitting diode (IRLED) for covert exterior aircraft lighting offered by Opto Diode

Opto Diode Corp. in Camarillo, Calif., is introducing the OD-110WISOLHT high-temperature, wide-angle infrared light-emitting diode (IRLED) for high-temperature applications, such as covert exterior aircraft lighting. The device features a peak emission wavelength of 880 nanometers and total power output ranging from 60 milliwatts to 120 milliwatts. With a spectral bandwidth of 55 nanometers, the IRLED has a half-intensity beam angle of 110 degrees and is packaged in a two-lead TO-39 can with an isolated case. Forward voltage is 1.75 volts to 2 volts; reverse breakdown voltage ranges from a minimum of 5 volts to 30 volts. IRLED for aircraft lighting features a continuous forward current of 500 milliamps, power dissipation at 1,000 milliwatts, and peak forward current of 1.5 amps while the reverse voltage is 5 volts. The lead soldering temperature at 1/16 of an inch from the case for 10 seconds is 260 degrees Celsius. For more information contact Opto Diode online at https://optodiode.com/pdf/OD110WISOLHTDS.pdf.

ELECTRONIC WARFARE

Lockheed Martin to build AH-64E EW system to counter enemy radar

U.S. Army combat helicopter designers needed electronic warfare (EW) systems to enable the AH-64E Apache Guardian attack helicopter to detect and identify enemy radar threats. They found their solution from Lockheed Martin Corp.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., have announced a $19 million contract to the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y., to build the Modernized-Radar Frequency Interferometer (MRFI).

The MRFI identifies intelligence, surveillance, and reconnaissance (ISR) emitters, and helps the AH-64E pilot to detect and engage an enemy radar threat long before the aircraft becomes vulnerable.

The system quickly detects, identifies, and locates enemy radar, and then ranks these hostile radars in order of priority for subsequent ground attack.

The MRFI is part of the AH-64E's digital receiver-based AN/APR-48B system, which performs target acquisition and cueing for the helicopter's fire-control radar system.

It also can deliver warning of radar directed antiaircraft threats and serve as the controller for an integrated aircraft survivability equipment. The system provides high sensitivity and precision angle of attack in a lightweight, modular configuration

The AN/APR-48B system primarily operates on a dual-redundant MIL-STD-1553B databus. Other commercial I/O interfaces available for future growth include Gigabit Ethernet, RS-232, and RS-422.

On this contract Lockheed Martin will do the work in Owego, N.Y., and should be finished by February 2023. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa.

WEAPONS CONTROL

Marvin to build missile launchers and bomb-ejector racks for Navy combat jets

U.S. Navy aerial warfare experts are ordering special new missile launchers and bomb-ejector racks to enable Navy F/A-18 Hornet jet fighter-bombers to carry the nation's latest and most lethal air-to-air missiles and smart munitions.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md. have announced a $132.5 million contract to Marvin Engineering Co. Inc. in Inglewood, Calif., to build as many as 1,339 BRU-32B/A bomb-ejector racks and as many as 1,056 LAU-127E/A guided missile launchers for the Navy the F/A-18E/F and EA-18G fighter-bomber and electronic warfare (EW) carrier-based jets.

The BRU-32B/A is the successor to the earlier BRU-32A/A, the latter of which is integrated on early-model F/A-18A/B/C/D Hornet jet fighter-bomber aircraft.

These systems are heavy-duty dual-piston pyrotechnic bomb-ejector racks to carry and release bombs, smart weapons, and other munitions that weight as much as 4,200 pounds. It features automatic store sway bracing and allows for 14- or 30-inch suspension from underneath the aircraft's wings. The BRU-32B/A is 37 inches long, 7.3 inches wide, 7.5 inches high, and weighs 76 pounds.

The Marvin LAU-127 missile rail launcher, meanwhile, enables the F/A-18 carrier-based strike fighter to carry and launch the radar-guided AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) and the AIM-9X Sidewinder heat-seeking missile.

This contract involves LAU-127E/A, which has a slight weight variation from the Marvin LAU-127A/A, LAU-127B/A, LAU-127C/A, LAU-127D/A, and LAU-127F/A versions.

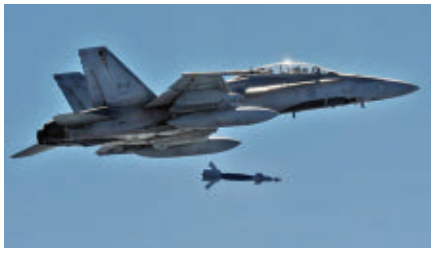
The LAU-127 provides the electrical and mechanical interface between the AMRAAM and AIM-9X air-to-air missile systems and F/A-18 combat jets, as well as the two-way data transfer between the missile and the aircraft's cockpit controls and displays.

The electrical interfaces between the LAU-127 and the F/A-18 air crew also supports preflight orientation and control circuits to prepare and launch the missiles.

The Marvin LAU-127 is part of a family of single-rail missile launchers that fire AIM-9 Sidewinder of AIM-120 AMRAAM missiles from under-wing stations of the aircraft, mounted to pylons, or on wingtip stations.

The LAU-127E/A is integrated with F/A-18A/B/C/D Hornets, F/A-18E/F Super Hornets and EA-18 Growlers. It contains a power supply and a supply of bottled nitrogen coolant for the missile seeker heads. The missile launcher is nearly nine feet long, 3.6 inches wide, and 6 inches high, and weighs 87 pounds.

On this contract Marvin Engineering will do the work in Inglewood, Calif., and should be finished by September 2027. For more informa-



tion contact Marvin Engineering online at http://marvineng.com, or Naval Air Systems Command at www.navair.navy.mil.

TEST AND MEASUREMENT

Lockheed Martin to upgrade eCASS to troubleshoot electro-optical targeting

U.S. Navy test and measurement experts needed the ability to test, diagnose, and repair electro-optical targeting systems on carrier-based helicopters and combat jets at shore bases and aboard surface warships. They found their solution from Lockheed Martin Corp.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J. announced a $21.4 million contract Wednesday to the Lockheed Martin Rotary and Mission Systems segment in Orlando, Fla., for the Electro-Optics fourth generation (EO4) console.

The EO4 electro-optical test console subsystem part of the electronic Consolidated Automated Support System family of automatic test systems, which is designed to help sailors and Marines troubleshoot and repair aircraft assemblies at sea or ashore and return the avionics to service quickly.

The EO4 subsystem of eCASS helps sailors and Marines test, diagnose and repair the Multispectral Targeting System aboard the Navy's SH-60 helicopter and Advanced Targeting Forward Looking Infrared weapon system aboard the F/A-18E/F jet fighter-bomber.

The EO4 component of eCASS is to replace the system's legacy Electro-Optics third generation console configuration to mitigate obsolescence, decreased availability, and rising sustainment costs.

The eCASS test equipment is replacing the Navy's legacy CASS test equipment originally fielded in the early 1990s. CASS is the Navy's standard automatic test equipment family supporting electronics on naval aircraft.

The first eCASS station went to the Navy in February 2014 to support all the aircraft in the Navy's fleet, extending to new weapons systems such as the F-35 Lightning II joint strike fighter.

The eCASS station is the workhorse for avionics repair across the naval aviation enterprise, Lockheed Martin officials say. The test gear helps aircraft maintenance technicians return equipment to readiness status quickly and efficiently. Compatibility with legacy CASS stations preserves the Navy's investment in more than 550 test program sets supporting 750 avionic components.

Lockheed Martin technicians will build and deliver EO4 consoles, eCASS interface cables, host eCASS augmentation assets, EO carts, and installation kits with mounting rails, shock isolators, and related components.

On this contract Lockheed Martin will do the work in Orlando, Fla., and should be finished by September 2023. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or the Naval Air Warfare Center Aircraft Division-Lakehurst at https://www.navair.navy.mil/lakehurst/.

SENSORS

FLIR Systems to provide BRITE Star II electro-optical targeting sensors

U.S. Navy avionics experts needed multi-sensor electro-optical targeting systems for manned and unmanned aircraft. They found their solution from FLIR Systems Inc. in Wilsonville, Ore.

Officials of the Naval Surface Warfare Center in Crane, Ind., has announced a $14.6 million contract to FLIR Systems for BRITE Star Block II multi-sensor targeting imaging systems.

The contract includes repair, data, training and engineering, and is for BRITE Star Block II systems for the U.S. Navy and for the Czech Republic under the Foreign Military Sales (FMS) program.

The BRITE Star Block II multi-sensor targeting imager provides intelligence, surveillance and reconnaissance (ISR), as well as target detection,

identification, and designation in daylight and at night for manned and unmanned aircraft.

The FLIR BRITE Star II has a 640-by-480-pixel indium antimonide focal plane array infrared thermal imager, a three-chip charged-coupled device (CCD) color daylight camera, as well as laser target designator, laser rangefinder, and laser pointer packaged in a chin-mounted pod for helicopters and fixed-wing aircraft. The system measures 16.2 by 19.3 inches and weighs 113.5 pounds.

The imaging avionics system has an inertial measurement unit (IMU) and navigation processor, as well as automatic target tracker. It is designed for target designation, armed reconnaissance, surveillance, and attack missions. The system and can be switched quickly among different aircraft.

On this contract FLIR Systems will do the work in Wilsonville, Ore., and should be finished by September 2025. For more information contact FLIR Systems online at www.flir.com.

FLIGHT COMPUTERS

General Dynamics to upgrade avionics computers for Navy combat jets

Military avionics experts at General Dynamics Corp. will upgrade U.S. Navy upgrade aircraft computers for the F/A-18E/F Super Hornet and EA-18G Growler combat aircraft with an extra microprocessor under terms of a $13.1 million contract announced last month.

Officials of the Naval Air Warfare Center's Aircraft Division at Patuxent River Naval Air Station, Md., are asking the General Dynamics Mission Systems segment in Bloomington, Minn., to upgrade Navy-owned Type 3 Advanced Mission Computers (AMC) with a fourth general purpose processor (GPP) to create a Type 3 extra processor.

The contract also asks General Dynamics to upgrade of all the Warfare Management Computer A11 cards with mission system computer equivalent GPPs in support of Advanced Mission Computer and Display.

The General Dynamics Type 3 AMC is for the Super Hornet and Growler aircraft, as well as The Mission Systems Computer (MSC) for the AV-8B Harrier jump jet.

The AMC is a rugged embedded computer that performs general-purpose, I/O, video, voice, and graphics processing. Communication is over several buses, including 1553, Fibre Optic Fibre Channel, and Local PCI.

Single-board computers and other modules in the AMC fit in an industry standard 6U VME backplane, and the I/O configuration may be tailored with PMC mezzanine card (PMC) modules. An Ethernet interface supports software development and system maintenance.

The AMC's core system software (CSS) is a real-time operating system with embedded system software, application program interface, and diagnostic software set for the AMC. The computer's I/O includes MIL-STD-1553 drivers, Fibre Channel drivers, VMEbus drivers, and discrete and serial I/O drivers.

The AV-8B's mission computer is a VME-based processing system based on the Freescale Power-PC open-systems processor architecture. The mission computer can control mission computers and displays, digital maps, network processors, and servers.

The AMC is the nerve center of the Navy Super Hornet. The commercial off-the-shelf (COTS)-based, open-systems architecture product is configurable to many operating environments.

The flight and mission computer is designed to handle mission processing; sensor processing; display processing; stores management; and information management.

On this contract General Dynamics will do the work in Bloomington, Minn., and should be finished by September 2023. For more information contact General Dynamics Mission Systems online at https://gdmissionsystems.com, or the Naval Air Warfare Center Aircraft Division at www.navair.navy.mil/nawcad.

SATELLITE COMMUNICATIONS

Systems & Technology Research to develop affordable SATCOM for Blackjack

U.S. military researchers needed a company to develop small, secure, and affordable military satellite communications (SATCOM) payloads for low-Earth orbit (LEO) that capitalize on modern commercial satellite technologies. They found their solution from Systems & Technology Research LLC in Woburn, Mass.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., has announced a $79.5 million contract to Systems & Technology Research to develop and demonstrate satellite payloads for the DARPA Blackjack program.

Blackjack seeks to develop low-cost space payloads and commoditized satellite buses with low size, weight, power, and cost (SWaP-C) with similar capabilities to today's military communications satellites that operate at geosynchronous orbit (GEO), but at a fraction of the cost.

Systems & Technology Research will bus and payloads for a two satellite on-orbit demonstration; and demonstrate a two-plane system in low-Earth orbit for six months. These jobs represent phases two and three of the Blackjack program.

The DARPA Blackjack program seeks to orbit a constellation of small, secure, and affordable military satellites that capitalize on modern commercial satellite technologies.

Blackjack seeks to develop low-cost space payloads and commoditized satellite buses with low size, weight, power, and cost (SWaP-C) with similar capabilities to today's military communications that operate at geosynchronous orbit (GEO), but at a fraction of the cost.

Military satellites are critical to U.S. warfighting capabilities. Traditionally they are placed in GEO to deliver persistent overhead access to any point on the globe.

Yet in the increasingly contested space environment, these costly and monolithic systems are vulnerable targets that would take years to replace if degraded or destroyed. Moreover, their long development schedules make it difficult or impossible to respond quickly to new threats.

The Blackjack program seeks to develop enabling technologies for a global high-speed network backbone in LEO that enables networked, resilient, and persistent military payloads that provide infinite over-the-horizon sensing, signals, and communications capabilities.

Historically, U.S. Department of Defense (DOD) satellites have been custom-designed, with lengthy and expensive design and upgrade cycles. The evolution of commercial space, however, has led to LEO broadband Internet communications satellites that could offer attractive economies of scale.

The Blackjack program will emphasize a commoditized bus and low-cost interchangeable payloads with short design cycles and frequent technology upgrades, based on a 'good enough' payloads optimized for more than one type of bus.

Commoditized satellite buses based on open-architecture electrical, software, and mesh network interface control could provide a way for dozens or hundreds of different types of military satellite payloads to operate in low-Earth orbit, DARPA officials say.

The goal is to develop a 60-to-200-satellite constellation operating at altitudes of between 310.7 miles and 807.8 miles above the Earth's surface. One operations center will cover all government satellites and payloads, and the constellation will be able to operate without the operations center for 30 days. Blackjack payload data processing will be performed on-orbit without the assistance of ground data processing.

For more information contact Systems & Technology Research online at www.stresearch.com, or DARPA at www.darpa.mil.

POWER ELECTRONICS

Diversified Technologies to upgrade power in Cobra Dane missile-defense radar

U.S. Air Force missile-defense experts are continuing a long-term project to keep a 1970s-vintage strategic radar systems up and running with additional advanced power electronics technologies.

Officials of the Air Force Life Cycle Management Center at Peterson Air Force Base, Colo., announced a $71.1 million contract to Diversified Technologies Inc. in Bedford, Mass., for an upgrade to the AN/FPS-108 Cobra Dane radar.

Cobra Dane is a passive electronically scanned array installation at Eareckson Air Station on Shemya Island, Alaska, for missile-defense early warning, missile treaty verification, and space surveillance. The radar, which stands 120 feet tall and has a 95-foot-diameter face, became operational in 1977.

Diversified Technologies will build and factory-test as many as 11 new transmitter groups for the Cobra Dane radar, as well as install and check out the first three production transmitter groups.

Cobra Dane is a ground-based, L-band, phased-array radar that provides midcourse coverage for U.S. Strategic Command's Ballistic Missile Defense System. The radar can detect sea-launched and intercontinental ballistic missiles, classify re-entry vehicles and other missile objects and track threats with enough accuracy to commit to launching interceptors and update in-flight targeting data.

The contract to Diversified Technologies also calls for installation and testing instruction and oversight of the Cobra Dane's second and third production groups and technical support of the system's final eight production transmitter groups.

The Cobra Dane radar, which faces west toward the Russian the Kamchatka Peninsula and Kura Test Range, operates in the 1215-to-1400-MHz frequency band. It sends data to the North American Aerospace Defense Command (NORAD) at Peterson Air Force Base. It can detect objects as far away as 2,000 miles.

In recent years Cobra Dane has taken on the role of tracking deep-space satellites as part of the larger Space Surveillance Network and provides observation data to agency command and control nodes.

On this contract Diversified Technologies will do the work in Bedford, Mass., and should be finished by September 2025. For more information contact Diversified Technologies online at www.divtecs.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

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new PRODUCTS

To submit new products for consideration, contact John Keller at jkeller@endeavorb2b.com.

TEST AND MEASUREMENT

Digital I/O instrument for applications in harsh environments introduced by Marvin

Marvin Test Solutions Inc. in Irvine, Calif., is introducing the GX3756 series digital I/O instrument for aerospace and defense test and measurement applications. The field-programmable-gate-array (FPGA)-based GX3756 delivers 56 channels of TTL logic-compatible I/O, segmented into 14 four-channel groups, in a high-performance 3U PXI hybrid slot-compatible instrument. Users can access each I/O channel using read-and-write register commands and can enable or tri-state each group of four TTL outputs. The GX3756 test and measurement device has the GX3700 FPGA carrier card and an I/O daughter card. Users can modify the FPGA to create their own functions. Users can configure four of the 56 TTL outputs to deliver 30-bit, 1 kHz serial data streams, and identify cables connectors with three connector ID bits. TTL input overvoltage protection ensures safe, reliable operation, and output state monitoring with the readback function helps users verify programmed operation. The GX3756 series is supplied with GxFPGA software that includes a virtual instrument panel, and a Windows 32/64-bit DLL driver and documentation. Interface files are provided to support access to programming tools and languages such as ATEasy, LabVIEW, C/C++, Microsoft C#, and Visual Basic .Net. It also comes with a Linux driver with the GtLinux software package. For more information contact Marvin Test Solutions online at www.marvintest.com.

RF AND MICROWAVE

Circulators/isolators for 5G, satellite, and radio introduced by Pasternack

Pasternack, an Infinite Electronics brand in Irvine, Calif., is introducing a line of high-performance circulators/isolators for 5G telecommunications, automotive radars, satellite communications, point-to-point radios, and aerospace applications. These RF circulators/isolators consist of 75 models with a maximum power rating as high as 100 Watts. They cover operating frequency ranges to 42.5 GHz and provide isolation and low insertion loss. They come in SMA, N-type, 2.4-millimeter and 2.92-millimeter connectorized designs. An RF isolator is a twoport ferromagnetic passive device that protects other RF and microwave components from excessive signal reflection. An RF circulator is a three-port ferromagnetic passive device that controls the direction of signal flow in a circuit.

"These circulators/isolators are ideal for initial proof-of-concept testing and prototype builds. They deliver quality RF performance and can be shipped same day with no MOQ required," says Steven Pong, Product Line Manager at Pasternack. Pasternack's new high-performance circulators/isolators are in-stock and available for immediate shipping. For more information contact Pasternack online at www.pasternack.com.

BOARD PRODUCTS

SOSA-aligned 6U single-board computer introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing the rugged SBC6511 sixth-generation 6U single-board computer for heavy-throughput embedded computing applications. The SBC6511 is aligned with The Open Group's Sensor Open Systems Architecture (SOSA) technical standard, and gives users a technology insertion at the data plane, expansion plane, and control plane. The design combines the Intel Xeon E 9th Generation microprocessor with the Xilinx ZU7EG Zynq UltraScale+ field-programmable gate array (FPGA) with advanced security capabilities. The FPGA is the root of trusted-computing in the new design, giving users advanced security compared to "bolt-on" solutions found in other designs. Additionally, the SBC6511 uses Mellanox ConnectX-5 for dual 40 Gigabit Ethernet KR4 data plane fat-pipes for increased bandwidth. It supports Linux, Windows, and VxWorks software operating systems. For more information contact Abaco Systems online at www.abaco.com.

DESIGN AND DEVELOPMENT TOOLS

System-on-chip development kit for PolarFire SoC FPGA introduced by Microchip

Microchip Technology Inc. in Chandler, Ariz., is introducing the RISC-V-based system-on-chip (SoC) field-programmable gate array (FPGA) development kit for PolarFire SoC FPGA-the industry-leading low-power, low-cost, RISC-V-based SoC FPGA. The

kit supports the free and open RISC-V instruction set architecture (ISA) for affordable, standardized development that embeds RISC-V technology and uses the RISC-V ecosystem. Designers who want to deploy a programmable RISC-V-based SoC FPGA can use the kit to start development and evaluate the broad network of RISC-V ecosystem products such as real-time operating systems (RTOS), debuggers, compilers, system on modules (SOMs) and security solutions. Microchip's Icicle Kit for PolarFire SoC and Mi-V ecosystem enables PolarFire SoC FPGAs with RISC-V processor complex from SiFive and embedded trace macro from UltraSoC; development tools from Adacore, Green Hills Software, Mentor Graphics and Wind River; commercial RTOS solutions such as Nucleus and VxWorks that complement Microchip's Linux and bare-metal solutions; middleware solutions from DornerWorks, Hex Five, Veridify Security and wolfSSL; and SOM and design services from organizations such as Antmicro, ARIES Embedded, Digital Core Technologies, Emdalo Technologies, Sundance DSP, and Trenz Electronic. For more information contact Microchip Technology online at www.microchip.com.

INTERCONNECT PRODUCTS

Spring-loaded power pins in a small form factor introduced by Mill-Max

Mill-Max Mfg. Corp. in Oyster Bay, N.Y., is introducing spring-loaded pins that deliver high current-carrying capacity in a small form factor for charging applications and delivering power via cable or board-to-board interconnects. These spring-loaded contacts are for docking stations, quick connects, blind mating applications, and board-to-board and cable connectors. The reduced size makes them suitable for low profile and dense packaging designs. The pins come in three different termination styles: surface mount, through-hole, and solder cup. Pins are available in three different termination styles: surface mount, through-hole, and solder cup. They have a current-carrying capacity of six amps at 30 degrees Celsius of temperature rise, with an above-board height of 0.204 inches for the surface-mount and through- hole versions. The solder cup version 0.374 inches long, and all have a maximum diameter of 0.083 inches. These design features result in low overall bulk resistance, efficient heat dissipation and electrical conductivity. Other attributes include gold plating on all components; cycle life rating of 1,000,000 at half stroke; a maximum contact resistance of 20 micro-Ohms, and spring force of 60 grams at mid stroke. For more information contact Mill-Max online at www.mill-max.com.

RUGGED COMPUTERS

Rugged computer servers for electronic warfare (EW) introduced by Crystal

Crystal Group Inc. in Hiawatha, Iowa, is introducing three rugged computer servers: the RS4105L22 4U GPU server, RS1.532L21X2F twin server, and Crystal Group FORCE RS2606 — all designed for ultra-high intelligence, surveillance, and reconnaissance (ISR) performance. Independently, each server delivers powerful performance, and when combined, these servers form an integrated system for real-time high-speed sensor data collection, computation, and daily hot-swappable data extraction. Optimized to extract and integrate data from multiple sensors via four NVIDIA Tesla V100 graphics processing units (GPUs), the RS4105L22 4U GPU server provides high-capacity storage for electronic warfare (EW), sensor fusion, signals intelligence, C4ISR, radar, and digital signal processing. Equipped with as many as 88 cores, the RS1.532L21X2F 1.5U rugged twin server delivers high-speed processing in a small form factor by consolidating capabilities of two separate computers into one unit with front I/O. For more information contact Crystal Group online at www.crystalrugged.com.

COMMUNICATIONS

System-in-package (SiP) for 5G communications introduced by Mercury

Mercury Systems Inc. in Andover, Mass., is introducing the RFS1080 trusted system-in-package (SiP) for aerospace and defense edge processing applications such as radar, electronic warfare (EW), and 5G communications. By delivering the latest commercially developed integrated circuits at chip scale, Mercury's SiP chips make the most of performance in a trusted and customizable architecture. The RFS1080 RF SiP uses high-speed digitization and field-programmable gate array (FPGA) technology to bring near real-time processing to harsh environments. The system-in-package offers wideband direct-to-digital operation; a compact ball grid array (BGA) package that measures less than two square inches; several communication protocols, including Ethernet and PCI Express; optional integrated Mercury BuiltSECURE IP with secure boot support; and support for vendor-agnostic chiplets for flexibility. The RFS1080 trusted SiP for edge processing meets requirements by the U.S. Department of Defense (DOD) for onshore manufacturing of critical microelectronics. For more information contact Mercury Systems online at www.mrcy.com.

CHASSIS AND ENCLOSURES

SOSA-aligned 3U OpenVPX embedded computing chassis introduced by Annapolis Micro

Annapolis Micro Systems Inc. in Annapolis, Md., is introducing the WC3170 next-generation 3U OpenVPX embedded computing chassis to help speed development of 40/100 Gigabit Ethernet systems that are aligned with the Sensor Open

Systems Architecture (SOSA) technical standard. The front-loading air-cooled COTS benchtop chassis has seven conduction-cooled slots four for payload, one for an I/O-intensive single-board computer, one 40/100 Gigabit Ethernet switch, and one VITA 62 power supply that delivers 700 Watts of power. Payload slots for the embedded computing chassis feature VITA 66.5C and VITA 67.3C connectivity, and optional MIL-DTL-38999 SOSA-aligned circular connectors with 19 RF connections. Other cabling options, including fiber optic, are available. Included is a chassis manager that is SOSA-aligned, VITA 46.11-compliant, and has a Xilinx UltraScale+ ZU5EG multiprocessor system on chip. For more information contact Annapolis Micro Systems online at www.annapmicro.com.

DATA RECORDERS

Industrial-grade rackmount data recorder introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the Talon RTR 2742 turn-key record and playback data recorder for ultra-wideband analog RF/IF signals. The RTR 2742 4U 19-inch rackmount recorder uses two 12-bit, 6.4 GHz A/D converters to achieve sustained recording of 2.4 GHz bandwidth signals at rates as fast as six gigabytes per second. Users can configure the recorder as a one- or two-channel system and can record real samples or complex I+Q digitally down-converted samples. Complemented by a 16-bit 6.4 GHz D/A converter, the RTR 2742 can play back analog signal bandwidths as large as 1.28 GHz. Built-in digital down- and up-converters provide flexible bandwidth and tuning frequency selection for record and playback. The industrial-grade 4U 19-inch rackmount chassis of the RTR 2742 has hot-swappable data drives, front-panel USB ports, and I/O connectors on the rear panel. The chassis is optimized for cooling and ruggedized to operate in challenging environments. The RTR 2742 includes a 12-bit 6.4 GHz A/D that can be clocked at rates from 1.6 to 6 GHz in single-channel mode. Data can be truncated and packed as 8-bit samples, to support continuous recording to the maximum sample rate. For more information contact Pentek online at www.pentek.com.

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