Gyroscope tech enhances navigation PG. 4 Earth observation & weather forecasting PG. 24

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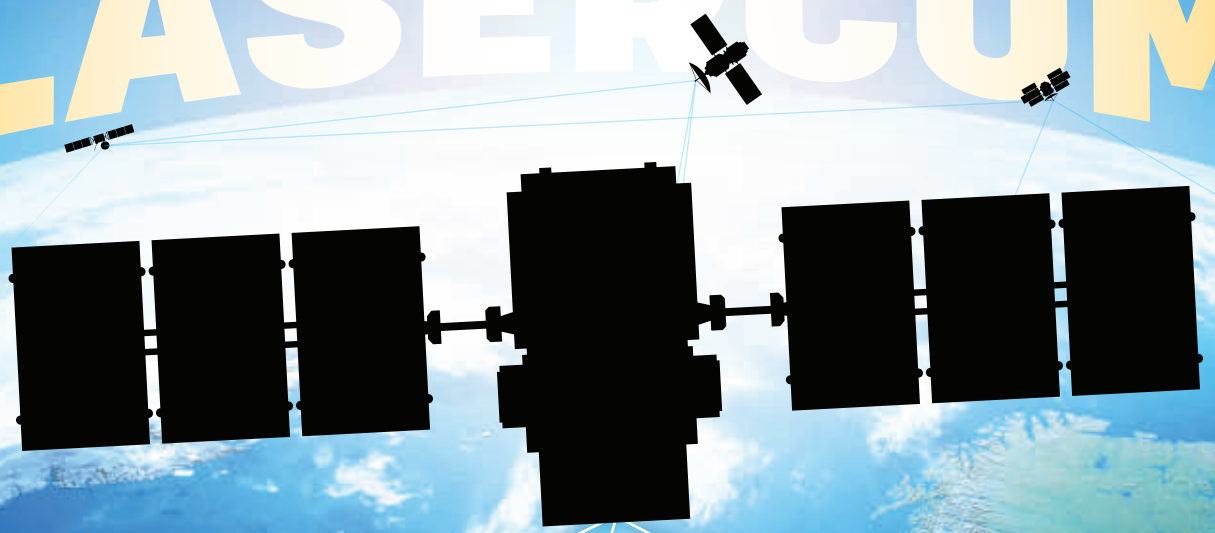

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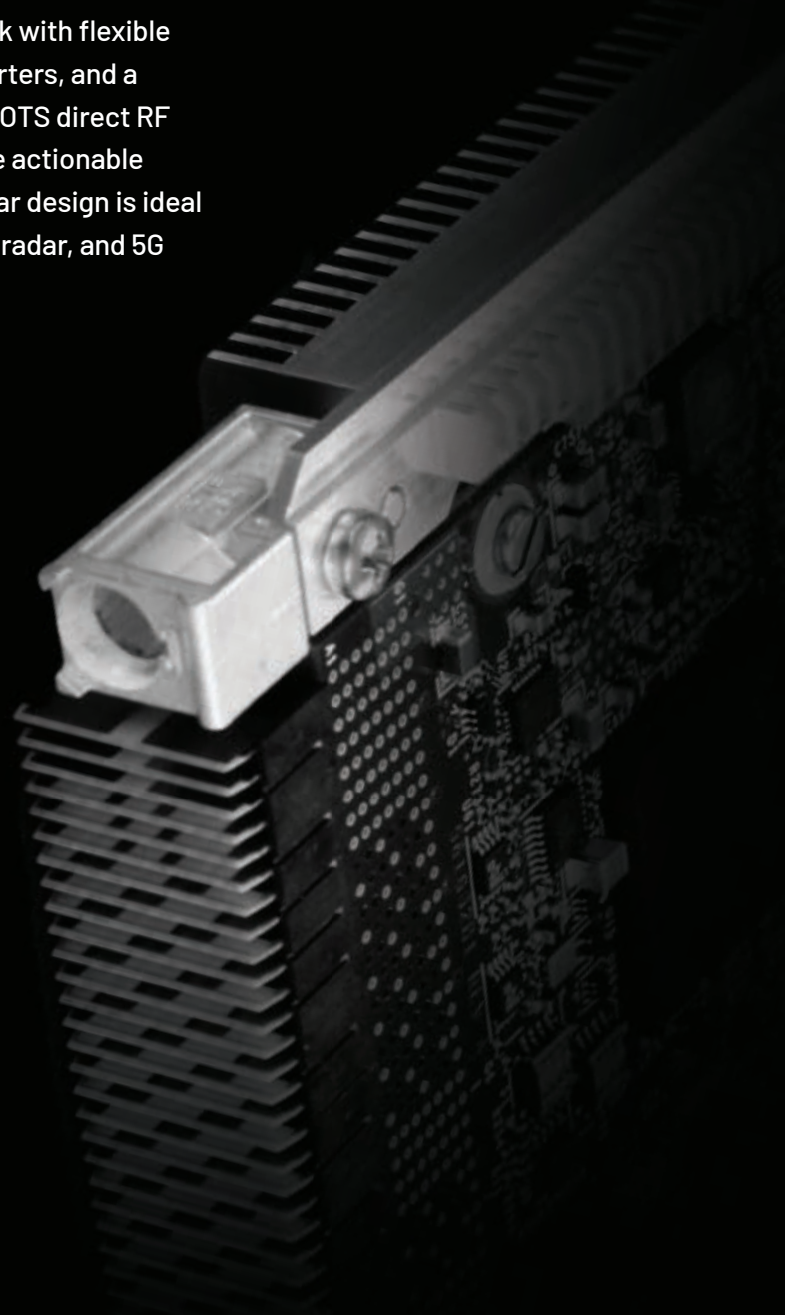

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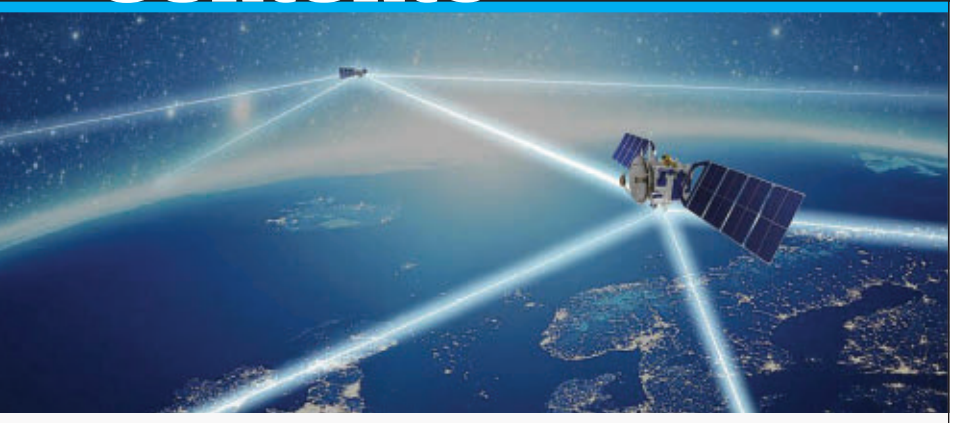

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Features

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Military & Aerospace Electronics®, USPS Permit 5901, ISSN 1046-9079 print, ISSN 2688-366X online, is published 10 times a year in January, February, March, April, May, June, July/August, September, October, November/December by Endeavor Business Media, LLC. 1233 Janesville Ave., Fort Atkinson, WI 53538. Periodical postage paid at Fort Atkinson, WI, and additional mailing offices. **POSTMASTER:** Send address changes to Military & Aerospace Electronics, PO Box 3257, Northbrook, IL 60065-3257. SUBSCRIPTIONS: Publisher reserves the right to reject non-qualified subscriptions. **SUBSCRIPTION PRICES:** U.S. $171 per year; Canada $198 per year; All other countries $224 per year. All subscriptions payable in U.S. funds.

Army plans taking shape for new generation of armored combat vehicles

BY **John Keller**
EDITOR IN CHIEF

The U.S. Army has taken major steps forward in influential armored combat vehicles programs over the past couple of months in efforts to field a new light battle tank for infantry brigade combat teams and a future armored personnel carrier to replace the ageing M2 Bradley Fighting Vehicle.

In late June the Army awarded a $257.6 million order to General Dynamics Land Systems in Sterling Heights, Mich., for low-rate initial production of the M10 Booker — a scaled-down version of the venerable Army M1A2 Abrams SEPv3 main battle tank.

The light tank has a 105-millimeter cannon, a 7.62-millimeter coaxial machine gun, externally mounted .50 caliber machine gun, and a 12.7-millimeter heavy machine gun. The M10's vetronics will include a commander's independent tactical viewer to provide long-range panoramic targeting and enhanced situational awareness. This electro-optical system is the PASEO from Safran Optics 1 in Bedford, N.H.

The M10 has a lightweight hull and turret, and a modern diesel engine, transmission, and suspension system. Army leaders say they plan to create an M10 Booker battalion at the division level, from which M10 Booker companies will be allocated to infantry brigade combat teams; each infantry brigade combat team will have 14 M10 Bookers. Low-rate initial production (LRIP) describes small-quantity production of a new weapon system before large orders begin.

The M10 Booker has a four-person crew, and will target and destroy fortifications, bunkers, buildings, and light-to-medium armored vehicles. The lighter weight of the combat vehicle makes it more transportable and maneuverable than the full-size M1 Abrams tank. Army leaders plan to move the new light tank into full-scale production in 2025.

Also in June, the Army narrowed down the number of defense contractors seeking to design next-generation fast armored combat vehicles and vetronics architecture to replace the Army M2 Bradley Fighting Vehicle, naming two separate contracts collective worth $1.6 billion to American Rheinmetall Vehicles LLC in Sterling Heights, Mich.; and to General Dynamics Land Systems to build prototypes of the Optionally Manned Fighting Vehicle (OMFV).

The OMFV will be able to operate with or without a human crew, and will emphasize advanced electronics, machine autonomy for operating in unmanned mode, a 30-millimeter cannon, and a second-generation forward looking infrared (FLIR) sensor system.

The NGCV program contains the OMFV to replace the Bradley Fighting Vehicle; the Armored Multi-Purpose Vehicle (AMPV) to replace the M113 armored personnel carrier; the Mobile Protected Firepower (MPF) light tank for Infantry Brigade Combat Teams (IBCTs); the Robotic Combat Vehicle (RCV) of three unmanned ground vehicles in light, medium, and heavy configurations; and the Decisive Lethality Platform (DLP), the replacement for the M1 Abrams main battle tank.

The M-2 Bradley, which the OMFV is to replace, has been in service since 1981. It moves infantry on the battlefield and provides fire support and attacks enemy armored fighting vehicles.

The C-17 cargo jet should be able to carry two OMFVs and have them ready for combat within 15 minutes of landing. The new vehicle should be able to fight in urban terrain, super-elevate weapons, and simultaneously engage threats using main gun and an independent weapons system.

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Fiber-optic gyro technology enhances accuracy of maritime inertial navigation

BY **John Keller**

CHARLOTTESVILLE, Va. – Inertial guidance experts at Northrop Grumman Corp. are capitalizing on fiber-optic gyroscope technology to enhance the navigational accuracy of U.S. Navy surface warships and submarines where satellite navigation signals are not available.

The Navy's newest maritime navigation system, the AN/WSN-12 uses the latest fiber-optic gyro (FOG) technology to replace decades-old ring laser gyro technology where signals from Global Positioning System (GPS) navigation satellites are blocked, jammed, or otherwise denied.

The Navy's Northrop Grumman AN/WSN-12 maritime navigation system uses the latest fiber-optic gyro (FOG) technology to provide fast and reliable navigation where satellite signals are unavailable.

The newer FOG technology in the WSN-12 navigation system not only helps keep surface ships and submarines on the right courses, but also enhances the accuracy of missiles and other weapons, as well as enables submarines to remain stealthily underwater safely for long periods of time. The WSN-12 FOG comes from the Northrop Grumman Mission Systems segment in Woodland Hills, Calif.

The transition to the WSN-12 is making navigation more accurate," says Rudy Fernandez, site director of the Northrop Grumman Maritime Systems and Integration operating unit in Charlottesville, Va. "The inertial navigation system in the WSN-12 is giving a lot more accuracy to our platforms, and keeps the submarine safer because you can stay underwater longer, and can shoot weapons with much more accuracy."

Inertial navigation accuracy especially is important for submarines, which periodically must surface to periscope depth to raise a GPS antenna to get the latest satellite navigation fix to keep the boat's navigation system up to date.

Any gyro — a FOG, ring-laser, or spinning-mass — naturally will drift over time, which decreases its reliability if not updated periodically with GPS positioning. "You reset the gyro to a GPS fix, and once you lose GPS, the area of uncertainty of that position over time starts to grow," Fernandez explains.

In other words, the longer a submarine operates submerged only on inertial navigation without a GPS position update, the larger its potential navigational errors. The WSN-7, for example, requires a submarine to come up for a GPS fix about every eight hours, while the WSN-12 can help a submerged submarine operate safely without a GPS update for longer periods of time, Fernandez says.

The WSN-12 is part of an overall surface ship and submarine navigation system upgrade that represents a transition from paper navigational chart maps to an all-electronic system that operates much like a GPS moving map display in a car.

The Northrop Grumman Electronic Chart Display System (ECDIS) takes inputs from GPS fixes, onboard inertial navigation systems, and from other sensors to update moving-map displays on electronic screens rather than using paper charts.

ECDIS "walks you through the entire route on the electronic chart, and will warn you if your route will be anywhere close to an undersea mount or shipwreck," Fernandez says. The Navy approved the Northrop Grumman ECDIS for deployment to ships and submarines last October. It is aboard the aircraft carrier USS Theodore Roosevelt (CVN 71).

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Northrop Grumman announced receipt of a Navy contract earlier this month to produce the AN/WSN-12 inertial sensor module (ISM) — a next-generation sensor that improves maritime navigation in GPS-denied environments for surface ships and submarines.

The Northrop Grumman-built AN/WSN-12 ISM provides maritime positioning data with or without GPS, and is a key component of the U.S. Navy's AN/WSN-12 Inertial Navigator System (INS), upgrading the Northrop Grumman built AN/WSN-7 INS. The 25-year-old WSN-7 is on nearly every ship in the U.S. Navy and has been the program of record for more than two decades.

The first ISM is expected to be ship tested this year, Northrop Grumman officials say. Northrop Grumman reported completion of the ISM's preliminary design review in May 2016, and critical design review in June 2018.

The ISM will help 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. For more information contact Northrop Grumman online at www.northropgrumman.com/what-we-do/sea.

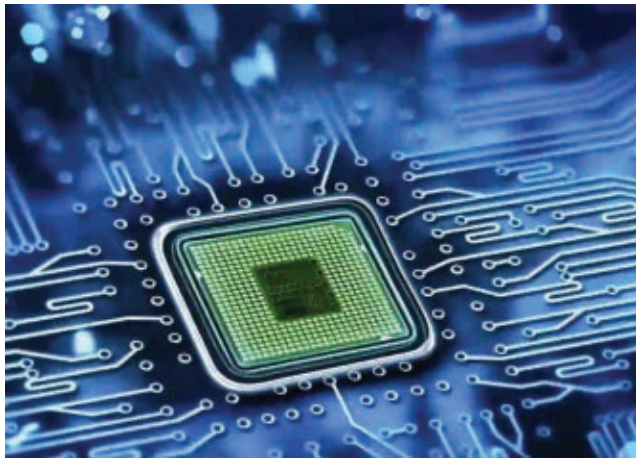
Northrop Grumman eyes 3D chip packaging for artificial intelligence (AI)

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio – U.S. military researchers needed a company to take the first steps in establishing a domestic center for research in advanced silicon and non-silicon 3D integrated circuits. They found their solution from Northrop Grumman Corp.

Officials of the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have announced a $2.8 million contract to the Northrop Grumman Space Park facility in Redondo Beach, Calif., for the Next Generation Microelectronics Manufacturing (NGMM) program.

NGMM will work to establish a domestic center for producing silicon and non-silicon 3D heterogeneously integrated (3DHI) circuit prototypes by defining examples of 3DHI microsystems and identifying the equipment, process, and facility requirements for manufacturing 3DHI chip packaging.



Northrop Grumman will help establish a domestic center for producing silicon and non-silicon 3D heterogeneously integrated (3DHI) circuit prototypes.

The Air Force Research Lab awarded the NGMM contract on behalf of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va. Additional NGMM contracts may be awarded. A contract for actually establishing the 3DHI research center will come later.

Microelectronics are essential to advanced computers, artificial intelligence (AI), autonomous systems, robotics, communications and networking, and networked sensing, researchers say. Yet over the next decade traditional technology scaling alone will provide only diminishing cost and performance improvements and is unlikely to drive future long-term microelectronics innovation.

Instead, researchers must address the next wave of innovation in microelectronics that will overtake the role that silicon complementary metal oxide semiconductor (CMOS) transistor scaling.

The next major wave of microelectronics innovation should involve integrating heterogeneous materials, devices, and circuits to produce tightly coupled 3D microelectronics with performance that exceeds what is available from today's monolithic approach, researchers say.

Microelectronics industry leaders today use 3D integration of modestly dissimilar silicon digital technologies for a narrow range of commercial products that range from stacked dynamic random access memory (DRAM) to CMOS imagers, to high-performance computing.

However, the opportunity to benefit defense systems broadly relies on expanding the types of microelectronics that can be integrated and assembled. Today's mature integration techniques — even those often referred to as 3DHI — focus primarily on low-power leading-edge CMOS, legacy CMOS, and silicon-based memory.

Advancing digital integration requires increasing interconnect densities well beyond today's state-of-the-art, not only for silicon CMOS devices, but also for compound semiconductors for radio frequency (RF) and photonics for interconnect, novel memory devices for computing, and wide-bandgap and ultra-wide bandgap semiconductors for power electronics.

This project also seeks to improve thermal management, power conditioning, testing and electrical characterization for known good die, and design tools for modeling and simulation of these new microsystems.

The NGMM program seeks to address such as lack of centralized facilities to facilitate information sharing during development; lack of common standards; lack of access to affordable manufacturing capacity for low-volume products; very long iteration cycles at existing facilities; expensive fabrication equipment; and limitations of expensive and proprietary design tools.

The U.S. today has no open-access manufacturing center for 3DHI research. In fact, most U.S. companies engaged in 3DHI research rely on foreign facilities for this kind of work.

Instead, establishing an open-access national manufacturing center for 3DHI research could promote an expansive wave of innovation, shared learning, and 3DHI research for low-volume products.

Military researchers are proposing to establish pilot-line manufacturing capability to test research designs without the need for expensive capability investments to bring about the next major wave of microelectronics innovation, which will come from integrating heterogeneous materials, devices, and circuits through advanced packaging.

On this project Northrop Grumman is expected to do the work in Redondo Beach, Calif. For more information contact Northrop Grumman Space Park online at www.northropgrumman.com/what-we-do/microelectronics-space-park, DARPA at www.darpa.mil, or the Air Force Research Laboratory at www.afrl.af.mil.

Raytheon to build unmanned underwater vehicle (UUV) to destroy ocean mines

BY **John Keller**

WASHINGTON – U.S. Navy counter-mine warfare experts needed a small unmanned underwater vehicle (UUV) mine neutralizer able to destroy or disable enemy ocean mines at safe distances from Navy vessels and personnel. They found their solution from the Raytheon Technologies Corp. Missiles & Defense segment in Portsmouth, R.I.

Officials of the Naval Sea Systems Command in Washington announced a $25.5 million order to Raytheon Missiles & Defense in June to manufacturer Barracuda Mine Neutralization Systems.

Barracuda is a modular, low cost, semi-autonomous, expendable mine neutralizer about the size of a Navy air-launched sonobuoy, or about three feet long and five inches in diameter.

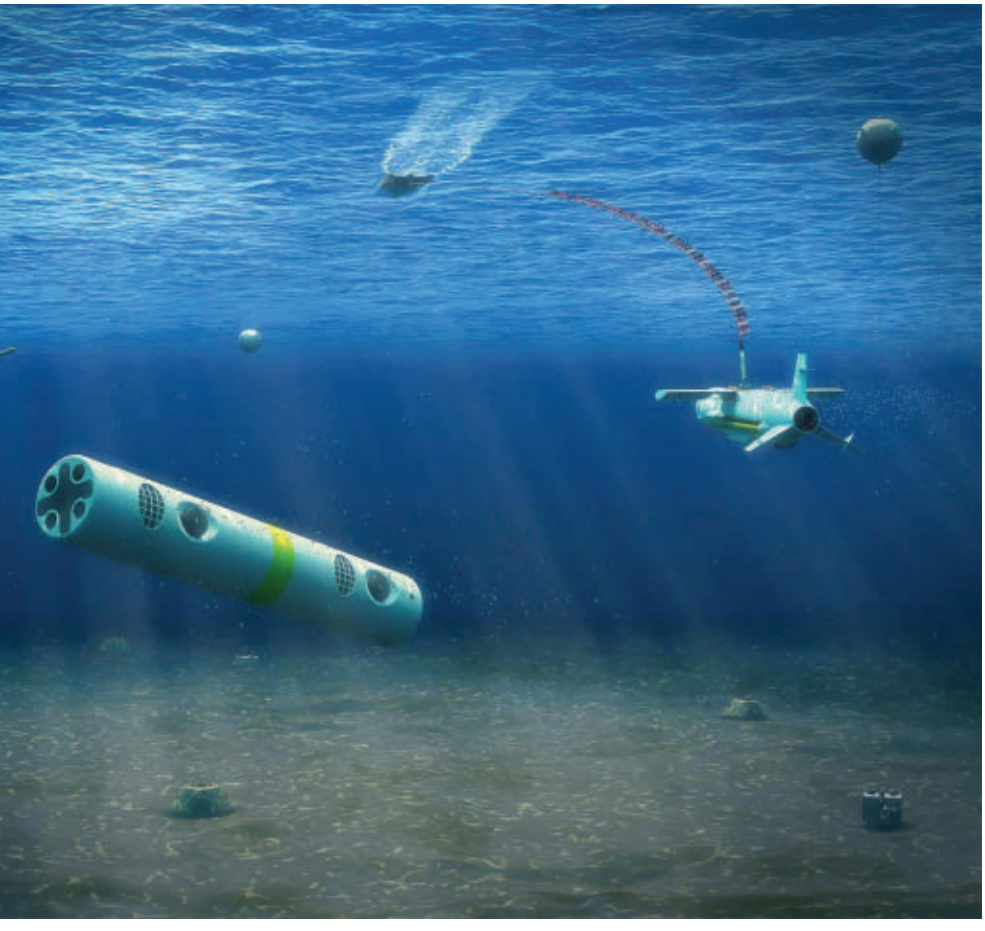
Raytheon won an $83.3 million contract in April 2018 to design, test and deploy the Barracuda mine neutralization system — an expendable, autonomous UUV to identify and neutralize bottom, near-surface, and drifting sea mines. That contract has options that could bring its value to $362.7 million.

A mine neutralizer is a small UUV, typically with an explosive warhead, which navigates to the known location of an ocean mine located on the water's surface, tethered to the bottom, or attached to the ocean bottom. Once the neutralizer reaches the mine, it blows itself up, taking the mine with it.

The Navy is deploying Barracuda from the Common Unmanned Surface Vehicle (CUSV) — an unmanned motorboat that deploys from the Navy's littoral combat ship. Barracuda uses wireless communications for tetherless operation from the CUSV, and in the future may be deployed from Navy sonobuoy launchers aboard helicopters or fixed-wing aircraft.

Navy officials are using the Barracuda as part of the littoral combat ship's mine countermeasure mission package, deployed from the CUSV. The Navy also will use the Barracuda at shore-based mine countermeasure operations to perform fleet training.

Barracuda conducts neutralization operations from the surface through deep water during the day or night. On this order Raytheon will do the work in Portsmouth, R.I., and McAlester, Okla., and should be finished by June 2025.



The U.S. Navy Raytheon Barracuda Mine Neutralization System uses wireless communications for tetherless operations, and in the future may be deployed from Navy sonobuoy launchers aboard helicopters and fixed-wing aircraft.

For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Sea Systems Command at www.navsea.navy.mil.

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Boeing to convert anti-submarine torpedoes into high-altitude glide weapons

BY **John Keller**

WASHINGTON – Airborne weapons experts at the Boeing Co. are building launch equipment for flying torpedoes that can enable U.S. Navy aircraft to attack submerged enemy submarines from long ranges at high altitudes.

Officials of the Naval Sea Systems Command in Washington have announced a $12 million contract to the Boeing Co. Defense, Space & Security segment in St. Louis for High Altitude Anti-Submarine Warfare (ASW) Weapon Capability (HAAWC) Air Launch Accessory (ALA) equipment, as well as production, engineering, and hardware support.

The HAAWC ALA enables the Raytheon MK 54 lightweight torpedo carried aboard the Navy Boeing P-8A Poseidon long-range maritime patrol jet to glide through the air from altitudes as high as 30,000 feet — essentially transforming the torpedo into a glide weapon that can attack enemy submerged submarines from long ranges.

As the flying torpedo for anti-submarine warfare (ASW) nears the water, it jettisons its wings and tail and takes on its original role as a smart torpedo that can detect, track, and attack enemy submarines autonomously.

After shedding its control surfaces, the HAAWC ALA activates a parachute that lowers the torpedo into the water to begin its run toward the target. When launched from 30,000 feet the HAAWC-equipped MK 54 torpedo will glide for seven to 10 minutes before entering the water.

While in flight the HAAWC glide weapons are completely self-contained. The ALA includes a flight-control computer, a GPS-based navigation system, and power sources.

The MK 54 always has been launchable from aircraft, but before the HAAWC ALA, crews of anti-submarine fixed-wing aircraft and helicopters had to release the torpedo from altitudes no higher than about 100 feet.

The HAAWC will enable the P-8A aircraft — a modified Boeing 737-800ERX passenger jetliner — to maintain optimum surveillance altitudes without wasting time and fuel to drop to low altitudes and then back to high patrol altitudes.

Attacking from high altitudes also enables the P-8A to reduce the time between target acquisition and attack, as well as to launch anti-submarine weapons outside the ranges of shore-based anti-aircraft defenses.

The Boeing High Altitude Anti-Submarine Warfare (ASW) Weapon Capability (HAAWC) jettisons its wings and tail as it enters the water and takes on its original role as a smart torpedo.

The Mk 54 is an all-digital lightweight torpedo that has advanced software algorithms developed originally for the larger submarine-launched Mark 48 torpedo.

The Boeing HAAWC ALA for the MK 54 torpedo consists of wings designed originally for the Boeing AGM-84H/K Standoff Land Attack Missile-Expanded Response (SLAM-ER). The ALA tail assembly includes the guidance kit designed originally for the Joint Direct-Attack Munition (JDAM), which contains a GPS navigation system. Boeing also is fitting the HAAWC with a data link to transmit target position updates while in flight.

On this order Boeing will do the work on this contract in St. Charles, Joplin, St. Louis, Joplin, and Piedmont, Mo.; Salt Lake City; Minneapolis; Orlando, Fla.; Cedar Rapids, Iowa; Chandler, Ariz.; Berea, Ohio; Wichita, Kan.; Albuquerque, N.M.; Lexington, Ky.; and Chatsworth, Calif., and should be finished by December 2025.

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.

Scientists beam solar power to Earth from space for first time

A space solar power prototype for the first time has shown that it can beam power wirelessly through space and direct a detectable amount of energy toward Earth. The experiment proves the viability of tapping into solar electric power from space. The Space Solar Power Demonstrator's Microwave Array for Power-transfer Low-orbit Experiment (MAPLE) of the California Institute of Technology (Caltech) in Pasadena, Calif., transferred collected solar power wireless to receivers in space and direct energy to Earth. MAPLE uses an array of transmitters to beam the energy to locations on Earth. Caltech says that MAPLE features two separate receiver arrays located about a foot away from the transmitter to receive the energy, convert it to direct current (DC) electricity, and use it to light up a pair of LEDs to demonstrate the full sequence of wireless energy transmission at a distance in space. MAPLE tested this in space by lighting up each LED individually and shifting back and forth between them. The experiment is not sealed, so it is subject to the harsh environment of space, including the wide temperature swings and solar radiation that will be faced one day by large-scale SSPP units.

Army to acquire radar-equipped anti-UAV guns for Ukraine

U.S. Army air-defense experts needed mobile air-defense guns to help protect warfighters and military equipment from air attacks. They found their solution from weapons distributor Global Military Products Inc. in Tampa, Fla. Officials of the Army Contracting Command-New Jersey in Newark, N.J., announced a $118.4 million contract to Global Military Products late last month for Gepard 35-millimeter air defense systems. The Gepard self-propelled anti-aircraft gun (SPAAG), manufactured by Krauss-Maffei Wegmann (KMW) in Munich, is based on the chassis of the German Leopard 1 main battle tank. It has twin Oerlikon GDF 35-millimeter belt-fed guns that fire 550 rounds per minute. The system carries 640 armor-piercing-incendiary rounds for use against air targets and 40 armor-piercing rounds for use against ground targets. These systems most likely are for the Ukraine armed forces in their war against Russia, where the systems reportedly have proven effective against unmanned aircraft. The air-defense system has a general-search radar at the rear of its turret roof and tracking radar between the guns. It has an identification friend-or-foe (IFF) system. The air-defense vehicle's radar of the Gepard has a range of 9.3 miles, and provides all-round scanning *Continued on page 13*

General Dynamics starts production on light tank and vetronics for brigade combat teams

BY **John Keller**

The M10 Booker light tank is to support infantry brigade combat teams, has a 105-millimeter cannon, and vetronics that include the Safran PASEO commander's independent tactical viewer for long-range targeting and situational awareness.

WARREN, Mich. – The U.S. Army is taking another step closer to full-rate production of the nation's newest light tank — the M10 Booker, formerly known as the Mobile Protected Firepower (MPF) system.

Officials of the Army Contracting Command Detroit Arsenal in Warren, Mich., announced a $257.6 million order in late June to General Dynamics Land Systems in Sterling Heights, Mich., for low-rate initial production of the M10 booker — a scaled-down version of the venerable Army M1A2 Abrams SEPv3 main battle tank.

The M10 Booker armored combat vehicle is designed primarily to support infantry brigade combat teams on the battlefield, and is not intended to fight alongside the larger M1 Abrams main battle tanks in combined arms battalions. The Army renamed the MPF as the M10 Booker earlier this month.

Low rate initial production (LRIP) describes small-quantity production of a new weapon system before large orders begin. M10 Booker LRIP seeks to produce a minimum number of the light tanks for live-fire and field testing, and increases its production rate toward full-rate production.

The M10 Booker has a 105-millimeter cannon, a 7.62 millimeter coaxial machine gun, externally mounted .50 caliber machine gun, and a 12.7 millimeter heavy machine gun. It also has an enhanced thermal viewer from Safran Optics 1 in Bedford, N.H.

The light tank's vetronics will include the Safran PASEO commander's independent tactical viewer to provide long-range panoramic targeting and enhanced situational awareness.

The light tank has a lightweight hull and turret, and a modern diesel engine, transmission, and suspension system. It is smaller and lighter than the Abrams main battle tank, and is easier to transport by aircraft.

The M10 Booker has a four-person crew, and will target and destroy fortifications, bunkers, buildings, and light-to-medium armored vehicles. The lighter weight of the combat vehicle makes it more transportable and maneuverable than the full-size M1 Abrams tank.

The vehicle has a range of 190 miles and can operate for 24 hours off the ramp or on arrival at drop zone. It can move over steep hills, valleys, cities, and ford rivers.

Army leaders say they plan to create an M10 Booker battalion at the division level, from which M10 Booker companies will be allocated to infantry brigade combat teams; each infantry brigade combat team will have 14 M10 Bookers.

General Dynamics won a won a $1.14 billion contract last June to build as many as 96 M10 Booker combat vehicles. Ultimately the Army is expected to buy more than 504 M10 Booker combat vehicles through 2035.

On this order General Dynamics will do the work in Sterling Heights, Mich.; Anniston, Ala.; Anniston, Ala.; and Lima, Ohio, and should be finished by October 2025. For more information contact General Dynamics Land Systems online at www.gdls.com, or the Army Contracting Command Detroit Arsenal at https://home.army.mil/detroit/index.php/units-tenants/acc-dta.

Continued from page 11 with simultaneous target tracking, with search-on-the-move capability. On this contract Global Military Products should be finished by May 2024. For more information contact Global Military Products online at www.globalmilitaryproducts.com, or the Army Contracting Command-New Jersey at https://acc.army.mil/contractingcenters/acc-nj/.

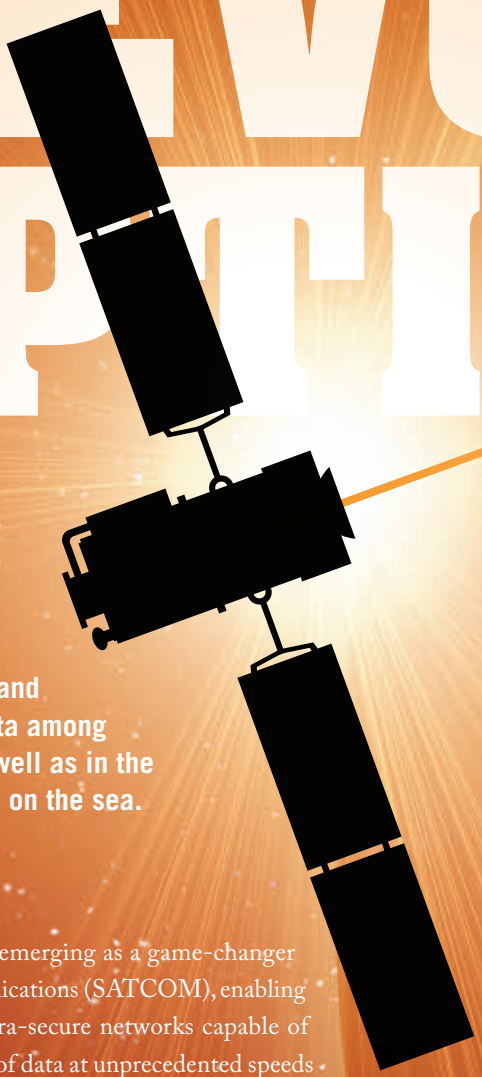
Four ways AI is improving the airport experience

With passenger numbers returning to pre-pandemic levels, offering a frictionless experience at every stage of the passenger journey is at the forefront of airports' priorities as they make plans for the future. But the manual processes still relied on by airports in a number of areas, from check-in and boarding to security, make it difficult to drive operational efficiencies and spot patterns that would allow them to make lasting improvements to the passenger experience. George Richardson, the co-founder and CEO of AeroCloud of Cheshire, U.K., says AI is well-suited for managing passenger flow when coupled with computer vision technology. "Using computer vision-powered solutions, operations teams can respond to issues in real-time and identify patterns that can create improvements in the long term," Richardson says.

Safran and Archer work on avionics for Archer's Midnight electric aircraft

Safran Electronics & Defense in Boulogne-Billancourt, France, and Archer Aviation Inc. in San Jose, Calif. shared details of their collaboration on avionics technology, which kicked off back in 2021. This collaboration is focused on delivering solutions to Archer that uses Safran's components. The two companies initially have focused their development and testing on Safran Electronics & Defense's ultra-compact avionics platform (UCAP) flight control computer (FCC) and SkyNaute navigation system, which are both used in Archer's Midnight electric vertical take-off and landing vehicle (eVTOL) aircraft. Equipped with a multi-core processor, Safran 's UCAP provides high-performance computing capabilities, as well as high-integrity and safety features. SkyNaute adheres to the safety and reliability requirements necessary for certification by relying on mature technologies such as HRG Crystal (Hemispherical Resonator Gyroscopes).

The promise of laser REVOLU OPTICAL



Free-space optical communications links use lasers to transmit and receive high-speed data among orbiting satellites, as well as in the air, on the ground, and on the sea.

BY John Keller

Laser technology is emerging as a game-changer in satellite communications (SATCOM), enabling the creation of ultra-secure networks capable of transmitting vast amounts of data at unprecedented speeds via satellite networks and constellations. With ongoing advancements, the industry is poised for growth and collaboration, seizing the untapped potential of unconnected populations. The ability to handle the surging volume of data is a key advantage offered by laser communications, providing a significant value proposition.

While it has its challenges, laser communications is promising for defense and space applications as U.S. government agencies continue to embrace the forward prospects for laser communications as they invest in further developments to enhance its use.

A revolution in satellite communications

The global space-based laser communication market — mostly for commercial applications - was worth about $1.13 billion in 2022, and is expected to quadruple by 2031, growing at nearly 26 percent per year, according to research conducted by Straits Research in Maharashtra, India, titled Space-Based Laser Communications Market.

Space-based laser communications has emerged as a ground-breaking solution for data transfer in remote and challenging locations. This technology offers a wide array of applications like inter-satellite communications, and satellite-to-ground connectivity. As the number of orbiting satellites continues to grow, space-based laser communications is becoming a prominent player in satellite communications systems.

communications to TIONIZE LINKS

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Investors, while cautious, are monitoring the industry's progress closely to compete with major operators commercial like Starlink and OneWeb. The expansive customer base awaiting connectivity presents a lucrative opportunity for growth and collaboration. With laser communications offering faster speeds, improved security, and greater efficiency, it is poised to reshape the landscape of satellite communications.

Laser communications are poised to redefine secure and efficient data transmission not only in commercial markets, but in defense and government markets as well. Through technological advancements, increasing affordability, and a rapidly expanding customer base, laser technology is heralding a new era in satellite communications. As researchers continue to enhance laser diode efficiency, power output, and wavelength stability, the performance and reliability of laser communication systems are set to reach new heights.

In the international community, standardization efforts also are in progress, spearheaded by organizations such as the International Telecommunication Union (ITU) and other industry consortia. The establishment of common standards ensures interoperability and widespread adoption of laser communication systems. This enables seamless integration with existing RF infrastructure, creating hybrid systems that provide enhanced reliability and performance.

Despite atmospheric challenges affecting laser communications, innovative techniques such as adaptive optics, beam steering, and error correction algorithms are being explored to mitigate these effects. Overcoming these hurdles is crucial for the practical implementation of laser communications.

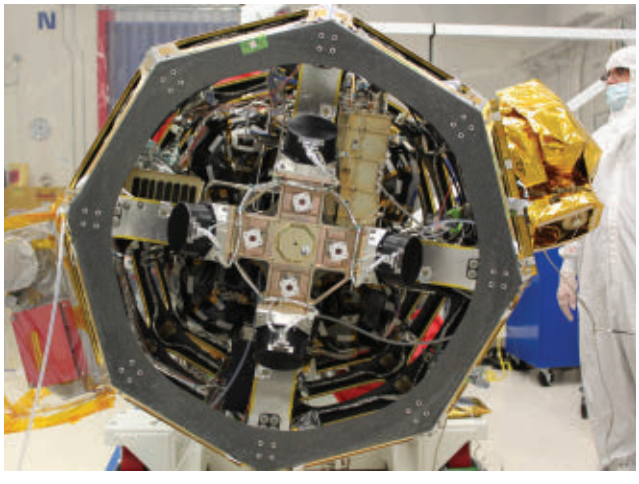
Suffice it to say that laser technology is revolutionizing the satellite communications industry. With its unparalleled capabilities, laser communications offer faster speeds, enhanced security, and increased efficiency than are available today. As the sector continues to mature, collaborations and partnerships will be instrumental in driving innovation and shaping the future of satellite communications.

Tim Dare is a distinguished engineer and a technical director at Booz Allen Hamilton, a technology research company in McLean, Va. Dare says the outlook for laser optical communications is bright.

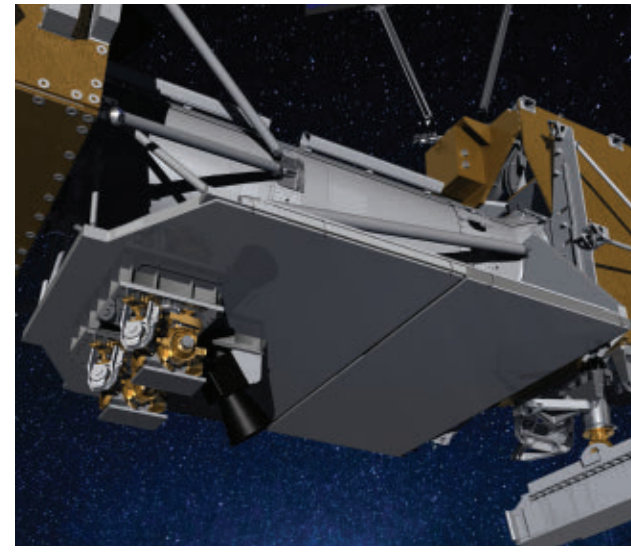
Bright future

"Those advancing the technology are focused on exploiting the advantages of laser optical communications over RF communications such as increased bandwidth, small beam size, hard to intercept/detect or jam, and the ability to utilize a largely unregulated portion of the spectrum," Dare says. "These benefits provide an outlook for laser communications that has a market expected to grow from hundreds of millions of dollars to multiple billions of dollars by 2030 according to multiple market analysis studies.

The typical use of laser communications is for space. "Traditionally, laser communications have been developed and employed for space-based applications such as satellite to satellite and ground to satellite data transfer, this is due to the impacts of the atmosphere on laser communications for terrestrial, maritime, and air domains, to include bandwidth, pointing, acquisition, and tracking, and resiliency of communication through multiple atmospheric conditions," Dare continues.



The NASA Lunar Laser Communication Demonstration (LLCD) will demonstrate laser communications from lunar orbit to Earth at six times the rate of the best modern-day advanced radio communication systems.



The NASA Laser Communications Relay Demonstration (LCRD) launched in 2021 to test a two-way laser relay system to link orbiting satellites.

"Technology developers are now concentrating investments on increasing the practical use of laser communications within these domains such as bandwidth, distance, and resiliency through a variety of atmospheric conditions," Dare says. Bandwidth nominally is in the 1 to 10 gigabits per second range today going to hundreds of gigabits per second in the future. Distance today is about 1 kilometer to up to tens of kilometers going to more than 50 kilometers in the future for terrestrial-terrestrial applications.

Kevin Huttenhoff is a senior manager for space data transport at the Lockheed Martin Space Systems segment in Denver. He also emphasizes that laser communications have many advantages: precise and targeted beams, difficulty to jam, and notable bandwidth. He, too, is bullish on the outlook for laser communications.

"The future of laser communications for satellite communications is very bright," Huttenhoff says. "Secure intersatellite links as well as space to ground communications will both leverage this technology in the future. While there will still be a need for spectrum management as this capability proliferates, this management should be much easier due to the narrowness of the beams."

Booz Allen's Dare says he sees the future of laser communications to rest much on reliable technologies that can operate through a wide array of atmospheric conditions.

"Implementing reliable technologies to increase bandwidth and operate in a variety of atmospheric conditions will eventually explode the terrestrial, maritime, and air domain laser communications markets within the next 3-5 years," he says.

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"The importance of creating solutions in these domains allows the use of laser communications to be leveraged in situations where radio frequency (RF) is contested, not available, or not affordable, such as in contested or anti-access/area denial (A2AD) environments, austere environments, on-the-move capabilities, and having to lay fiber in difficult terrain or urban areas, Dare continues.

"Each of these capabilities can be utilized in multiple markets, such as defense, civil, commercial, and agricultural. We anticipate the markets will expand its laser communication usage in the next few years to leverage the benefits mentioned as the capabilities and practicality of laser communications through the atmosphere become widely available," Dare says.

▲ **The Integrated LCRD Low-Earth Orbit User Modem and Amplifier Terminal (ILLUMA-T) will bring laser communications to the Space Station and empower astronauts living and working there with enhanced data capabilities.**

Not without challenges

Laser communications are influenced by the atmosphere they penetrate and transmit through; if not ideal, communications may have problems. Namely, the beam that is used for directional communications can be fidgety against different atmospheric conditions. According to Booz Allen's Dare, these and other considerations mean that laser communication has its challenges.

"One of the advantages of laser communications, the small beam size, also presents one of the most difficult challenges in implementation," explains Dare. "The small beam requires very precise control to establish and maintain the link. This is referred to as pointing, acquisition and tracking (PAT)."

Pointing the laser in less-than-ideal conditions can be a challenge.

"The line-of-sight nature of laser communications necessitates an understanding of where to transmit (point), allow for link establishment (acquisition), and an ability to adjust to maintain the link (tracking)," Dare says. This PAT equation becomes more challenging when transmitting through a domain that can impact the beam-the atmosphere or water (for subsurface communications).

Converting satellite laser communications links for in-atmosphere links can be an option. "PAT systems are in use today for some laser communications such as satellite to satellite and terrestrial to satellite," Dare says. "These systems can be upgraded to provide the capabilities for the more complex systems that are purely within the atmospheric domain to allow for laser communications on the move (terrestrial, maritime, air, or subsurface) through a PAT system."

Establishing a laser communications link is one thing, but maintaining it can be quite another. "A challenge that must be overcome includes the ability to establish and maintain an on-the-move link in potentially challenging 3-axis conditions, countering the effects of sea state, rugged terrain, air turbulence, or subsurface currents. Another basic challenge that must be overcome is the condition of the atmosphere (or subsurface)," Dare says. "Several conditions can cause interference with a high-quality laser communications link such as dust, heat, turbulence, rain, spray, clouds, etc. Any solution that will be resilient enough to work in a true operational environment must have the ability to counter the impacts of these conditions to maintain a reliable link."

Lockheed Martin's Huttenhoff says he also sees challenges. "Several challenges are present as we continue to mature this technology for the future," he says. "First, if systems are going to be interoperable with each other, then some form of standard will need to be generated by industry to be an enabler. Second, as we look at the increasing data-rates that are possible with laser communications, the need for processors that can perform data switching and processing in space at these rates will need to be developed."

Booz Allen's Dare says that until these challenges are overcome, space and defense leaders should utilize laser communications as an additional tool to address their communication requirements. "It is a complement to RF communications as part of an overall plan. Additionally, it is important to note that laser communication is not a one size fits all solution; laser

communications can provide a highly tailorable solution based on mission and domain requirements," he says.

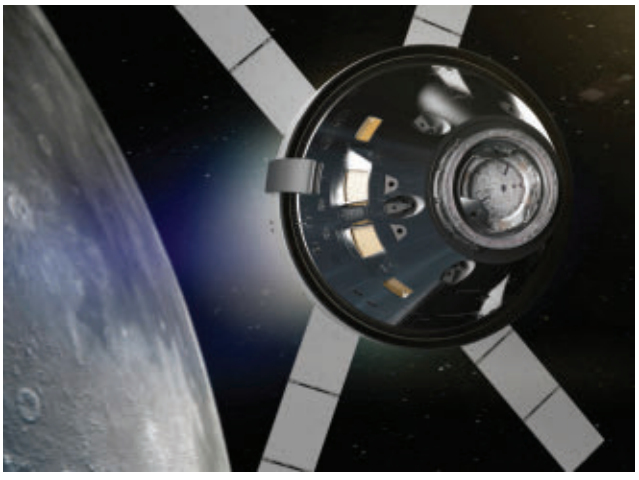
Many use cases for laser communications

As Dare explains, laser communications crosslinks have been employed in the space environment for applications like satellite-to-satellite links, ground to satellite links, and "last mile" connections terrestrially, which can bypass the need for fiber optics.

"These applications will continue to expand to increase distance, setup time, and dynamic situations to allow reliable on-the-move communications," he says. "The current state of laser communications for terrestrial applications are limited in throughput and distance due to the precision required for establishing and maintaining a link as well as varying atmospheric conditions. At this point laser communications is applicable to a niche market due to the limitations, however systems can be provided to meet specific customer needs that utilize stable platforms — these systems can be miles apart and provide gigabits per second speeds, however they will still be impacted by atmospheric conditions.

As technology advances, laser communications increasingly will shift to cross-domain opportunities — particularly in terrestrial and ground to space applications. For RF communications this will provide an ability to expand data flows that the spectrum cannot accommodate."

Dare adds that there are advantages and scenarios where laser communications are best used. "We see government customers exploiting the low probability of interference and low-probability-of-detection attributes and employing laser communications in covert scenarios or in an RF denied environment," says Dare. "Specific areas of growth for terrestrial applications will depend on the ability to acquire and maintain link, and more importantly to increase bandwidth with high resiliency to be able to communicate in a variety of atmospheric conditions. It is clear the benefits laser communications bring to contested and denied RF environments, however the ability of significantly increasing reliance in multiple atmospheric conditions and also reducing the Size, Weight, Power and Cost (SWaP-C) will be key to providing end users a capability that will meet needs across all markets."



The Orion Artemis II Optical Communications System (O2O) will bring laser communications to the Moon aboard NASA's Orion spacecraft during the Artemis II mission to transmit high-resolution images and video.

Investments in laser communications

There are many initiatives across government agencies. The U.S. National Aeronautics and space Administration (NASA) in Washington, for example, seeks to advance laser communications. Several other research initiatives are in progress that stand to serve defense needs. They are taking steps to enhance the capabilities of laser communications and are collaborating with industry leaders to get down to the nitty gritty of optical materials that could be useful and disruptive for laser communications in important defense applications.

The U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a disruption opportunity in May for Accelerating discovery of Tunable Optical Materials (ATOM) project seeking breakthroughs in tunable optics for free-space optics and integrated photonics intended for use in laser communications.

Phase change materials, which can switch between amorphous and crystalline states through thermal energy, are particularly appealing for these purposes. Germanium antimony tellurium, a commonly considered phase change material, exhibits fast switching times of less than 10 microseconds and substantial index contrast. However, its usefulness is restricted by considerable loss in short-wavelength applications below the short-wave infrared range.

The ATOM program's aim is to discover new tunable optical materials that possess large refractive index contrast across the entire spectrum while maintaining low loss and fast switching times. The program also seeks to demonstrate a device with a minimum area of 250 square microns, capable of achieving repeatable and stable multi-state switching, all while preserving bandwidth and performance.

The NASA TeraByte InfraRed Delivery (TBIRD) optical communications payload, launched last year, showcases 200-gigabit-per-second data downlinks - the highest optical rate ever achieved by NASA.

Public-private partnerships are being forged by government agency organizations such as DARPA to develop technology to improve the utility of laser communications and help lower the risk and cost of space operations.

Late last year, DARPA also moved forward with industry-contracted research to develop miniature optical beam steering for applications like free-space laser optical communications and light detection and ranging (lidar) for use in laser communications. Late last year they launched a microsystems exploration topic for the Steerable Optical Aperture Receivers (SOAR) project.—SOAR will explore new approaches to optical beam steering in miniature form factors, and experimentally demonstrate their operation in receive mode with small aperture sizes.

Currently, optical beam steering primarily relies on mechanical systems such as gimbals or motors to adjust the direction of optical lenses. However, these gimbal-based beam steering systems are often too large and heavy for small autonomous vehicles that require onboard laser communications and lidar capabilities.

Integrated photonics has emerged as a plausible solution to assist microscopic devices on chips replicate the functions of discrete optics. According to the announcement, this not only leads to a significant reduction in size but opens possibilities for new and intricate optical system architectures that were previously impractical at the macroscopic scale. The impetus behind the SOAR project is to address critical questions regarding optical receiver performance, scalability, and integration.

Intricate optical systems

SOAR aims to develop optical interfaces capable of receiving light from any direction without precise knowledge of the incoming angle. This is achieved by steering the angle of acceptance to capture and couple the input beam into a common output mode or detect the optical signal within the receiver interface.

SOAR is technology-agnostic; It aligns with the program's goals. Two-dimensional optical parametric amplification (OPA), non-planar integrated photonics, optical meta surfaces, directional optical scattering techniques, and discrete micro-optics are all

among the approaches that researchers are considering, in addition to the generation of multiple simultaneous beams is of interest to the project.

The U.S. Space Development Agency (SDA) Is Investing in Low-Earth Orbit Satellite Development

In parallel to DARPA, the U.S. the Space Development Agency (SDA) is also aggressively investing in and collaborating with industry to pursue advanced research to assist laser communications. The agency announced in March of 2022, that Northrop Grumman Corporation was selected to create an innovative constellation of 42 low-Earth orbit (pLEO) satellites and establish the Tranche 1 Transport Layer (T1TL) mesh satellite communications network. The Space Development Agency, a new agency, plans to boost the delivery of space-based capabilities to support terrestrial missions.

The announcement described the T1TL network as a low-latency, high-volume data transport network used to support critical U.S. military missions. Its primary objective is to connect various components of an integrated sensing architecture, ensuring persistent and secure connectivity. The network is expected to play a vital role in the Joint All Domain Command Control initiative.

Specifically, the T1TL network will integrate advanced technologies and infrastructure to enable future space missions, prioritizing key aspects such as battle management, missile tracking, and target custody. According to the announcement of the initiative, laser communication terminals will be employed to connect the global constellation, while providing persistent, networked Link-16 and high-rate Ka-band connectivity to air, maritime, and ground users

Northrop Grumman is collaborating with commercial marketplace partners. Their intent is to assist SDA's efforts to boost speed and expedite the delivery of an innovative system.

Northrop Grumman has a good history in this type of work and is credited with the assembly, integration, and testing of the sophisticated Iridium NEXT satellite constellation, consisting of 81 satellites that were successfully launched into low-Earth orbit in 2019.

Optical communications terminals that use lasers to beam data across space will be tested in upcoming experiments by the Space Development Agency and the Defense Advanced Research Projects Agency.

The road ahead for laser communications

The research sponsored by DARPA and SDA is among the many efforts to improve secure high data-rate laser communications via satellite. Kevin Huttenhoff of Lockheed Martin says that the future of secure, high data-rate satellite communications along with the benefits of optical communications are becoming very compelling. "We can envision a data-centric satellite communications architecture in space that is enabled utilizing laser communications," he says. "This would include not only satellites in low earth orbit, but higher data-rate terminals in medium earth orbit providing data backhaul. By leveraging such an architecture, we can envision data reaching the user with much less latency than today."

The General Atomics Electromagnetic Systems Laser Interconnect and Networking Communications System (LINCS) cubesats each host a C-band dual-wavelength full duplex optical communication terminal and an infrared payload to increase the speed, reliability, distance, and variability of communications in space.

Tim Dare of Booze Allen says that while there may be challenges ahead in the forward progress of laser communications, there's much reason to be optimistic.

"As with any new technology, there will be multiple industry and government initiatives that will try to get to market first to exploit the benefits of laser communications," he says. "The problem set in implementing a reasonable cost, reliable, high-bandwidth solution is not small, and care must be taken when thinking through the myriad of potential solutions. Developers of the technology must focus on the end user and the environment in which they will be using laser communications. It will be a non-stable, dirty environment with most likely poor atmospheric conditions. The internal mechanisms for laser communications demand a clean environment with precision in the transmit and receive modules for optical alignment. The mounts must be rugged enough to withstand the environment and handling of the system without damaging or causing internal alignment or contamination issues — these are not easy problems to solve."

Dare emphasizes that early adopters of the technology exist and understand that there will be success and failures in being able to use the new technology. "It is important that solution providers and the early adopters work together closely to allow the technology issues to be resolved," he says. "The benefits for laser communications are great and one day will become a standard part of the communications toolkit; as such, the ability to find partners to allow the technology solutions to be refined in a true operational environment will be key to achieving those positive outcomes."

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For more information on laser communications search for "laser communications" at www.militaryaerospace.com

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Keeping a watchful eye on Earth observation and weather forecasting

Monitoring changes to Earth's environment pushes image and signal processing, artificial intelligence (AI), radiation-hardened electronics, and networking technologies to their limits.

BY **Jim Romeo**

The Earth observation (EO) industry continues to grow in technological innovation, which is driving investment opportunities for commercial and government applications. Innovations are capitalizing on new satellite communications that will improve Earth observation and subsequent weather forecasting.

"Earth weather and space weather imaging technology has made incredible leaps forward with each generation of weather satellites, and the GOES-R series of weather satellites Lockheed Martin has built for NOAA is no exception," says Jagdeep Shergill, director of geo weather programs, and lead of all Earth-related weather program execution at the Lockheed Martin Space segment in Denver.

In its first six months of operation, the U.S. Geostationary Operational Environmental Satellite (GOES)-16 transmitted more weather data than all previous GOES-series weather satellites combined. "This is largely due to the state-of-the-art suite of six instruments aboard those spacecraft, Shergill says.

"For example, the main imager on these satellites, the Advanced Baseline Imager (ABI), provides three times more spectral information, four times the spatial resolution, and more than five times faster coverage than the previous generation imager

A vast number of space-, air-, sea-, and ground-based sensors constantly monitor Earth's environment, which poses a formidable challenge for data digital signal processing. NASA photo

— leading to more timely refresh rates of images and more accurate forecasts that can save lives," Shergill continues.

"Another example is Lockheed Martin's Geostationary Lightning Mapper (GLM) aboard the satellites," Shergill says. "It provides better-than-ever lightning data, due to the special wavelength that it sees in — day or night. GLM has enabled forecasters to observe increased lightning frequency in such intricate detail, that they've been able to correlate lightning intensification with tornado generation, and this has helped meteorologists to better predict where tornadoes will happen and issue earlier warnings to protect lives and property. That gives you an idea of the high-fidelity data that weather instruments these days are able to provide."

Earth-observation sensing

When it comes to Earth observation technology, it's important to note that it's not just a technology that applies deep into outer space; historically there has been much technology that is not so far away from Earth.

"The origins of remote sensing itself are from the late 19th and early 20th centuries, says Kanna Rajan, a senior scientist at the RAND Corporation in Santa Monica, Calif., and an expert on ocean observations and ocean weather.

Rajan emphasizes that it is important to note that Earth-observation remote sensing data does come just from space, but also is from high-altitude aircraft and balloons. Weather balloons and sounding rockets took off after World War II when rocket technologies started gaining technological momentum. The age of space-based remote sensing was initiated only recently with the first Landsat satellite 1972.

Rajan points out that while rocket technologies have stabilized and launching Earth observation missions is relatively common, the fundamental advances in the last 20 years have come in sensors and in the actual frame of a satellite.

Imagers and radiometers, which use other parts of the electromagnetic spectrum beyond visible light, have developed substantially for optical and other means to observe the Earth.

"The use of optics to provide imagery is useful, absent cloud cover," adds RAND's Rajan. "With cloud cover, other radiometric instruments, where development has been leveraged from radar-based techniques, have made substantial inroads, not just for weather, but also for security."

Rajan points out that the top of this list would be Synthetic Aperture Radar (SAR) which can not only measure wave heights and turbulence especially in coastal zones, but also spot ships and other surface craft.

"RGB techniques themselves have made substantial inroads driven by the confluence of high-end optical measurements for spying from space, as well as, and more importantly from lower end development of miniature cameras riding on the smartphone revolution, he says. "Ocean remote sensing, leading to better weather predictions, similarly has had advances in the optical and radar-based methods. Ocean weather is primarily driven by capturing data on wind, surface currents, sea surface height (SSH) and geodesy - the study of the shape of the Earth including its oceans) in a time varying manner."

Sensors on the ground

Ground sensors have their own unique technologies. Most fielded ground-based weather radars today are mechanically rotating systems with either klystron or magnetron-based systems or elaborate RF and microwave front-end circuitry including heterodyning approaches, explains Mike Jones, a senior manager for ADEF systems platforms for Analog Devices Inc. in Raleigh, N.C. These technologies can include A/D converters, D/A converters, and front-end filters.

Monitoring changes in Earth's weather and climate is a growing challenge that involves enabling technologies like sensor processing, artificial intelligence (AI), and high-speed networking. NASA photo

Other technologies may be involved "Microwave mixers may be employed for the up-conversion and down-conversion," Jones says. "Parabolic dish antennas are used to emit and detect over-the-air signals. The processing in the back-end involves field programmable gate arrays (FPGAs) or application-specific integrated circuits (ASICs) which help perform digital signal processing (DSP) on the radar signal returned from the target. This DSP employs processing algorithms which translate the bits from the received data to an image which can be analyzed by us humans, which then enables meteorological analysis to interpret existing storms and forecast where and when they may occur."

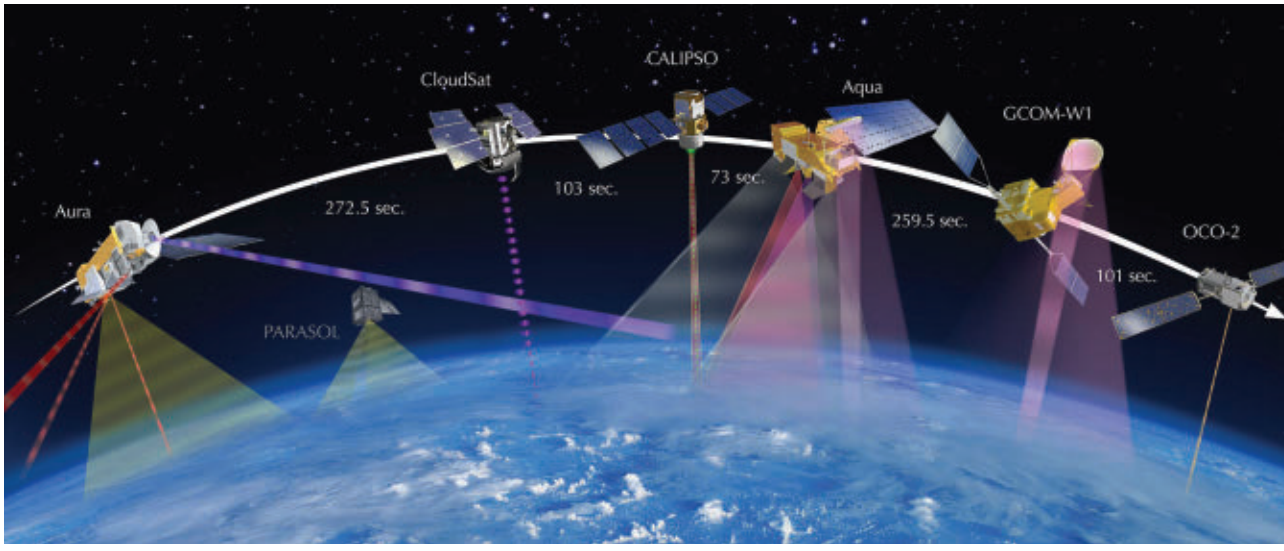
Sandy Brown, vice president for digital and mission solutions at the Raytheon Technologies Corp. (RTX) Raytheon segment (formerly the Raytheon Intelligence & Space and Raytheon Missiles & Defense segments) in Aurora, Colo., notes that there are great advancements in commercial space payload construction and data computing.

"In recent years, technological advancements have led to significant advances in Earth observation and weather forecasting," Brown says. "Commercial space payload construction has undergone a revolution because of advanced manufacturing practices and digital engineering. In addition to extending such payloads' capabilities, these innovations have significantly reduced their costs and dramatically reduced their footprint as well. It is these smaller satellites that have contributed to the growth of the SmallSat market. Smaller and more affordable satellite constellations are being deployed to ensure operational resilience and enable quick replacement of lost spacecraft."

Computing capabilities

Brown adds that in addition to these advancements, there are significant improvements in computing capabilities as well.

"Cloud platforms have made it possible to process data more efficiently and faster," brown adds. "Furthermore, applications can now be containerized, allowing them to run seamlessly across various computing environments. artificial intelligence



U.S. and international space agencies operate many different Earth-observation satellites, which use sensors from all parts of the electromagnetic spectrum.

(AI) accessibility has been greatly improved, thanks to enhanced computing power. AI algorithms now play a pivotal role in data analysis and will soon replace certain aspects of traditional physics-based weather models. Graphics Processing Units (GPUs) have become instrumental in accelerating numerical modeling, leading to improved forecast accuracy. As computing capabilities continue to advance, decentralized and quantum computing hold the promise of further enhancing forecast abilities. These advancements will drive the widespread adoption of AI capabilities in Earth observation and weather forecasting."

Also making great contributions to Earth observation is light direction and ranging technology, otherwise known as lidar, points out David Peterson, a meteorologist at the U.S. Naval Research Laboratory's Marine Meteorology Division in Monterey, Calif. "A discussion about Earth observation must include credit to the advancements in lidar in monitoring and tracking Earth events and observing them," Peterson says.

"The combination of atmospheric profiles from ground and spaceborne lidar with other satellite observations is critical for research into all aerosol plumes such as smoke, dust, pollution, and downstream impacts," Peterson says. "Lidar is the best tool available to understand the vertical profile of wildfire smoke, which has significant implications on where it will be transported and who will be affected. This was especially evident during the recent smoke event that affected the eastern United States, including New York City. Smoke was present in many levels of the atmosphere from near the ground to above the cruising altitudes of jet aircraft. This is a very challenging situation to forecast."

Peterson says the Naval Research Lab employed spaceborne lidar to show that the smoke plumes injected into the stratosphere by wildfire-driven thunderstorms rival or exceed the majority of volcanic plumes at these altitudes over the past decade.

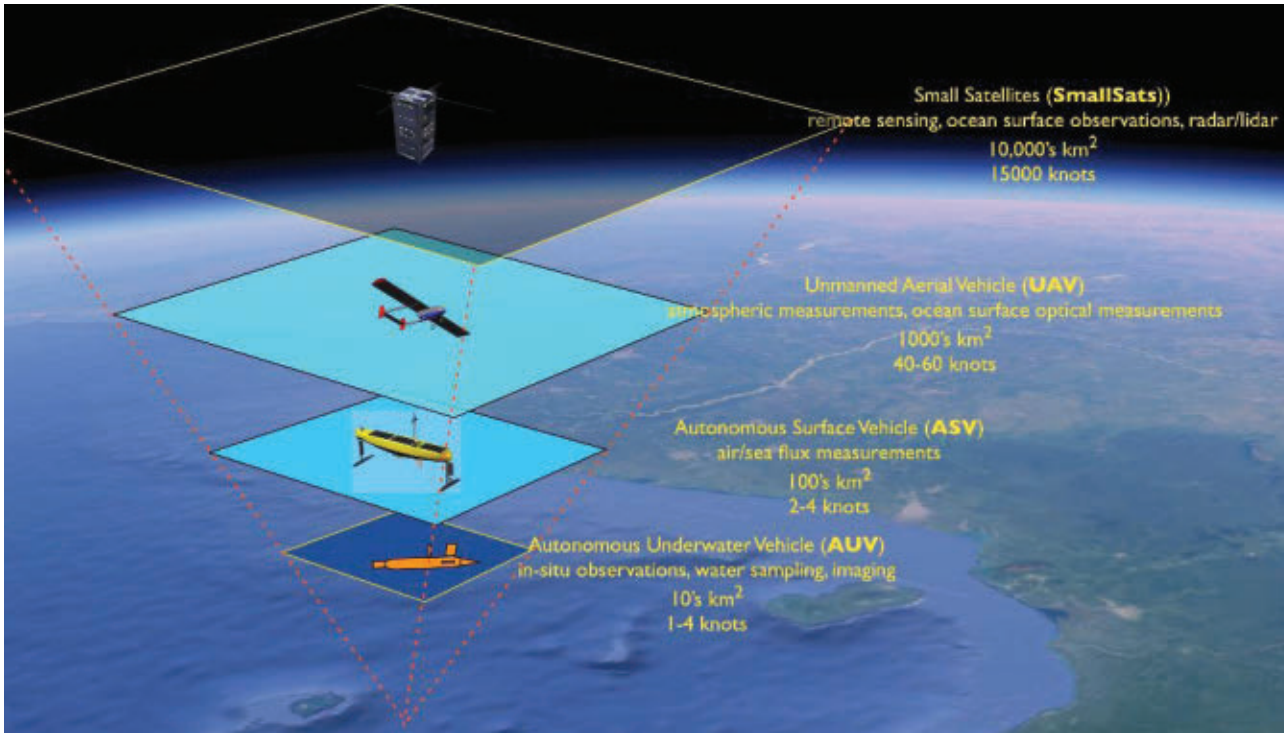
"This means that wildfire smoke can have a lasting impact on the climate system," Peterson says. "The plume from the 2019/20 Australian wildfire events, for instance, persisted in the stratosphere for more than a year."

Advancements in data applications

Advancements in the state of technology for Earth observation and weather forecasting have enabled faster imaging and reporting and sophisticated algorithms that allow for the merging of observational data giving more accurate predictions. Notable technologies that are having an influence include satellite technology; radar systems; numerical weather prediction (NWP); weather observation systems; remote sensing techniques ; big data analytics and machine learning; high-resolution imaging; communications; and data sharing, points out Daryl Madden, vice president geospatial systems at Textron Systems in Sterling, Va.

"Technology in these areas continues to evolve rapidly, and ongoing research and development efforts will continue to enhance Earth observation and weather forecasting capabilities," Madden says. "Here at Textron Systems, we have been working with various types of geospatial data for over 25 years. We have continued to apply the latest in commercial satellite technology into our products to provide actionable insights to our users. The SeeGEO web-enabled platform has the capability to ingest, display, store and exploit geospatial data. RemoteView, our premier imagery exploitation product, allows the imagery analyst to display, measure, compare, and contrast different modalities of remote sensing data to meet their specific needs and missions."

The speed of data processing often is critical, Madden says. "With the increasing threat of natural disasters, fast assessment of the situation is critical to response and rescue efforts. Having access to recent historical imagery to provide change detection assists with more accurate information outputs, such as building and infrastructure damage. In addition, having access to different types of modalities is important for assessment in varying



▲ A range of SmallSats from picoSats, to microSats to CubeSats and larger vehicles have been designed, built, tested and flown with a range of Earth-observation sensor payloads.

conditions; for example, after a hurricane, the geographical area may still be covered with clouds and synthetic aperture radar (SAR) data allows the user to "see through the clouds" to determine flood levels. RemoteView and SeeGEO support various types of imagery such as electro-optical and SAR."

Future weather modeling teams will be hungry for higher-fidelity data that sample Earth's ecosystem at greater resolution than current systems, says Tim Hall is a principal scientist for weather, water, and climate at The Aerospace Corporation in El Segundo, Calif.

"Their models will benefit from an expanded, diverse architecture of sensors observing the atmosphere with diverse space-based sensor types, along with expanded networks of non-space terrestrial and ocean sensors.

Dealing with data

Myriad challenges in fueling weather models are associated with the avalanche of data from current and forthcoming space-based Earth-observation systems. Primary limiting factors include moving data around once it is collected by satellites and the compute capacity to assimilate this data into models. Artificial intelligence (AI) and machine learning techniques are expected to relieve some pressure on compute for data assimilation.

Technology in the Earth observation and weather forecasting domain is evolving at an incredibly rapid pace, says Jerry Johnston, managing director in the Risk and Financial Advisory practice of the Deloitte accounting firm in New York.

"A number of converging trends are driving this evolution including the commercialization of space technology and decreasing costs for satellite build and launch; remarkable advances in AI and machine Learning that enable rapid production of insight and intelligence from raw data; and changes in commercial go-to-market strategies to include subscription services and end-to-end capabilities for a broad range of vertical markets" says Johnston, who also is a geospatial technology leader focused on the defense, security, and justice sector. He previously worked as a geospatial information officer at the U.S. Department of the Interior and U.S. Environmental Protection Agency.

As Johnston sees it, the defense and aerospace industry is already adopting these emerging capabilities to advance their strategies and objectives; the impact will only increase as time goes on.

"As the temporal, spatial, and spectral resolution of commercial Earth observation capabilities continues to improve, the industry has begun to rely on this data to support readiness and mission objectives," adds Johnston. "These include high resolution, hyper local weather forecasting using radio occultation, microwave and other advanced technologies."

The U.S. Department of Defense (DOD) in Washington has identified climate change as a critical national security issue and seeks to integrate climate considerations into its policies, strategies and partner engagements. "The expansion of modalities and technical capabilities provides the data and insights necessary for advancing resiliency and sustainability of global action," Johnston says. "The ability of the defense and aerospace sector to move away from ordering, managing and processing imagery to directly procuring answers and insights from Earth observation capabilities will only continue to grow over time."

Aircraft and Earth observation

In addition to specific advancements intrinsic to technology and data applications and processing, new aircraft are being built military and government missions.

"Lockheed Martin's C-130 Hercules and P-3 Orion aircraft have long supported weather reconnaissance and forecasting missions for the U.S. Air Force and the National Oceanic and Atmospheric Administration (NOAA). Both turboprop airlifters are known for tracking hurricanes but are used throughout the year in gathering and conducting weather research," says Richard Cree, an engineer with Lockheed Martin Skunk Works in Palmdale, Calif. He specializes in airlift mission capabilities for aerial fire-fighting and weather reconnaissance.

Lockheed Martin produced and delivered the WC-130J for the U.S. Air Force to perform reconnaissance missions. "This Super Herc is configured with palletized weather instrumentation for penetration of tropical disturbances and storms, hurricanes and winter storms to obtain data on movement, size and intensity," Cree says. "The WC-130J is the weather data collection platform for the 53rd Weather Reconnaissance Squadron based at Keesler Air Force Base, Miss."

NOAA operates two WP-3 Orions for targeted observations by radars and UAS of supercells (TORUS) operations. These aircraft are equipped with scientific instrumentation, radars, and recording systems for in-situ and remote sensing measurements of the atmosphere, the Earth, and its environment. "NOAA P-3s support a wide variety of national and international meteorological, oceanographic and environmental research programs in addition to its widely known use in hurricane research and reconnaissance," Cree adds.

The future of Earth observation

"Observation and weather forecasting technologies have big implications on defense and aerospace strategies right now and in the future," says Raytheon's Brown. "For defense strategy and tactics, it's crucial to use current constellations. SmallSats and cloud usage improve enterprise resilience and provide support for civilian and defense applications in bandwidth-limited environments."

A Raytheon Visible Infrared Imaging Radiometer Suite is being tested by the company in El Segundo, Calif.

Brown says that onboarding more satellites, the defense and aerospace industries will have access to high-resolution data at a faster refresh rate from instruments like the Visible Infrared Imaging Radiometer Suite (VIIRS). As a result, high-resolution satellite data will be used more effectively, leading to a better

understanding of atmospheric initial conditions and improved numerical weather models. For meteorologists and defense planning, the prospect of a global high-resolution satellite with refresh rates under 15 minutes will significantly enhance forecasting capabilities.

"Over the next three to five years, the military and aerospace electronics industry will see several advancements in technology to support and improve Earth observation and weather forecasting," Brown says. "In the future, AI will handle more tasks and analysis. Spacecraft will have more onboard processing to reduce communication bandwidth and get mission-specific data. Spacecraft construction will become even more cost-effective and efficient with more advancements in digital engineering and advanced manufacturing. The military's capability to provide actionable weather data in remote areas will expand using micro-weather sensors, portable radars, higher-resolution satellite data, and increased observation stations. The industry's open-source approach will foster exponential knowledge sharing, leading to advances in meteorology techniques as developers collaborate, build upon existing ideas, and innovate in novel ways."

Tim Hall of the Aerospace Corporation says that the U.S. depends on a combined civil-military constellation of space-based environmental monitoring (SBEM) systems to support warfighters while also fueling NOAA's mission to protect U.S. lives and critical infrastructure. In essence, he says, the U.S. SBEM constellation (including capabilities provided by international allies such as the European Organization for the Exploitation of Meteorological Satellites, or EUMETSAT) represents critical national and economic security infrastructure.

"The Department of Defense and NOAA work together effectively in numerous forums (e.g., Interagency Council for Advancing Meteorological Services, or ICAMS)," says Hall. "To build on the work done in those forums, the U.S. would benefit from a mechanism to conduct formal interagency planning of a combined, civil-military U.S. SBEM constellation. The architecture generated through such a joint process could help boost the resilience of future capabilities critical to all users, in peacetime and during military conflict."

The U.S. Air Force operates the Lockheed Martin WC-130J Super Hercules as part of the 53rd Weather Reconnaissance Squadron based at Keesler Air Force Base, Miss., for weather and hurricane reconnaissance missions.

EARTH OBSERVATION

For more information on Earth observation and weather forecasting companies search for "weather" at www.militaryaerospace.com

Hall adds that in the next three to five years, new capabilities in Earth observation, including space-based environmental monitoring (SBEM) satellites, will continue to emerge.

"The U.S. government will explore new, streamlined approaches to acquisition, including giving serious consideration to commercial data services offerings," he says. "I expect that increasing collaboration between government and industry will help identify sweet spots in hybrid SBEM architectures that would feature traditional, exquisite, highly calibrated, long-lived instruments alongside augmenting commercial capabilities such as GPS radio occultation (GPS-RO) that will enhance weather forecasting. New concepts continue to emerge in instrument modalities scaled to small satellite platforms, ranging from sounders the measure vertical slices of the atmosphere to precipitation radar. Advanced understanding of the future needs of weather models (i.e., from the mid-2030s) will be critical for government to identify the most promising commercial offerings."

Deloitte's Johnston says the industry will see a continued uptick in the launch of new Earth observation and weather forecasting instruments. "The planned launch schedules alone over the next several months provide strong evidence of this," says Johnston. "The growing number of Earth observation sensors in Low and Very Low Earth Orbit are providing ever higher resolution and adding to the resiliency and flexibility of the Earth observation ecosystem. As the Earth observation market diversifies and grows — and enormous volumes of data from a rich constellation of sensors become more available — the industry will expand its use of these assets. With all of the new entrants into the marketplace, there is no doubt that the community will continue finding new and innovative solutions for their mission problems."

L3Harris to build RF and microwave tactical networking terminals for aircraft and ships

BY **John Keller**

WASHINGTON – U.S. Navy shipboard communications experts will develop and build digital tactical networking datalinks to enable the MH-60R multimission helicopter to share information from sensors in real time with surface warships under terms of a potential $141.8 million contract.

Officials of the Naval Sea Systems Command in Washington are asking L-3Harris Communication Systems-West in Salt Lake City to develop and build the AN/SRQ-4 Radio Terminal Set (RTS) Common Data Link (CDL) Hawklink for surface combatants.

The initial one-year contract is for $16 million, and has options that could increase its value to $141.8 million and extend the contract's length through April 2028.

The L3Harris rugged AN/SRQ-4 Hawklink shipboard terminal is aboard Navy Arleigh Burke-class destroyers and Ticonderoga-class cruisers, and provides command and control, sensor data transfer, datalink operation, and built-in test, L3Harris officials say.

The tactical RF and microwave networking link enables surface ships and MH-60R helicopters to share information from radar, video, network, and acoustic data interfaces, and enables naval personnel to exploit aircraft sensor data in real time to extend situational awareness over the horizon. It has a range of about 100 nautical miles.

The Ku-band communications system runs on an open-systems architecture with touch-screen interfaces. Its 43-inch directional antenna offers auto-switching between open-loop pointing and closed-loop tracking, depending on the range between the helicopter and the ship.

The tactical data link terminal is interoperable with the AN/SQQ-89 warship undersea warfare combat system and shipboard navigation sensors. It is software-configurable with Common Data Link (CDL) waveforms, and is compatible with SAU7000 digital messaging interfaces.

In addition to the MH-60R helicopter, the system also can work with the Fire Scout unmanned aerial vehicle (UAV), the P-8 Poseidon reconnaissance aircraft, and the P-3 Orion maritime patrol aircraft.

On this contract L3Harris will do the work in Salt Lake City, and should be finished by April 2023. For more information contact L3Harris Communications-West online at www.l3harris.com, or Naval Sea Systems Command at www.navsea.navy.mil.

The AN/SRQ-4 Hawklink terminal provides Navy Arleigh Burke-class destroyers and Ticonderoga-class cruisers with command and control, and sensor data transfer.

Lockheed Martin to provide submarine EW systems to detect enemy radar

BY **John Keller**

WASHINGTON – Submarine combat systems experts at Lockheed Martin Corp. will design and test U.S. Navy AN/BLQ-10 electronic warfare (EW) systems for Navy submarines under terms of an $18 million order.

Officials of the Naval Sea Systems Command in Washington are asking the Lockheed Martin Rotary and Mission Systems segment in Syracuse, N.Y., for the design, prototyping, and qualification testing of submarine electronic warfare equipment.

The order involves a modification to a potential $970.1 million 10-year contract announced in February 2019 for Lockheed Martin to design, upgrade, and support the AN/BLQ-10 submarine EW system technology insertion cycles TI-20, TI-22, and TI-24.

The AN/BLQ-10 provides automatic detection, classification, localization, and identification of potentially hostile radar and communications signals at sea.

The AN/BLQ-10 helps Virginia-, Los Angeles-, and Seawolf-class fast-attack submarines, Ohio-class conventional guided-missile submarines, and future Columbia-class ballistic-missile submarines detect enemy radar and communications. It is not for existing Ohio-class ballistic-missile submarines.

The AN/BLQ-10 processes signals from the submarine's imaging mast or periscope when the boat is at periscope depth. It provides threat warning to avoid counter-detection and collision; determines the number and location of targets for subsequent prosecution; and conducts intelligence, surveillance, and reconnaissance (ISR) to support the fleet or battle group.

The program is adopting an open-architecture, incremental development process that fields hardware and software technology insertions every two years. The AN/BLQ-10 blends modular interoperable systems that adhere to open standards with published interfaces.

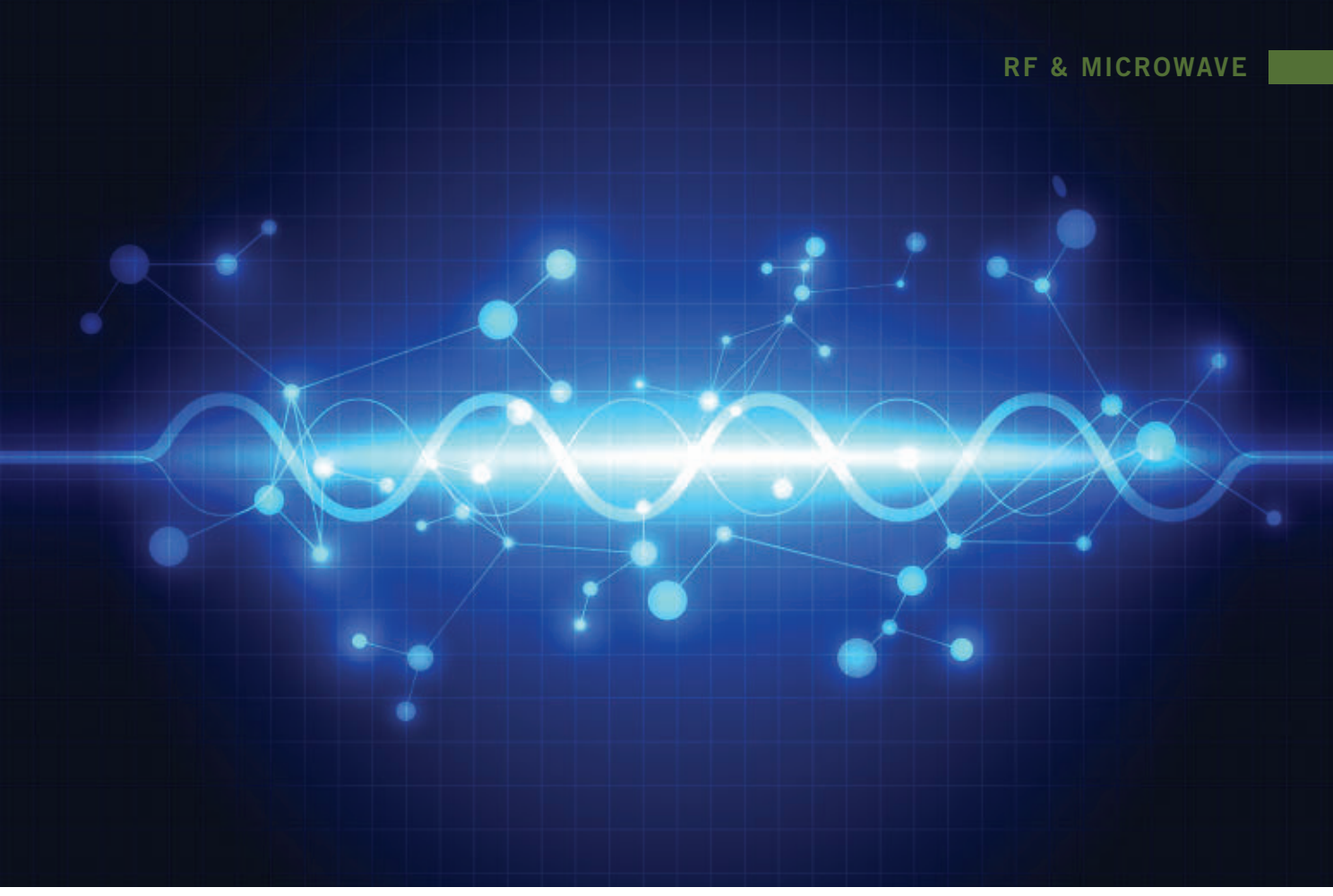
The system's first technology insertion in 2008 added a subsystem to intercept some low-probability-of-intercept radar signals. Fielded upgrades from the 2010 technology insertions updated commercial off-the-shelf (COTS) processors and displays, and Improved Communications Acquisition and Direction Finding (ICADF) system.

For TI-20, Lockheed Martin built an upgraded AN/BLQ-10 for Virginia- and Columbia-class submarine new construction, and in-service Virginia-class modernization.

TI-22 work upgraded AN/BLQ-10 systems for in-service Los Angeles- and Seawolf-class attack submarines, as well as for Ohio-class conventional missile submarines. TI-24 work builds an upgraded AN/BLQ-10 for Virginia-class and Columbia-class new construction, as well as for in-service Virginia-class modernization.

The AN/BLQ-10 electronic warfare (EW) systems for Navy submarines provides automatic detection, classification, localization, and identification of potentially hostile radar and communications signals at sea.

On this order Lockheed Martin will do the work in Syracuse, N.Y., and should be finished by February 2024. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com/en-us/who-we-are/business-areas/rotary-and-mission-systems.html.



Wanted: tiny efficient military RF and microwave transmitters and receivers

BY **John Keller**

ARLINGTON, Va. – U.S. military researchers are asking industry to develop small RF receivers, transmitters, and antennas for space-constrained RF and microwave applications in sensors and communications.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a broad agency announcement in June (HR001123S0041) for the Macaroni project to develop tiny RF receivers and transmitters. Details of the project are secret.

These RF and microwave components not only should exceed today's state of the art, but also should seek to overcome long-established design limitations of the so-called Chu Limit that constrains the bandwidth of data that can be sent and received from small antennas.

Measurement and control of the electromagnetic spectrum is a key research area the U.S. Department of Defense (DOD), researchers point out. Spectrum dominance requires quick and efficient control of electromagnetic radiation from DC to the X-ray regime.

▲ Primary challenges involve developing receivers and transmitters that are much smaller than the signal wavelengths they send and receive.

The primary challenge of the Macaroni project involves receivers and transmitters that are much smaller in size than the wavelength of the sent and received electromagnetic radiation.

In classical antenna theory, the sensitivity-bandwidth product is fundamentally limited by the shape and size of the antenna. This performance degrades significantly as the antenna size becomes much smaller than the electromagnetic wavelength of operation.

Yet size-, weight-, and power- (SWaP)-constrained applications are driving efforts to move beyond traditional constraints, and develop efficient, electrically small antennas still presents a challenge.

Recent advances in quantum sensors, materials science, electromagnetic shielding, laser technology, resonators, cryogenic

systems, and vacuum components have pushed the state of the art in sensing technologies. As these enabling technologies improve, a wider variety of protocols and methodologies become possible and previous notions of the performance limits require validation, researchers say.

For transmitters, new insights in active antenna technology, control schemes, methods of impedance matching, and strategies for volume filling also present new opportunities. Recent efforts in piezoelectrics, magnetoelectrics, high-index materials, and multiferroic materials may be leveraged to improve the efficiency trade space for small antennas.

DARPA researchers are interested in any transmit and receive technologies that can achieve performance beyond the Chu limit that can incorporate electric and magnetic technologies — especially in solutions that minimize the antenna size relative to the operating wavelength.

DARPA would like proposals that involve teaming arrangements within and among organizations with relevant expertise, research facilities, and capabilities in electrically small receivers and transmitters. Researchers say they believe proposals from multi-disciplinary teams will be necessary to achieve the Macaroni goals.

Disciplines spanning physics, electrical engineering, mechanical engineering, materials science, computer modeling, and systems engineering are expected.

The Macaroni program is a 45-month three-phase program, starting next February, with an 18-month first phase, an 18-month second phase, and a nine-month third phase. The project emphasizes two technical areas: receivers and transmitters.

Receiver work will focus on receive sensitivity, link closure, and systems integration. Transmitter work will focus on transmitter strength, demonstrating a transmitter system, and system ruggedization.

Companies interested should request the classified addendum to the Macaroni project for additional technical details by filling out a request form, online at https://sam.gov/api/prod/opps/v3/opportunities/resources/files/620b30e-4acc44e7a87f6a34f260b7e4e/download?&token=, and emailing it to HR001123S0041@darpa.mil.

Those interested in bidding were asked to submit abstracts in July, and should upload full proposals by 13 Sept. 2023 to the DARPA BAA website at https://baa.darpa.mil. Email questions or concerns to DARPA's Jonathan Hoffman at HR001123S0041@darpa.mil. More information is online at https://sam.gov/opp/07e3eda5a19f4462be14e613d4712ad9/view.

Coaxial couplers for space and military uses introduced by Smiths Interconnect

Smiths Interconnect in London is introducing coaxial couplers in UHF to Ku-band for space satellites launch systems, and deep-space mission management, as well as for military ground, airborne and naval defense applications. Designed to perform in assigned frequencies from UHF to Ku-band, Smiths Interconnect's coaxial couplers are tested to customer specifications and are space qualified using the company's Qualification and Test laboratory in Dundee, Scotland. Space qualification testing routinely includes thermal shock and cycling, sine/random vibration, mechanical shock and, where appropriate, continuous waveform and peak power, critical power, and seeded multipaction. Summary and qualification data reports are available to prospective customers. Smiths Interconnect's coaxial coupler components offer optimized electrical performance; environmentally robust shielding; connectors based on operating frequency and RF power; and internal terminations and resistors are analyzed to maintain reliability under fault conditions. For more information contact Smiths Interconnect online at www.smithsinterconnect.com.

Radiation-hardened power switch controller introduced by CAES

CAES in Arlington, Va., is introducing the Smart Power Switch Controller (SPSC) for power electronics designs in high-reliability space applications. The SPSC offers extensive fault detection, isolation, and recovery capabilities in one package. The radiation-hardened device features a high level of space assurance, wide temperature range, and quick fault detection and recovery. The Smart Power Switch Controller offers extensive fault detection, isolation and recovery capabilities in one package. The device offers PMBus, which communicates over an I2C serial bus. This two-wire command, configuration and control protocol can manage dozens of power switch channels with a small host controller. The device is also a power bus protection device, with the ability to detect high- and short-circuit faults and isolate the circuit in 250 nanoseconds. CAES's radiation-hardened design techniques meet high-reliability mission profiles and can withstand harsh environments, including QML-Q and QML-V for military and space-grade qualification. For more information contact CAES online at https://caes.com.

Eve Air Mobility to bring electric manned and unmanned commuter flights to San Francisco

BY **Jamie Whitney**

SÃO JOSÉ DOS CAMPOS, Brazil - Eve Air Mobility, a subsidiary of Embraer in São José dos Campos, Brazil, and Chicago-based United Airlines announced plans to bring manned, and eventually unmanned, urban air mobility (UAM) to San Francisco by launching electric commuter flights throughout the Bay Area.

Both companies will be working with local and state officials, as well as infrastructure, energy and technology providers to ensure the appropriate infrastructure is in place to introduce manned and unmanned electric vertical takeoff and landing (eVTOL) aircraft flights. The companies also are trying to identify origin and destination areas and a future route network.

Manned and unmanned aircraft in the future are expected to shuttle airline passengers to and from major Bay Area airports in Oakland, San Jose, and San Francisco.

Eve's eVTOL will offer United's customers a way to get to its hub airports and commute in dense urban environments. Eve's eVTOL is 100 percent electric and has a range of 60 miles, which enables it to complete a variety of urban air mobility missions in the San Francisco Bay Area, which includes major commercial airports in Oakland, San Jose, and San Francisco.

The aircraft features a lift + cruise configuration with dedicated rotors for vertical flight and fixed wings to fly on cruise, with no components required to change position during flight. It will be piloted at launch but evolving towards unmanned operations in the future.

Eve officials note that eVTOL flights in the Bay Area could provide new employment opportunities for pilots, aircraft service technicians, training, and technical services, as well as infrastructure employment to support eVTOL operations.

In 2022, United announced a $15 million investment in Eve Air Mobility and a conditional purchase agreement for 200 eVTOL aircraft plus 200 options.

A key piece of United's and Eve's relationship includes access to Embraer's global service centers, parts warehouses, and field service technicians. Upon entry into service, United could have its entire eVTOL fleet serviced by Eve's service and support network.

For more information contact Eve Air Mobility online at https://eveairmobility.com, United Airlines at www.united.com/ual/en/us/fly/company/united-airlines-ventures.html, or Embraer at https://embraer.com/global/en.

General Atomics to build SkyGuardian unmanned aircraft for Taiwan

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio – Unmanned aerial vehicle (UAV) designers at General Atomics Aeronautical Systems Inc. in Poway, Calif., will build four MQ-9B SkyGuardian UAVs for Taiwan under terms of a $217.6 million contract.

Officials of the U.S. Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, are asking General Atomics to build the four MQ-9B UAVS, two certifiable ground-control stations, spare parts, and support equipment.

▲ The MQ-9B SkyGuardian unmanned aircraft is a version of the General Atomics Predator B UAV that meets the STANAG-4671 NATO standard.

The MQ-9B SkyGuardian unmanned aircraft is a version of the General Atomics Predator B UAV that meets the STANAG-4671 NATO standard, which is the NATO UAV airworthiness certification to enable military UAVs to operate in the airspace of other NATO members. It incorporates designs necessary to achieve a type-certifiable system.

General Atomics is building the MQ-9B SkyGuardian reconnaissance UAV from the ground up to meet global airworthiness standards, and involves hardware and software upgrades such as improved structural fatigue and damage tolerance, high-reliability flight-control software, enhancements that enable operations in adverse weather conditions like icing, and the ability to survive bird and lightning strikes.

MQ-9B can be configured with UAV sensor payloads such as detect and avoid (DAA), and airborne due regard radar (DRR) for operation in non-cooperative airspace. The MQ-9B can fly as high as 40,000 feet above sea level, as fast as 210 knots, and can fly unrefueled for as long as 40 hours.

It has the Raytheon MTS-B multispectral targeting system electro-optical system, the General Atomics Lynx multi-mode radar, VHF/UHF radios, DO-178 and DO-254 design assurance for software and avionics, de-ice/anti-ice system. automatic takeoff and landing, and fire-protected engine bay.

The weaponized version of the MQ-9B can carry a variety of precision-guided missions, multimode maritime surface-search radar, and automation information system.

On this contract General Atomics will do the work in Poway, Calif., and should be finished by May 2025. For more information contact General Atomics Aeronautical Systems online at www.ga-asi.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

QinetiQ to build Talon and MTRS unmanned ground vehicles for bomb disposal

BY **John Keller**

INDIAN HEAD, Md. – U.S. Navy bomb disposal experts are beefing-up their inventory of unmanned ground vehicle (UGV) robots that are designed to detect, pinpoint, and neutralize improvised explosive devices (IEDs) and other roadside bomb threats.

The U.S. Navy is using the QinetiQ MK 2 Man Transportable Robotic System (MTRS) for detecting and disposing of roadside bombs.

Officials of the Naval Surface Warfare Center Indian Head Explosive Ordnance Disposal Technology Division in Indian Head, Md., announced a $10.6 million order to QinetiQ North America in Waltham, Mass. for option year two of production, engineering support, and post production support of the MK 2 Man Transportable Robotic System (MTRS) and Talon systems.

The MK2 MTRS from QinetiQ is one of several MTRS designs that provides stand-off capability to detect, identify, and dispose of IEDs and related hazards using unmanned ground vehicles equipped with special IED-disposal payloads.

The MTRS provides the ability to locate, identify, and clear land mines, unexploded ordnance, and IEDs in the path of maneuvering Army or Joint forces.

The QinetiQ version of the MTRS is based on the company's Talon tracked unmanned ground vehicle. These lightweight vehicles are designed for IED and explosive ordnance disposal, reconnaissance, communications, countering chemical, biological, radiological, nuclear, and explosive (CBRNE) threats, security, heavy lift, defense, and rescue missions.

Talons can move as fast as six miles per hour, are transportable by one person, works in bad weather and rugged terrain, and have high payload capacity and payload-to-weight ratios.

The Talon V provides 16 I/O ports including Interoperability Profile (IOP) A and B connectors; has JAUS AS4-compliant software; supports plug and play discovery of IOP devices; offers a variety of high-definition and standard-definition camera options in addition to an optional, dual purpose Thermal/Daytime zoom camera; has a heavy-lift multiple-degree-of-freedom arm manipulator; and supports a variety of third party and legacy Talon manipulators.

The order to QinetiQ announced last month is to exercise option two of MK2 MTRS production, as well as for depot-level repair parts, spare kits, approved accessories, consumable parts, reconditioning, conversions, engineering enhancements, and configuration management in support of the Joint Service Explosive Ordnance Division program.

QinetiQ won the company's original $9.4 million MTRS contract in September 2014. The company won a separate $9.9 million MTRS order in September 2015.

On this order, QinetiQ will do the work at locations to be determined on individual task orders, and should be finished by March 2026. For more information contact QinetiQ North America online at www.qinetiq.com/en-us, or the Naval Surface Warfare Center Indian Head Explosive Ordnance Disposal Technology Division at www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Indian-Head.

Airbus and STMicroelectronics eye power electronics for unmanned electric aircraft

Airbus in Blagnac, France, and STMicroelectronics in Geneva are working together to develop light and efficient power electronics for future manned and unmanned hybrid-powered aircraft and full-electric urban air mobility vehicles. The collaboration focuses on wide-bandgap semiconductor materials like silicon carbide (SiC) and gallium nitride (GaN) for aircraft. These materials could enable applications that require high-power, high-frequency, or high-temperature operations. The co-operation revolves around developing semiconductor materials for Airbus aerospace applications. The companies will demonstrate these components for e-motor control units, high- and low-voltage power converters, and wireless power transfer systems.

Kratos to build 15 unmanned target drones for anti-ship missile practice

BY **John Keller**

PATUXENT RIVER NAS, Md. – High-performance target drones experts at Kratos Defense & Security Solutions Inc. are building another 15 subsonic aerial targets that will help Navy aircraft and surface warship crews learn to defeat enemy anti-ship cruise missiles.

Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced an $11.1 million order in late March to the Kratos Unmanned Systems segment in Sacramento, Calif. (formerly Composite Engineering Inc.), for 15 full-rate-production lot-4 BQM-177A surface-launched aerial targets.

The Kratos BQM-177A unmanned target drone helps Navy surface warship crews practice how to evade and defeat enemy anti-ship missiles.

The order includes rocket-assisted takeoff kits, research data, fleet gunnery and missile training exercises, and fleet air-to-air missile and surface-to-air missile training exercises for the Navy.

The BQM-177A is the Navy's next-generation subsonic aerial target that mimics the behaviors and radar cross sections of high-subsonic sea-skimming anti-ship cruise missiles to help naval personnel practice air-to-air engagements.

The contract includes 55 rocket-assisted takeoff attachment kits, 277 mission kits, and data for the U.S. Navy and the militaries of Canada and Australia.

The BQM-177A unmanned aerial vehicle (UAV) program is designed to meet the U.S. Navy's requirements for a high fidelity target to replicate subsonic anti-cruise missile threats in direct support of fleet training and weapon system testing and evaluation.

In November 2016 Kratos Unmanned Systems officials announced they had achieved the final development program milestone for the BQM-177A target drone leading up to low-rate initial production (LRIP). In June 2018 Kratos began LRIP on the BQM-177A with a Navy order for 45 of the high-performance target drones. Last January Kratos moved to full-rate production of the target drones with a $49.6 million contract to build 55 new BQM-177As.

Capable of speeds in excess of 730 miles per hour and a sea-skimming altitude as low as 10 feet above the surface of the water, the BQM-177A carries internal and external payloads including proximity scoring, identification friend or foe (IFF), passive and active RF augmentation, electronic countermeasures, infrared plume pods, chaff and flare dispensers, and towed targets.

The BQM-177A is based on the Kratos BQM-167X aircraft, a derivative of the U.S. Air Force BQM-167A Skeeter target. The BQM-177A introduces a new fuselage with area ruling, high-mounted wings, and an internally integrated MicroTurbo TR-60-5+ turbo jet engine for reduced transonic drag.

The BQM-177A will augment and later replace existing BQM-74E aerial targets, and will deliver longer range, lower cruise altitudes, and greater maneuverability than previous-generation target drones.

The BQM-177A is 17 feet long, has a 7 -foot wingspan, and weighs 620 pounds with fuel or payloads. It can fly at altitudes as low as 6.6 feet above the ground or water, and as high as 40,000 feet above sea level.

On this order Kratos will do the work Sacramento, Santa Ana, Concord, and Chatsworth, Calif.; Dallas; Fort Walton Beach, Fla.; Blacksburg, Va.; Newton, Kan.; and Milwaukie, Ore., and should be finished by May 2024. For more information contact Kratos Unmanned Systems online at www.kratosdefense.com/about/divisions/unmanned-systems, or Naval Air Systems Command at www.navair.navy.mil.

Air Force eyes next-generation speed-of-light sensors to characterize nuclear explosions

BY John Keller

PATRICK SPACE FORCE BASE, Fla. – U.S. Air Force researchers are surveying industry to find companies able to develop new speed-of-light sensors able to collect, characterize, and transmit nuclear weapons detonation phenomena in gamma, electromagnetic pulse (EMP), RF, and optical teller light spectra.

Officials of the Air Force Technical Applications Center at Patrick Space Force Base, Fla., issued a request for information (FA702223RSOLS) in May for the Next Generation Speed of Light Sensors project.

Researchers want next-generation speed-of-light sensors to detect, identify, and characterize nuclear explosions and to report nuclear forensic information to national authorities.

The sensor design can be an original concept or the use and modification of ubiquitous commercial or government technologies for collecting the phenomena to produce a reaction time history (RTH) of nuclear reactions within the bomb that manifest as electromagnetic spectrum emissions over time.

Researchers want to decrease the shape, size, dimensions, mass, and weight of the hardware, and decrease the language and media for software; enable an item to interface physically with another item; and increase the quality for which an item is designed to perform.

▲ Researchers want next-generation speed-of-light sensors to detect, identify, and characterize nuclear explosions and to report nuclear forensic information to national authorities.

Concepts should reduce the use of materials and parts with low availability, limited vendors, and custom and proprietary parts or software.

Unmanned sensor requirements include high operational availability; significant remote maintenance and calibration capabilities; limited physical preventative maintenance; and ruggedization to withstand environmental conditions like exposure to high and low temperatures, solar radiation, rain, wind, snow, humidity, fungus, salt, and dust.

Solutions should be deployable on the ground, in the air, or in space, Respondents shall provide schedule outlines and cost estimates.

Companies were asked to email six-page technology overviews of proposed next-generation speed-of-light sensor research by 2023 to the Air Force's James Pattullo at james.pattullo@us.af.mil. Email questions or concerns to James Pattullo at james.pattullo@us.af.mil. More information is online at https://sam.gov/opp/7719c7facadc406bbcad5b7d26aa9ef9/view.

Leonardo DRS to build mercury cadmium telluride infrared weapon sight for snipers

BY **John Keller**

ABERDEEN PROVING GROUND, Md. – U.S. Army night-vision experts needed a thermal weapon sight for Special Operations soldiers. They found their solution from the Leonardo DRS Electro-Optical Infrared Systems segment in Melbourne, Fla.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., announced a $94.8 million contract to Leonardo DRS for the Family of Weapons Sights-Sniper Improved Night/Day Observation Device (INOD) Block III system.

INOD Block III provides a daylight and nighttime rifle sight that can penetrate battlefield smoke, haze, and bad weather for Special Operation Forces (SOF) snipers. It clips in front of the existing rifle day scope, and enables the shooter to maintain the existing day scope zero.

The INOD employs a mercury cadmium telluride passive micro-cooled mid-wave infrared (MWIR) sensor to provide quality 640-by-480-pixel resolution that is usable with day scope magnifications from 5x to more than 25x to match or exceed current sniper weapons systems capabilities.

The INOD has been ruggedized for use with all special forces and U.S. Army sniper weapons — particularly for long-range target detection and identification, observation of environmental indicators, and is capable of tracking bullet trajectory.

The device has hot-swap battery capability and external power for persistent surveillance on long missions. It has a rear facing focus knob enables one-handed gloved operation.

INOD offers rapid identification, acquisition, and target engagement; passive enemy engagement; super elevation for target engagement to extreme ranges.

It measures 9.63 by 3.5 by 4.14 inches; weighs 3.5 pounds; and operates in temperatures from -20 to 50 degrees Celsius; and focuses from 20 meters to infinity, with a 2.48-degree field of view.

The INOD runs for more than five hours on six 3-volt DC lithium batteries, or on external power of 12 to 32 volts DC. For more information contact Leonardo DRS Electro-Optical Infrared Systems online at www.leonardodrs.com/who-we-are/our-segments/electro-optical-infrared-systems, or the Army Contracting Command-Aberdeen at https://acc.army.mil/contractingcenters/acc-apg/.

INOD Block III provides a daylight and nighttime rifle sight that can penetrate battlefield smoke, haze, and bad weather for Special Operation Forces (SOF) snipers.

Electron detection device for radiation-detection introduced by Opto Diode

Opto Diode Corp. in Camarillo, Calif., is introducing the AXUV100G electron detection device designed for use in radiation-detection applications. The device offers a 100-by-100-millimeter active area, and its electron photodetector features electron responsivity at energy levels as low as 100 ectronvolts (eV). The shunt resistance is a minimum of 20 milliohms, and its reverse breakdown voltage is 5 volts minimum and 10 volts typical. Its capacitance is 5 nanofarads (nF) typical, and its rise time is a maximum of 10 microseconds. Ambient storage and operating temperatures for this electron detection device range from -10 to 40 degrees Celsius nitrogen or vacuum storage, and operating temperatures range from -2 to 80C. The lead soldering temperature for the UV device is 260C. For more information contact Opto Diode online at https://optodiode.com/products-photodiodes.html. Download the data sheet at https://optodiode.com/pdf/AXUV100GDS.pdf.

Javelin has an imaging infrared-guided seeker to guide the warhead to its target.

Raytheon and Lockheed Martin to provide anti-armor missiles, electro-optical guidance

BY **John Keller**

REDSTONE ARSENAL, Ala. – Missiles experts at Lockheed Martin Corp. and Raytheon Technologies Corp. will build additional Javelin anti-armor missiles under terms of a $1 billion contract.

Officials of the U.S. Army Contracting Command at Redstone Arsenal, Ala., are awarding the contract to the Raytheon/Lockheed Martin Javelin Joint Venture based in Tucson, Ariz., to build Javelin weapon systems.

The Javelin, which has electro-optical guidance, is an infantry fire-and-forget anti-armor weapon with lock-on before launch and automatic self-guidance designed to destroy main battle tanks, armored personnel carriers, and other armored combat vehicles. The missile also is effective against buildings and enemy helicopters.

Javelin has an imaging infrared-guided seeker to guide the warhead to its target. The tandem warhead has two shaped charges: a precursor warhead to detonate any explosive reactive armor, and a primary warhead to penetrate base armor.

Javelin offers lock-on before launch and automatic self-guidance that attacks the vulnerable tops of armored vehicles. A two-person infantry team typically carries the missile.

Raytheon produces the command launch unit, missile guidance electronic unit, and system software at Raytheon Missile Systems segment in Tucson, Ariz. Lockheed Martin, meanwhile, produces the missile seeker and the electronic safe, arm, and fire electronic module in Ocala, Fla., and performs missile all-up-round assembly in Troy, Ala.

On this order the Raytheon/Lockheed Martin Javelin Joint Venture will do the work at locations to be determined with each order, and should be finished by May 2027. For more information contact Raytheon at www.raytheonmissilesanddefense.com/what-we-do/land-warfare/precision-weapons/javelin-missile, Lockheed Martin at www.lockheedmartin.com/en-us/products/javelin.html, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa/.

WIRING HARNESSES

▲ Air Force picks five contract manufacturers for wiring harnesses on F-16 jet fighters

U.S. Air Force combat aircraft avionics experts are looking to five electronics contract manufacturing companies to provide wiring harnesses and kit assemblies for the Air Force F-16 combat jet fleet.

Officials of the Air Force Life Cycle Management Center at Hill air Force Base, Utah, has awarded a collective $900 million eight-year contract to these companies to provide low-cost and rapid delivery of diverse harness parts and kits for the F-16 jet fighter fleet to include all Block aircraft.

The companies are Cherokee Nation Aerospace and Defense LLC in Stillwell, Okla.; Interconnect Wiring LLP in Fort Worth, Texas; KIHOMAC Inc. in Reston, Va.; Parts Life Inc. in Moorestown, N.J.; and Richard Manufacturing Co. in Ogden, Utah.

Cherokee Nation Aerospace & Defense offers manufacturing capabilities to support the U.S. government and OEM partners. The company's manufacturing division produces aerospace wiring harnesses, electro-mechanical assemblies, aviation sheet metal and machined parts, tactical trailers, and shipping and storage containers.

Interconnect Wiring provides electrical products and services, modification and repair of wiring harnesses and panel assemblies, engineering design, and aircraft wire removal and replacement. The company is the original equipment manufacturer for many F-16 electrical products such as wiring harnesses, cockpit panels, and power-distribution panels.

KIHOMAC Inc. provides services in acquisition, armor systems calibration, complex manufacturing, data development, field tech support, reverse engineering and prototyping, software engineering, sustainment, systems engineering, and measurement science.

Parts Life makes electrical and electronic assemblies, high-reliability electronics, electro-mechanical assemblies, fiber-optic assemblies, electrical components, wiring harnesses, wiring assemblies, cable and conduit assemblies, adapter and connector assemblies, panel and switch assemblies, and box and enclosure assemblies.

Richard Manufacturing provides wiring harnesses for control systems, ground support cables, power cables, EMI-shielded cables, flexible and semi-rigid coax cables, molded cables and modules, matrix relay assemblies, control and switch panels, test consoles and test sets, electromechanical assemblies, and printed circuit board assemblies.

On this contract, the five companies will do the work in Ogden, Utah; Fort Worth, Texas; Stillwell, Okla.; Moorestown, N.J.; and Reston, Va., and should be finished by May 2031.

For more information contact the Air Force Life Cycle Management Center at Hill Air Force Base online at www.hill.af.mil/About-Us/Fact-Sheets/Display/Article/1583368/air-force-life-cycle-management-hill-afb-site/.

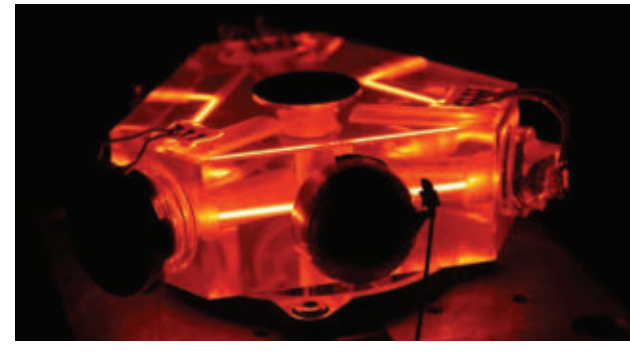
NAVIGATION AND GUIDANCE

▼ Honeywell to supply ring laser gyros for surface warship navigation and guidance

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 Supply Systems Command Weapon Systems Support activity in Mechanicsburg, Pa., have announced a $12 million order to the Honeywell International Inc. Aerospace segment in Minneapolis to provide ring laser gyros for the AN/WSN-7 inertial navigation system.

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 ring laser gyro-based replacement for the old WSN-2 navigation system. Navy officials are extending the life of the WSN-7 as long as possible as they develop a WSN-7 replacement.

The Northrop Grumman Corp. operating unit in Charlottesville, Va., provides the AN/WSN-7, and 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.

Northrop Grumman reported completion of the ISM's preliminary design review in May 2016, and critical design review in June 2018. The ISM will be a critical component of the WSN-12 replacement.

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 Honeywell will do the work in Minneapolis, and should be finished by April 2024. For more information contact Honeywell Aerospace online at https://aerospace.honeywell.com, or the Naval Supply Systems Command Weapon Systems Support activity at www.navsup.navy.mil/NAVSUP-Enterprise/NAVSUP-Weapon-Systems-Support.

COMMUNICATIONS

▼ L3Harris to develop path-agnostic mobile military communications via space internet

Space communications experts at L3Harris Technologies Inc. are moving forward with a U.S. Air Force research project to find new ways to distribute information among land, sea, and air forces quickly to support high-speed decision-making.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have announced an $80.8 million contract to the L3Harris Technologies C5 Integrated Systems segment in Camden, N.J., for the Defense Experimentation Using the Commercial Space Internet (DEUCSI) program.

This project seeks the ability to move and share data seamlessly among a wide variety of fixed and mobile operating locations using constantly available, high-bandwidth, beyond-line-of-sight communications.

DEUCSI space-based capability will be called path-agnostic communications because its users will be able to communicate reliably to any location in the world without explicitly specifying which nodes of a communication network to use.

L3Harris will seek to establish the ability to communicate with Air Force and other military platforms via several different commercial space internet constellations using common user terminal hardware elements.

The vision for path-agnostic communications is becoming possible due to the burgeoning commercial space internet, Air Force officials say. Several commercial companies plan to establish space internet constellations consisting of hundreds to thousands of satellites, each to create global internet services.

The DEUCSI program seeks to establish resilient, high-bandwidth, high-availability Air Force communications and data sharing capabilities by leveraging developing commercial space internet networks.

This approach differs radically from traditional military satellite communications programs in which the government typically specifies and funds every aspect of the program, Air Force researchers point out.

Instead, taking advantage of the commercial space internet will concentrate government efforts on the few areas that are unique to Air Force applications.

The project has three phases: establish connectivity between several Air Force sites using commercial demonstration satellites and terminals; expand connectivity to many Air Force assets by proliferating user terminals to several locations and vehicle types; and special experiments to address military-unique requirements not otherwise met by commercial space internet vendors.

The L3Harris Communication Systems West segment in Salt Lake City won a $17.9 contract in late 2019 for the DEUCSI Call 002 Vendor Flexibility effort to establish the ability to communicate with Air Force platforms via several commercial space internet constellations using common user terminal hardware elements.

Other DEUCSI contractors include the Lockheed Martin Aeronautics segment in Fort Worth, Texas; Ball Aerospace & Technologies Corp. in Boulder, Colo.; the Raytheon Technologies Corp. Intelligence & Space segment in McKinney, Texas; and the Northrop Grumman Information Technology Enterprise Solutions – 3 Services (ITES-3S) segment in Herndon, Va. For more information contact L3Harris Technologies online at www.l3harris.com, or the Air Force Research Laboratory at www.afrl.af.mil.

AVIONICS

▼ Sierra Nevada to provide avionics for special forces C-130J secure communications

U.S. Air Force avionics experts needed production kits as part of the low-rate initial production (LRIP) phase of the C-130J Airborne Mission Networking (AbMN) program. They found their solution from Sierra Nevada Corp. in Sparks, Nev.

Officials of the Air Force Life Cycle Management Center at Robins Air Force Base, Ga., have announced a $56.1 million order to Sierra Nevada for production kits, spares, interim-contractor support, program management, and provisioning support for the AbMN system to provide mission-critical secure data communications for special operations versions of the Lockheed Martin C-130J four-engine turboprop aircraft.

The AbMN tactical networking system enables aircrew and mission personnel aboard MC-130J aircraft to send and receive mission-critical data to and from tactical and operational nodes in war zones.

AbMN capabilities include secure line-of-sight and beyond-line-of-sight voice and data communications, friendly force identification, mission tracking, threat identification, full-motion video, collaboration, chat, email, and data links.

AbMN avionics enables Special Forces MC-130 aircraft to streamline command and control, improve situational awareness, and reduce operational risk through real time exchange of digital information among aircraft, components, and other tactical and operational nodes.

The special operations MC-130J Commando II aircraft flies clandestine, or low-visibility single or multiship low-level air refueling missions for special operations helicopters and tiltrotor aircraft.

The MC-130J also performs infiltration, exfiltration, and resupply of Special Forces by air or by land inside of politically sensitive or hostile territories. The MC-130J primarily flies missions at night to reduce probability of visual acquisition and intercept by airborne threats. Its secondary mission includes the airdrop of leaflets.

On this contract modification Sierra Nevada will do the work in Centennial, Colo., and should be finished by May 2023. For more information contact Sierra Nevada Corp. online at www.sncorp.com, or the Air Force Life Cycle Management Center-Robins at www.robins.af.mil/Units/AFLCMC.

MARITIME NAVIGATION

▲ Northrop Grumman to build shipboard inertial navigation for ship and submarine upgrades

U.S. Navy shipboard navigation and guidance experts needed an inertial sensor to keep U.S. Navy surface warships on-course, even when signals from satellite navigation systems like the Global Positioning System (GPS) are lost or jammed. They found their solution from Northrop Grumman Corp.

The Navy has awarded the Northrop Grumman Corp. operating unit in Charlottesville, Va., a production contract for the new AN/WSN-12 inertial sensor module (ISM) — a next-generation sensor that improves maritime navigation in GPS-denied environments for surface ships and submarines.

The Northrop Grumman-built AN/WSN-12 ISM provides maritime positioning data with or without GPS, and is a key component of the U.S. Navy's AN/WSN-12 Inertial Navigator System (INS), upgrading the Northrop Grumman built AN/WSN-7 INS. The 25-year-old WSN-7 is on nearly every ship in the U.S. Navy and has been the program of record for more than two decades.

"The new AN/WSN-12 Inertial Navigator System will deliver more precision and performance for the warfighter while occupying the same footprint as its predecessor." says Todd Leavitt, vice president of naval and oceanic systems at Northrop Grumman. "This allows upgrades to be made on existing systems where space is at a premium."

Surface ships and submarines rely heavily on the positioning data provided by GPS for navigation, for safety at sea, and to fire weapons. The AN/WSN-12 ISM helps establish assured position, navigation, and timing (A-PNT) maritime solutions in the absence of satellite navigation technology.

The first ISM will be fielded later this year, Northrop Grumman officials say. Northrop Grumman reported completion of the ISM's preliminary design review in May 2016, and critical design review in June 2018.

The ISM will help 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. For more information contact Northrop Grumman online at www.northropgrumman.com.

IFF INTERROGATORS

▶ BAE Systems to provide land- and sea- VME IFF) interrogators for air defense

U.S. Navy air defense experts needed digital identification-friend-or-foe (IFF) interrogators for Navy surface warships and land sites. They found their solution from BAE Systems.

Officials of the Naval Air Systems Command at Patuxent River NAS, Md., announced a $18.9 million contract to the BAE Systems Electronic Systems segment in Greenlawn, N.Y., for 18 AN/UPX-50(C) digital identification boxes and 50 retrofit kits to convert AN/UPX-41(C) to AN/UPX-50(C) for the Navy and U.S. Coast Guard.

The AN/UPX-50(C) digital IFF interrogator that is the upgraded U.S. Navy Mode 5 level 1and level 2 and Mode S interrogator. It is a tech refresh upgrade to the Navy's AN/UPX-41(C) and AN/UPX-45(C) IFF interrogators.

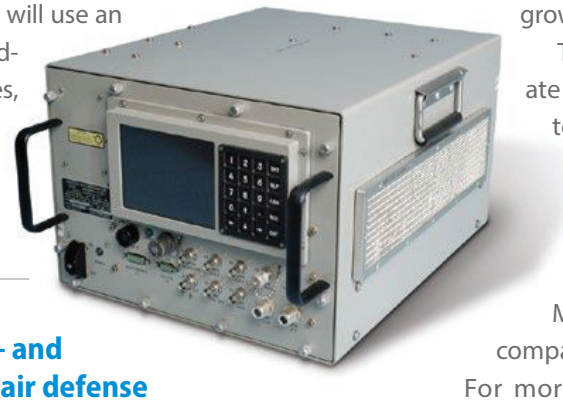
The IFF interrogator is part of the Mark XII and Mark XIIA IFF interrogator processing system. It includes Mode 5 and Mode S, and adds a third receive channel for passive acquisition of Mode 5 Level 2 and ADS-B In.

The Mark XIIA IFF interrogator is for naval and land-based air defense, and conforms to U.S. military, NATO, ICAO, and U.S. FAA airborne surveillance, and air traffic control standards.

Its modular and digital architecture accommodates customized configurations for air defense, weapon systems, air traffic control, and range instrumentation.

The interrogator can generate digital target reports, wideband video for passive and active decoding, and provides amplitude monopulse for improved azimuth accuracy over conventional systems. It operates autonomously, or with a host radar.

The AN/UPX-50(C) digital IFF interrogator is based on the VME embedded computing design standard, uses embedded M5 NSA certified crypto, offers built-in test, offers growth for a target data extractor.



The interrogator can operate at altitudes to 12,000 feet in temperatures from -28 to 65 degrees Celsius. It meets MIL-S-901D for shock and vibration, exposure to salt fog and humidity, and meets MIL-STD-461D electromagnetic compatibility.

For more information contact BAE Systems Electronic Systems online at www.baesystems.com/en-us/our-company/inc-businesses/electronic-systems, or Naval Air Systems Command at www.navair.navy.mil.

POWER ELECTRONICS

▲ Industrial-grade diodes for rugged automotive applications introduced by Nexperia

Semiconductor experts Nexperia in Nijmegen, The Netherlands, is introducing four 650-volt, 1-amp Clip-bonded FlatPower (CFP)-packaged rectifiers for industrial and automotive power electronics applications. These power electronics devices come in CFP3 and CFP5 packages, and are for use in onboard chargers (OBC) and inverters for electric vehicles, power converters, PV inverters, and power supplies in industrial applications. Standard products include the PNU65010ER (CFP3) and PNU65010EP (CFP5), while AEC-Q101-qualified products include the PNU65010ER-Q (CFP3) and PNU65010EP-Q (CFP5). These automotive and industrial-grade rectifiers provide a tradeoff between ultrafast soft switching behavior and low forward voltage drop to help keep power losses low in high-frequency applications. Their small CFP footprint saves board space in high-density designs without compromising on electrical performance. For more information contact Nexperia online at www.nexperia.com/automotive-recovery-rectifier.

POWER ELECTRONICS

Microcontroller-based smart power supplies offered by TDK-Lambda

TDK-Lambda Americas Inc. in San Diego is introducing the MU4 series of 1U-high power supplies for industrial equipment, test and measurement, medical, and broadcast applications. These power electronics devices offer low acoustic noise and BF-ready medical isolation, and can provide 600 Watts with an input of 85 to 264 volts AC (derate below 90 volts AC) and 800 Watts with a 180 to 264 volts AC input. Systems designers can configure as many as five isolated output voltages using TDK-Lambda's on-line quick product finder. An intelligent fan speed control circuit uses a microcontroller algorithm to monitor the temperature of the primary converter and each individual secondary module. This enables users to adjust the speed of the fan to provide an audible noise as low as 36 dBA, even with an 80 percent load. A low noise level improves patient comfort and reduces operator fatigue. Initially nine 150-to-400-Watt output industrial-grade modules are available, providing continuous coverage from 3.3 volts to 104 volts DC. Each module includes remote on/off, remote sense, and an output good signal as standard. Options for the MU4 include a 5-volt and 2-amp standby voltage, fan fail signal, inhibit and enable for all outputs, AC fail, PMBus communication, and current share for configurations requiring parallel operation. The models meet EN 55011-B, EN 55032-B radiated and conducted emissions and comply with the EN 60601-1-2:2015 (Edition 4) and EN 61000-4 immunity standards. For more information contact TDK-Lambda Americas online at www.us.lambda.tdk.com.

POWER TEST

◀ Rail probes for testing low-voltage DC power introduced by Teledyne LeCroy

Teledyne LeCroy in Chestnut Ridge, N.Y., is introducing the 2 GHz RP2060 and 4 GHz RP4060 power rail probes to enable engineers to probe a low-impedance, low-voltage DC power/voltage rail signal without loading the device under test (DUT). The power electronics rail probes provide

plus-or-minus 30 volts of probe offset to display a DC power/voltage rail signal in the vertical center of the oscilloscope regardless of the gain setting. These test and measurement probes feature plus-or-minus 60-volt offset capability; plus-or-minus 800-millivolt dynamic range; 50 kilo-ohms DC input impedance for low loading of low-impedance power rails); 1.2:1 attenuation for low additive noise; MCX-terminated cable with a variety of board connections: 4 GHz-rated MCX PCB mount; 4 GHz solder-in; 3 GHz coaxial cable to U.FL PCB mount; and optional 500 MHz browser. Bandwidths listed are for the 4 GHz RP4060. Maximum bandwidth when used with RP2060 is 2 GHz. One driver is the increase in the number and size of data centers needed to support cloud computing and other data-intensive applications, and the new power architectures they require. The new rail probe is designed to meet the needs of engineers working with power rails rated to 48 volts DC. To power individual servers in the racks that make up data centers, traditional server farms would step down power to the 12 volts DC necessary to input to the server, where within the server it would be further stepped down to the 5 volts, 3 volts, 1 volt or less to power the many individual chips. This process loses much energy to heat, which in turn requires more energy to cool, raising costs. The average data center today uses an average of 3 to 5 kilowatts of electricity per rack. For more information contact Teledyne LeCroy online at https://teledynelecroy.com.

COMMUNICATIONS

▲ Emergency locator transmitter (ELT) that uses satellite navigation certified by Orolia

Orolia USA in West Henrietta, N.Y., have received certification for the company's Ultima-S survival emergency locator transmitter (ELT) that relays aircraft location information to search and rescue teams in case of aviation accidents. The Ultima-S provides free and global coverage service through the dedicated Cospas-Sarsat search-and-rescue satellite communications (SATCOM) system. Orolia offers non-rechargeable lithium batteries that comply with U.S. FAA and European Union Aviation Safety Agency (EASA) TSO-C142b/DO227A special conditions standards. The Ultima-S also meets ELT performance and environmental standards through TSO-C126c. Safran Electronics & Defense in Boulogne-Billancourt, France, acquired Orolia last July. Orolia's European headquarters are in Les Ulis, France, outside Paris. Once activated, the Ultima-S transmits a 406 MHz distress signal that includes the ELT location from the system's internal satellite navigation receiver. This built-in global navigation satellite system (GNSS) capability can enhance the distress signal's probability and speed of detection. For more information contact Orolia online at www.orolia.com, or Safran Electronics & Defense at www.safran-group.com.

TEST AND MEASUREMENT

▼ Differential displacement measurement system for laser communications introduced by Kaman

The Measuring Division of Kaman Precision Products, Inc. in Middletown, Conn., is introducing the KD-5100+ high-reliability differential displacement measurement system for directed-energy weapons, laser communications, and image stabilization. The KD-5100+ offers nanometer resolution, stable design, extremely small size, and low power consumption. It is an upgraded, higher reliability version of Kaman's proven KD-5100 measuring system and uses the identical proprietary hybrid microcircuit. The KD-5100+ measurement system incorporates upgrades to the circuit layout, ground connections, and sensor connectors, and adds high-reliability diodes and capacitors. The system measures 2 by 2.12 by 0.75 inches, and is manufactured to Mil-PRF-38534 Class H, with MIL-SPEC components used throughout the

electronics. The KD-5100+ differential displacement measurement system features a mean time between failures exceeding 238,000 hours in a space flight environment and 55,000 hours in a tactical environment. Kaman also offers the DIT-5200, a commercial version of the KD-5100+ for applications where mil-spec requirements, size, weight and power consumption are less critical. For more information contact Kaman Measuring Products online at www.kamansensors.com.

SERVO ACTUATORS

Linear DC servo actuators for motion control in laser steering offered by Moticont

Moticont in Van Nuys, Calif., is introducing the compact 1-inch-stroke SDLM-025-095-01-01M and SDLM-025-095-01-01 linear DC servo actuators for motion control in laser beam steering, laser machining and drilling, scanning, medical, assembly, work holding and clamping, sorting, packaging, sampling, and filtering applications. These high force-to-size electric cylinders have linear encoders mounted internally for closed loop servo operation. Additionally, to operate at peak efficiency, integral temperature sensors provide data to achieve the highest possible throughputs. The enclosed SDLM-025-095-01-01M and SDLM-025-095-01-01 servo actuators are 1 inch in diameter, the housing is 3.75 inches long, and the length of the housings and shafts is 5.5 inches. The 0.125-inch non-rotating shafts have M2.2X0.45 x 5.1 min DP or 2-56 UNC-28 x 0.20 min DP threaded holes, for direct zero backlash connections to a load at either end. The shafts of the servo actuators have support at both ends by long life plain linear bearings and can tolerate side loads as strong as 7.2 ounces, and have a HOME sensor. For more information contact Moticont online at www.moticont.com.

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AirBorn

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Raytheon's STEP-Tech demonstrator completes first engine run and electrical system integration test

BY **Jamie Whitney**

PARIS - Raytheon Technologies Corp. (RTX) in Arlington, Va., announced at the Paris Air Show that its subsidiary companies Pratt & Whitney and Collins Aerospace have made progress on its hybrid-electric propulsion through the Scalable Turboelectric Powertrain Technology (STEP-Tech) demonstrator, which completed its first engine run and electrical system integration test.

As a modular and scalable demonstrator, STEP-Tech is for rapid prototyping of distributed propulsion concepts for next-generation aircraft, including advanced air mobility vehicles, high-speed electric vertical take-off and landing (eVTOL) and blended-wing-body aircraft.

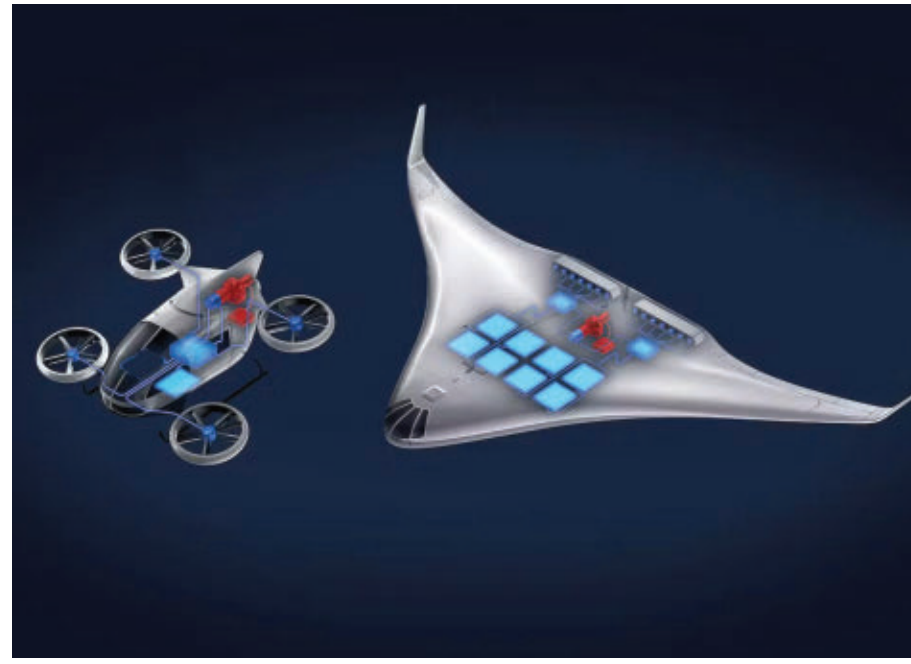
"Hybrid-electric propulsion is a key part of RTX's roadmap for enabling more sustainable aviation, with the potential to enhance efficiency across many future aircraft applications, from advanced air mobility to regional aircraft and single-aisles," says Mark Russell, chief technology officer at RTX.

"Harnessing deep expertise from Pratt & Whitney, Collins Aerospace and Raytheon Technologies Research Center in the fields of both aircraft propulsion and electrical systems, RTX is leading the development of hybrid-electric technology through multiple demonstration programs, including STEP-Tech," Russell says.

Conducted at the Raytheon Technologies Research Center in East Hartford, Conn., the test included the first run of STEP-Tech's turbogenerator loaded at partial power.

This was followed by an electrical test where the battery and supercapacitor energy storage systems were integrated with the high-voltage distribution system. STEP-Tech next will progress testing to a full-power turbogenerator run and validation of the electric fans (propulsors) through the high voltage electrical system.

RTX also is advancing hybrid-electric propulsion as part of its hybrid-electric flight demonstrator program, supported by the governments of Canada and Quebec, and the Sustainable Water-Injecting Turbofan Comprising Hybrid-Electrics (SWITCH) consortium, supported by the European Union's Clean Aviation Joint Undertaking.



RTX Pratt & Whitney and Collins Aerospace are making progress on hybrid-electric aircraft propulsion through the Scalable Turboelectric Powertrain Technology (STEP-Tech) demonstrator.

Daher, Safran, and Airbus demonstrate hybrid-electric distributed propulsion aircraft

BY **Jamie Whitney**

PARIS - EcoPulse, a hybrid-electric distributed propulsion aircraft demonstrator developed by Daher, Safran, and Airbus, made its first public appearance at June's Paris Air Show where the team revealed the final external configuration.

After passing the first ground tests, the demonstrator will perform its first flight with hybrid-electric propulsion later this year.

This demonstrator is one of the major collaborative projects in France in the field of aviation decarbonization. The project gets support from the French Civil Aviation Research Council (CORAC) in Paris, and co-funding the French Civil Aviation Authority (DGAC) in Paris through France Relance and NextGeneration EU.

EcoPulse aims to evaluate the advantages of integrated hybrid-electric distributed propulsion that features reduced noise and CO2 emissions. This design enables one independent electrical power source to provide power to several engines distributed throughout the aircraft.

The demonstrator also will demonstrate its efficiency, including high-voltage electrical propulsion with battery, turbogenerator, and control technologies.

Based on a Daher TBM aircraft, EcoPulse has six Safran integrated electric thrusters or e-Propellers distributed along the wings. Its propulsion integrates two power sources: a Safran electric generator driven by a gas turbine and an Airbus battery pack.

At the heart of this architecture is a Safran power distribution and rectifier unit that protects the high-voltage network and distributes the available electrical power, and Safran high-voltage power harnesses.

The demonstrator has passed milestones leading to its maiden flight in 2022 with its conventional thermal engine without an operational electric system. The ground and flight tests validated its aerodynamics and systems configuration.

"The demonstrator so far has amassed around 27 hours of flight time with the electric propellers feathered," says Pascal Laguerre, chief technology officer at Daher. "Flight tests of the hybrid-electric powertrain are due to begin later this summer. We expect by the end of 2027 to be able to offer our first hybrid aircraft to the market."

The EcoPulse hybrid-electric distributed propulsion aircraft will demonstrate integrated hybrid-electric distributed propulsion that features reduced noise and CO2 emissions.

OneSky and Ansys team on autonomous, AI-based UAM solutions

OneSky Systems in Exton and Ansys in Canonsburg - both in Pennsylvania - are collaborating to progress autonomy in advanced air mobility (AAM) solutions. OneSky is providing its airspace technology integrated with Ansys' solutions to develop artificial intelligence (AI)-based software equipped with perception and decision-making software. The collaboration enables OneSky and Ansys AAM customers to train and validate neural networks (NN) with simulation to reduce the risk, time, and costs associated with physical testing required for airworthiness certification. The software accelerates and enhances the development, validation, and certification processes of autonomous AAM transport systems. As a developer of uncrewed traffic management (UTM) and testing in support of urban air mobility (UAM) platforms, OneSky combines its operations simulation and flight planning methodologies with Ansys' autonomy solution to strengthen the fidelity of its systems-level simulations. This integrated solution provides aircraft developers and suppliers solutions to help ensure unmanned aircraft systems (UAS) are safe, efficient, compliant, and scalable from one vehicle to a full fleet. Digital mission engineering expands simulation from a static model to an interactive model of the operational environment, which is critical in accurately predicting and validating the behavior of autonomous systems.

Companies work together on avionics for electric vertical take-off and landing (eVTOL) aircraft

BY **Jamie Whitney**

PARIS - Safran Electronics & Defense in Boulogne-Billancourt, France, and Archer Aviation Inc. in San Jose, Calif., are working together to demonstrate the Safran ultra-compact avionics platform (UCAP) flight control computer (FCC) and SkyNaute navigation system on Archer's Midnight electric vertical take-off and landing (eVTOL) aircraft.

The Archer Midnight electric vertical take-off and landing (eVTOL) aircraft is demonstrating a Safran compact flight computer SkyNaute navigation system.

Equipped with a multi-core processor, Safran's UCAP provides high-performance computing and safety features. SkyNaute adheres to the safety and reliability requirements necessary for certification by relying on mature technologies such as hemispherical resonator gyroscopes (HRG) crystal.

This navigation system achieves performance and integrity while providing a 35 percent reduction in size and weight when compared to alternatives.

With a range as far as 100 miles and an expected payload of 1,000 pounds, Archer's Midnight is a piloted, four passenger aircraft rapid back-to-back flights with minimal charge time in-between. Archer's goal is to replace 60-to-90-minute commutes by car, with estimated 10-20 minute electric air taxi flights.

"These achievements with the UCAP flight computer and SkyNaute navigation system help pave the way for the entry into service of Archer's eVTOL aircraft," says Franck Saudo, Safran Electronics & Defense CEO.

Supernal partners with UMBRAGROUP on actuation technology for eVTOL planes

Advanced air mobility company Supernal in Washington and aeronautics manufacturer UMBRAGROUP in Foligna, Italy, are partnering on technology to enhance flight control in electric vertical takeoff and landing (eVTOL) aircraft. UMBRAGROUP will supply actuators and motor control electronics needed to deploy a safe system architecture for Supernal's future vehicles, which the company plans to launch for commercial flights in 2028. The collaboration aims to create new actuation standards, both for rotary and linear applications, that will deliver for Advanced air mobility (AAM) manufacturers, which are concerned about size, weight, power, reliability, and safety. Traditional rotary actuators use a gearbox connected to a power source that then operates an aircraft's flight control surface. UMBRAGROUP's new line of actuators eliminates the use of the gearbox, making its product smaller, lighter and more efficient. Based on ball screws, this assembly can last beyond 20 years in commercial aircraft and is ideally suited for the AAM market where vehicles are often characterized by thin wings and limited component space. UMBRAGROUP brings unique capabilities in developing linear jam-tolerant actuators, which have a mechanism that can resolve a failure within an actuator and are a new solution in eVTOL vehicles. Supernal and UMBRAGROUP's partnership marks the first time this type of technology will be integrated with electro-mechanical actuators (EMA), making them appropriate for primary and critical flight-control surfaces.