OCTOBER 2021

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## Advanced undersea warfare

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## Thermal management for high-performance computing

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# COUNTER-UAV TECHNOLOGIES FOR PERIMETER SECURITY

*Military services rely on RF, electro-optical, electromagnetic, and even acoustic sensors to bring enemy unmanned aircraft.* PAGE 16

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# Military & Aerospace Electronics



COVER STORY







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BY **JOHN KELLER**, EDITOR IN CHIEF

# Electromagnetic warfare emerging for high-energy electrical weapons that damage or destroy enemy electronics

There's an emerging brand of waging war that uses electrical energy instead of bombs and bullets to attack an enemy's means and will to continue the fight — electromagnetic warfare.

This approach uses aimed electrical and magnetic energy to destroy or disable critical electronics for navigation and guidance, computing, communications, displays, timing, sensors, and many other military applications.

What's coming to be known as electromagnetic warfare has been classified under names like high-power electromagnetics (HPEM), directed-energy weapons, microwave weapons, and electromagnetic pulse (EMP) weapons.

Typically electromagnetic warfare involves the use of, and defense against, microwave and EMP weapons. It does not involve electronic warfare (EW), optical warfare, laser weapons, or cyber warfare. It's often lumped into directed-energy weapons, but that description misses the mark because it includes laser weapons and laser targeting, which can confuse the issue.

Future uses of electromagnetic warfare will be on land and , in the air, in space, and perhaps even under the sea. It involves the same kind of energy as static electricity, which can give a stinging shock in dry weather, but it's controlled and measured, and typically doesn't leave explosive destruction behind like bombs, missiles, and bullets.

Electromagnetic warfare differs from electronic warfare in that it seeks to destroy or damage electronics, rather than jam, spoof, or eavesdrop on electronic signals for communications or radar sensors. It differs from laser weapons in that electromagnetic weapons use electronic energy rather than optical energy.

It's not as though electromagnetic warfare is a new discipline. Probably the oldest and best-known electromagnetic weapon is lightning. It's quick, and does a great job of frying electronics. Unfortunately it's all-but-impossible to control and aim, and can cause widespread collateral damage. There's still no practical implementation of a lightning weapon.

Still, researchers in the U.S. Department of Defense (DOD) are working on electromagnetic weapons that might be the next-best-thing to controlled lightning.

In 2005, for example, U.S. Air Force researchers awarded a $7.5 million contract to the Raytheon Technologies Corp. Missiles & Defense segment in Tucson, Ariz., to design a portable Active Denial System, a type of nonlethal, directed-energy weapon that focuses millimeter waves on the skin of a suspicious person. The beam causes agonizing pain, but does no lasting damage, they say.

In 2004 Raytheon built a mobile Active Denial System onto a Humvee. That version also fit on a flatbed truck or into a C-130 turboprop aircraft.

Raytheon was back in the news in 2017 when the Air Force Research Laboratory at Kirtland Air Force Base, N.M., awarded the company a $15 million contract to determine the feasibility of using electronics-killing EMP weapons aboard combat aircraft.

That same year Air Force researchers announced a $2.3 million contract to Verus Research in Albuquerque, N.M., to find ways of integrating future electronics-killing HPEM technologies onto military weapons platforms.

Both contracts sought technologies that would emit a short burst of EMP — or an electromagnetic disturbance — that would damage or destroy targeted electronic systems such as radar, communications, power grids, land vehicles, and aircraft. In fact, the effects of an HPEM would be similar to those of a lightning strike by disabling or destroying any kind of unshielded modern electronics, ranging from computers, to electric generators, to small appliances.

It won't be long until electromagnetic warfare comes into common usage to describe a new class of military weapons and doctrine.


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# Navy orders Integrated Common Processor (ICP) for bistatic sonar and ASW

BY **John Keller**

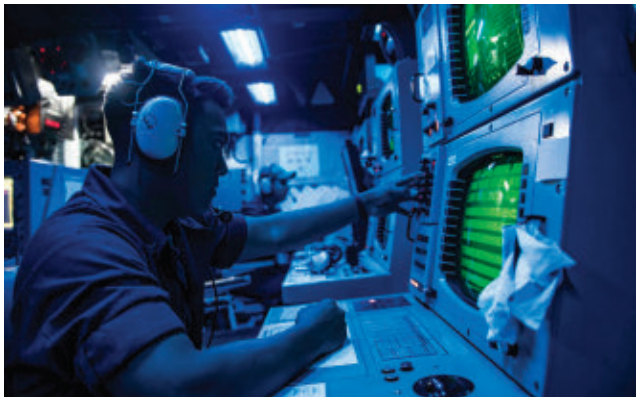
**SAN DIEGO** — Undersea surveillance experts at Lockheed Martin Corp. are enhancing technology to detect, classify, and track quiet enemy diesel attack submarines in shallow coastal waters.

Officials of the Naval Information Warfare Systems Command (NAVWAR) in San Diego have announced an $63.6 million sole-source order to the Lockheed Martin Rotary and Mission Systems segment in Manassas, Va., for the Integrated Common Processor (ICP) program.

The ICP program provides a common Integrated Undersea Surveillance Systems (IUSS) signal processing and display system software and hardware suite for Surveillance Towed Array Sensor System (SURTASS) ships and IUSS shore sites.

The ICP is a component of the Navy's Maritime Surveillance Systems (MSS) system of fixed, mobile, and deployable acoustic arrays that help detect, localize, and track quiet diesel and nuclear submarines.

The IUSS is a large-area ocean basin surveillance system to track surface ships and submarines over large swaths of the world's oceans. It consists of fixed fields of hydrophones and sonar sensors such as the Sound Surveillance System (SOSUS) and Fixed Distributed System (FDS); the Advanced Deployable System (ADS) relocatable sonar sensor field; the Surveillance Towed-Array Sensor System (SURTASS) aboard long-endurance surveillance ships; and the Surveillance Direction System (SDS) that provides command, control, communications, and data fusion to combine the capabilities of SOSUS, FDS, and SURTASS.



**Lockheed Martin will build the Navy's Integrated Common Processor (ICP) to enhance technology to detect, classify, and track quiet enemy diesel attack submarines in shallow coastal waters.**

Navy anti-submarine warfare (ASW) experts are fine-tuning MSS technology to be effective against modern diesel and nuclear submarines in regional, littoral, and broad ocean areas of interest. That's where the ICP program comes in.

ICP is developing the capability to process and display data from all fixed and mobile underwater systems to take advantage of automation advancement, array technology improvements, hardware insertions, and the common software components of the submarine and surface undersea warfare systems.

Eventually the ICP program is intended to provide processing power to support the Navy's low-frequency active (LFA) ASW bistatic sonar processing using the Lockheed Martin Twin-line 29A towed-array sonar for SURTASS submarine-hunting ships.

To optimize sonar signal-processing power and keep costs as affordable as possible, the ICP is capitalizing on the Navy's Acoustics-Rapid COTS Insertion (A-RCI) program, which uses the latest generations of commercially available computer server technology for sonar signal processing aboard Navy submarines and surface vessels.

The ICP will have the capability to process and display data from all fixed and mobile underwater systems, and will be used for all new system installations and replace the legacy systems as they reach end of life and require upgrading.

Since 2011 Lockheed Martin engineers have been developing automation algorithms and techniques for addressing multi-array high beam count requirements in the ICP program, and have continued with sonar signal processing upgrades in coordination with the Submarine A-RCI program.

*On this contract Lockheed Martin will do the work in Manassas, Va., and should be finished by December 2022. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or NAVWAR at www.navwar.navy.mil.*

# Low PIM Rated Sub 6 Ghz 5G Antennas

In-building distributed networks and outdoor wireless networks call for robust antennas that offer wide bandwidth coverage, low PIM ratings as well as MIMO and SISO technology support.

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# Air Force eyes AI and machine learning for cognitive electronic warfare (EW)

BY **John Keller**

**WRIGHT-PATTERSON AFB, Ohio** — U.S. Air Force researchers plan to kick-off a project to develop new kinds of artificial intelligence (AI) and machine learning to enable attack aircraft to engage and defeat next-generation enemy integrated air-defense systems (IADS).

Officials of the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have released a pre-solicitation (FA8650-22-S-1004) for Project Kaiju to apply AI and machine learning to future cognitive electronic warfare (EW) systems to help aircraft penetrate air defenses that rely on multispectral sensors, missiles, other air-defense assets.

The next evolution of advanced IADS is likely to employ radars, surface-to-air missiles, and air-to-air defenses that use multi-spectrum technology, Air Force researchers explain. Future U.S. aircraft must deal with missiles guided by electro-optical and RF sensors for detection, navigation, and tracking.

Cognitive refers to systems that use AI and machine learning an attempts to mimic human decision making by using sensors, perceptions, learning, reasoning, and memory autonomously. AI and machine learning can help generate and analyze growing amounts of mission data in real-time, and open opportunities for using autonomous cognitive EW.

Project Kaiju seeks to develop AI and machine learning technology that can migrate into fielded systems. The project will rely on open-systems standards, agile software algorithm development, and process validation tools.

The five-year Project Kaiju seeks to spend as much as $150 million to advance technologies in nine main tasks: big data for cognitive EW research; software-defined radio (SDR) research; multi-spectrum threat defeat; RAPTURE Laboratory; electronic attack demonstration; real-time algorithm development; RF EW demonstrator for next sortie mission data reprogramming; advanced threat defeat; and program management.

Air Force researchers say they plan to award two contracts for Project Kaiju effort, one for the main nine tasks, and one for extra work on the electronic attack demonstration, real-time algorithm development, RF EW demonstrator for next sortie mission data reprogramming, and advanced threat defeat. Work on these contracts will be at the top-secret classification level.

Researchers will conduct industry briefings at a yet-unspecified time in late October before releasing a formal solicitation for Project Kaiju. The formal solicitation is expected in January 2022.

*Email technical questions or concerns to the Air Force's Gary Kaufman at gary.kaufman.1@us.af.mil, and contracting questions to Caleb Rose at caleb.rose.1@us.af.mil. More information is online at http://www.fbodaily.com/archive/2021/09-September/12-Sep-2021/FBO-06128643.htm.*

**The Air Force Project Kaiju will apply AI and machine learning to future cognitive electronic warfare (EW) systems to help aircraft penetrate sophisticated enemy air defenses.**

## Northrop Grumman to develop software for battlefield command and control

Battlefield command-and-control experts at Northrop Grumman Corp. will develop the U.S. Army Air and Missile Defense Workstation (AMDWS) under terms of a $21.7 million contract. Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking the Northrop Grumman Mission Systems segment in Herndon, Va., to continue developing AMDWS Block VI software to support the Army Battle Command System (ABCS) Common Operating Environment (COE). The ABCS is a suite of networked digital components to give commanders a solid perspective of their operating environment to improve decision-making. Decision-making models of the ABCS may include recognition primed decision making; observe, orient, decide, and act (OODA); or other emerging processes to help commanders make quick decisions during combat operations. Northrop Grumman Mission Systems is the prime contractor for command and control, engineering, and general support for the AMDWS software. This contract is for supplies or services. On this contract Northrop Grumman will do the work and locations to be determined with each order, and should be finished by September 2024. For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa.

## BAE Systems to arm Marine ACV armored combat vehicle with 30-millimeter cannon

U.S. Marine Corps amphibious warfare experts are asking BAE Systems to design a high-firepower version of the Amphibious Combat Vehicle (ACV) armed with a 30-millimeter cannon under terms of a $27.8 million order. Officials of the Marine Corps Systems Command at Quantico Marine Base, Va., are asking the BAE Systems Platforms & Services segment in Sterling Heights, Mich., for phase-three design and development of the ACV medium caliber cannon mission role variant. BAE Systems is the ACV prime contractor. The ACV is a wheeled armored combat vehicle able to move Marine infantry warfighters

*Continued on page 15*

# 2021 Military and Aerospace Technology Innovators Awards span embedded, space, and PNT electronics

BY **John Keller**

**NASHUA, N.H.** — *Military & Aerospace Electronics and Intelligent Aerospace are recognizing companies offering substantial military, aerospace, and avionics design solutions in their 2021 Technology Innovators Awards, which were announced in September. Awards are in three tiers — ranging from platinum, the highest, to the gold awards, and finally to the silver awards — and are based on the recommendations of an independent panel of industry judges. Here are some highlights of this year's awards.*

Neousys Technology America Inc. in Northbrook, Ill., was honored with a platinum awards for the SEMIL-1748GC, a IP67-rated, waterproof and dust-proof graphics processing unit (GPU) computer with pre-installed NVIDIA Tesla T4 for demanding environments. It is for rugged edge artificial intelligence (AI) solutions, and features a patented system architecture to guarantee fanless operation in temperatures from -25 to 70 degrees Celsius, and non-throttling GPU performance to 62 C ambient.

Planar Monolithics Industries Inc. in Frederick, Md., is a platinum awarded honoree for the company's PRX-20-1G18G-850M-SFF-V2 1-18 GHz channelized receiver for surveillance applications with copious transmission signals present in various frequency bands at any given time. The receiver limits the noise to help identify low-power signals without compressing output power for the higher power signals. The channelized receiver offers 20 850 MHz BW outputs up to 4.4 GHz while providing good 50 ohm matches for the broadband input and all outputs.

Systel Inc. in Sugar Land, Texas, also is a platinum awarded honoree for the company's Kite-Strike rugged artificial intelligence (AI) edge computing system, which offers workstation performance in an embedded size, weight, and power (SWaP)-optimized system. Kite-Strike supports force-protection high-resolution sensor systems, with significant AI-enabling capabilities to help shift the workload from soldier to sensor. Kite-Strike enables the real-time AI inferencing, deep learning, and machine learning capabilities with centralized sensor ingest and data fusion support for edge AI inferencing for mission-critical applications.

Elma Electronic in Fremont, Calif., is a gold honoree for three products, and a silver honoree for one product.

The gold-honoree Elma CompacFrame test and development platforms represent a next-generation platform to accelerate development and test of plug-in cards aligned to the SOSA Technical Standard and VITA 65 OpenVPX standards. With an updated, lightweight construction, the unit is tilted up 5 degrees for easier viewing and plug-in cards insertion. User interfaces are designed for easy access, simplifying and reducing design time, and the integrated carrying handle ensures portability. The platforms come in three different standard sizes: a slimline version accommodates open standards-based backplanes of as many as four slots; the mid-range version supports as many as eight slots; and a development platform that will hold as many as five single-slot 3U VPX backplanes for VITA 48.8 air flow-through (AFT) cooling of plug-in cards.

**The Systel Kite-Strike rugged artificial intelligence (AI) edge computing system, is a platinum honoree in the 2021 Military & Aerospace Electronics Technology Innovators Awards.**

The Elma NetSys 5310/11 rugged Cisco ESR-6300 platforms, a gold honoree, bring Cisco's ESR-6300 embedded services router and its Cisco-certified mobile IP routing protocols to the network edge in mission-critical and harsh environments. Housed in a in a SWaP optimized platform, the Cisco ESR-6300 based platforms deliver IP-based data, voice and video and significantly faster crypto throughput for mobile users who require greater bandwidth for increased needs of sensor data and video streaming. Both NetSys versions enable the design of secure and reliable tactical communications networks deployed in harsh environments encountered in mobile and autonomous ground, shipboard and air military vehicles, homeland security, transport infrastructure, oil and gas, and drilling and mining operations.

The Elma 3U conduction-cooled load card aligned to SOSA, a gold honoree, complies with ANSI-VITA mechanical and 12-volt centric electrical connection standards. Developed to enable testing of systems aligned to the SOSA standard, the load card aids the system designer in confirming that the chassis will provide adequate cooling and verifying that a conduction cooled plug-in card aligned with SOSA is capable of meeting the power requirements for that system. The load card acts as user configurable electrical and thermal load to test system under various conditions. By locating hot spots in the chassis, a system designer can verify that the cooling techniques are optimized to prevent overheating. The load card accelerates productivity by quickly and accurately characterizing electrical and thermal performance of the systems at low cost.

The Elma MR50 rugged multi-rotary selector switch, a silver honoree, is qualified to MIL-STD-202G, and has 16, 12, or 10 positions at 22.5, 30° or 36 degrees indexing angles respectively. Available turning torques to 6 Newton centimeters (Ncm) ensures good tactile feedback even through heavy gloves, and the 10.5-millimeter depth behind the

*Continued on page 14*

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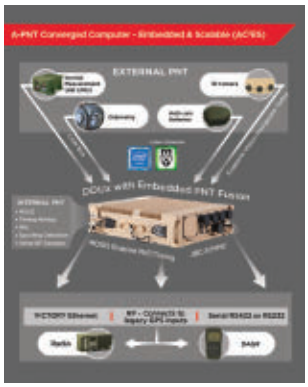


A-PNT Converged Computer – Embedded and Scalable (AC²ES) provides A-PNT information in Global Positioning System-threatened environments by using a range of technologies from anti-jam and anti-spoofing, M-Code receivers, image-based terminal, and inertial measurement units. These technologies are converged into a platform Processing Unit, eliminating the need for a separate A-PNT LRU while providing advanced and next-generation A-PNT capabilities not currently available with existing stand-alone single-purpose alternatives. AC²ES is also scalable to suit diverse mission requirements.

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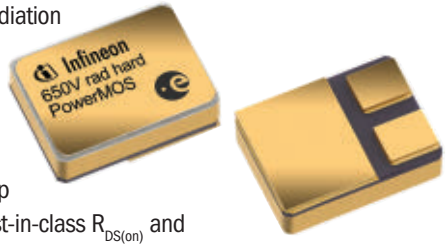


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# Booz Allen and Ball Aerospace to develop trusted computing technology for avionics

BY **John Keller**

**WRIGHT-PATTERSON AFB, Ohio** — U.S. Air Force researchers are asking two defense companies to develop and demonstrate cyber security tools to make legacy and future Air Force weapon systems far more resilient to cyber attacks than they are today.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have awarded contracts to Booz Allen Hamilton Inc. in McLean, Va., and to Ball Aerospace & Technologies Corp. in Boulder, Colo., for the Trusted and Elastic Military Platforms and Electronic Warfare (EW) System Technologies (TEMPEST) program.

The companies will share as much as $200 million for a portion of the TEMPEST program called Agile and Resilient Platform Architectures (ARPA). The objective is to develop, prototype, and demonstrate cyber security technologies to protect the avionics in Air Force weapon systems.

Booz Allen and Ball Aerospace will perform enhanced development, technology demonstrations, component development, and prototyping of tools, techniques, and capabilities to identify and mitigate vulnerabilities in avionics systems; harden and protect avionics systems against cyber-attack; advance current techniques to detect, respond, and adapt to new and unusual cyber-attacks on avionics in real-time; demonstrate integrated mission systems and advanced prototype components leveraging current and emerging open-systems architecture standards and approaches; and prototype agile next-generation architectures to enable rapid integration and fielding of enhanced trusted computing in Air Force avionics.

**The Trusted and Elastic Military Platforms and Electronic Warfare (EW) System Technologies (TEMPEST) program will demonstrate cyber security tools to make legacy and future Air Force weapon systems resilient to cyber attacks.**

The companies will develop security technologies that will include assessment and testing tools; vulnerability mitigation and cyber-hardening technologies; malware detection and adaptive response techniques; and technologies to secure open-systems and agile-architecture platforms.

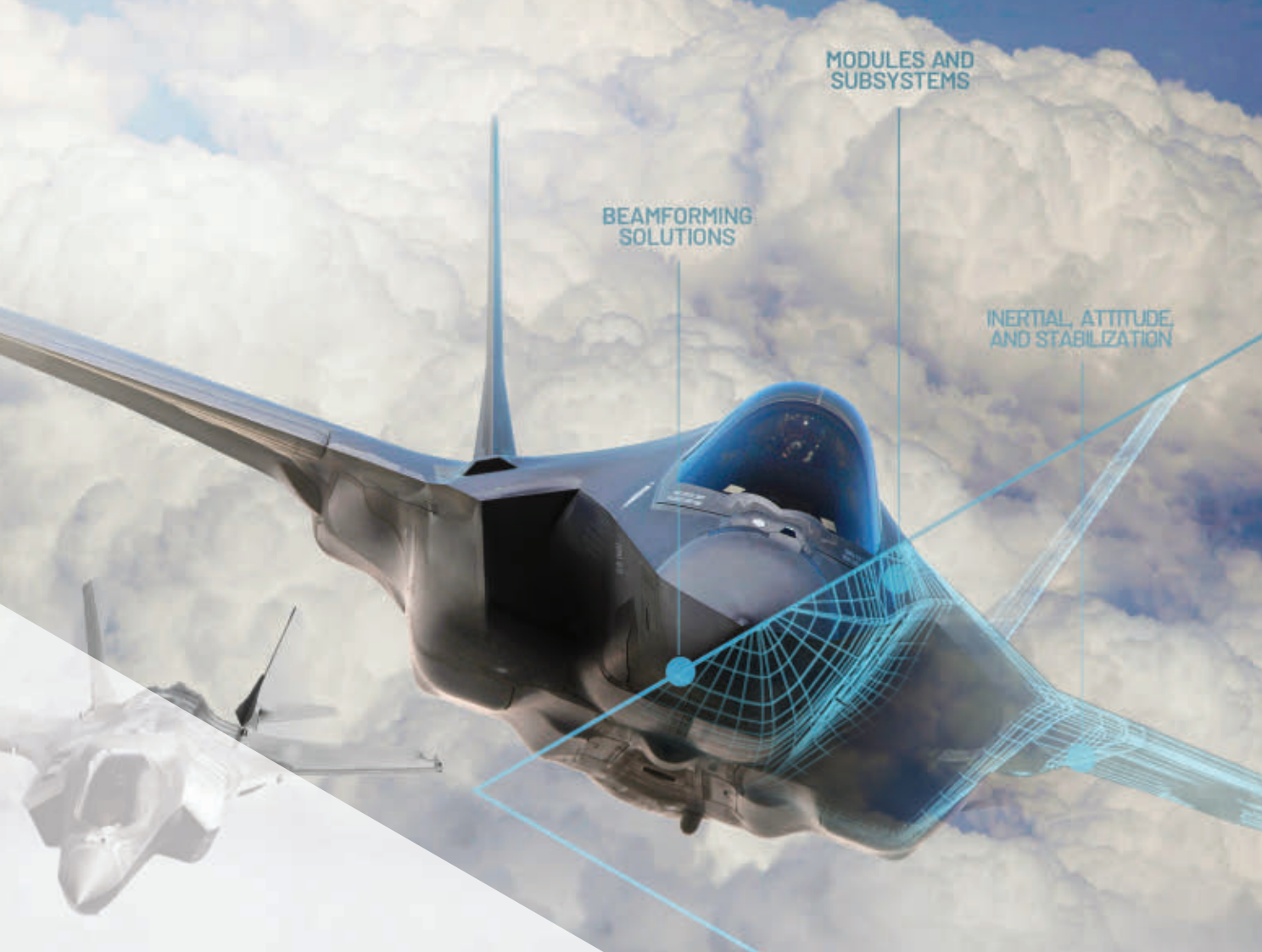
Booz Allen and Ball Aerospace engineer will develop cyber security technologies such as tools for avionics vulnerability assessment and testing; modeling and simulation environments to test avionics and cyber protection; reverse engineering and system assurance tools to identify vulnerabilities or malicious logic in software, firmware, or hardware; malware detection tools and countermeasures; technologies to mitigate vulnerabilities and cyber-harden avionics; and techniques to detect, adapt to, and react to the kinds of cyber attacks that may never have been seen before.

The companies also will develop techniques to develop cyber security and resiliency for next-generation avionics; improve the resiliency of avionics at different stages of the acquisition life cycle from hardening existing legacy systems to designing cutting-edge security technologies with future avionics systems.

Ultimately, the companies will develop, demonstrate, and prototype a digital architecture that combines digital engineering, software factories, and current advanced avionics architecture technologies to advance warfighting capability for current and future Air Force weapon systems.

On these contracts Booz Allen will do the work in Beavercreek, Ohio, and Ball Aerospace will do the work at Wright-Patterson Air Force Base, Ohio. Both companies should be finished by August 2028.

*For more information contact Booz Allen Hamilton online at www.boozallen.com, Ball Aerospace & Technologies at www.ball.com/aerospace, or the Air Force Research Laboratory at www.afrl.af.mil.*

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*Continued from page 9*

panel allows for close circuit board spacing. The switch's front panel meets IP68 panel sealing for ingress protection and operates in temperatures from -45 to 85 degrees Celsius, and the stainless-steel shaft provides resistance to lateral impacts.

The A-PNT Converged Computer - Embedded and Scalable (AC²ES) from Leonardo DRS in Arlington, Va., provides assured position, navigation, and timing (A-PNT) capability with minimal size, weight, power, and cost (SWAP-C) because it is embedded in the Data Distribution Unit — Expandable (DDUx) II. In addition, AC²ES is scalable, and users can select and add position and timing features based on their accuracy needs and budget. PNT information from GPS is essential to the warfighter. Aside from simple navigation - GPS is used for rescue missions, missile launches, reconnaissance and guiding unmanned systems.

The rugged MIL/COTS SWaP-C computer server from MPL AG in Baden, Switzerland, a gold honoree, is fanless and available in versions that include soldered CPUs with many as 16 cores out of the Intel road-map with long-term availability. The server was designed MIL-STD-810, and is packaged in a compact IP67 housing with eight D-38999 connectors, including a dual fiber optical 10-gigabit LAN port. It operates in temperatures from -20 to 60 degrees Celsius. The standard MXCS server comes with interfaces such as BMC, redundant AMI BIOS, USB, serial lines, LAN ports, and 2x 10 Gigabit Ethernet fiber ports. The system also accommodate as much as 128 gigabits of ECCDDR4 memory that is conductive cooled.

The PowerMOS 650V rad hard MOSFET from International Rectifier HiRel Products Inc., an Infineon Technologies company in El Segundo, Calif., is a silver honoree. The radiation-hardened N-channel PowerMOS is rated to 650 volts, making it one of the industry's highest-voltage rad-hard FET option. While there are commercial GaN alternatives that list higher permissible drain-to-source voltages beyond their absolute max ratings, none are yet available as rad hard. Total Ionizing Dose (TID) hardness of the 650-volt PowerMOS is specified to 100 kilorads, and to 300 kilorads on request, with SEE rated up to 95 LET. The PowerMOS is ESA-qualified per ESCC-5000.

*Continued from page 7*

from ships offshore to fight their way onto invasion beaches. BAE Systems reportedly has selected a version of the MCT-30 medium-caliber turret from Kongsberg Defence & Aerospace in Kongsberg, Norway, for the ACV version. The company reportedly will deliver as many as 150 of the MCT-30 remote turret weapon systems for the ACV. For more information contact BAE Systems Platforms & Services online at www.baesystems.com, or Marine Corps Systems Command at www.marcorsyscom.marines.mil.

### Lockheed Martin to build AGM-114 laser-guided Hellfire II air-to-ground missiles

U.S. Army missile experts are asking Lockheed Martin Corp to build AGM-114 laser-guided Hellfire II missiles, which can be launched from manned and unmanned aircraft, surface ships, and military ground vehicles. Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced a $101.3 million contract to the Lockheed Martin Missiles and Fire Control segment in Orlando, Fla., to provide Hellfire II missiles. The AGM-114R is the latest Hellfire II variant, and is equipped with semi—active laser seekers to defeat many kinds of targets. The AGM-114R can be launched from several different kinds of fixed-wing aircraft and helicopters, surface ships, and military ground vehicles. Hellfire II also is the missile of choice for several kinds of unmanned aerial vehicles (UAVs) such as the MQ-1B Predator, MQ-9 Reaper, and MQ-1C Grey Eagle. Eventually these missiles may arm U.S. military unmanned helicopters. The Hellfire II will be replaced early this decade by the Lockheed Martin AGM-179 Joint Air-to-Ground Missile (JAGM) semi-active-laser-and millimeter-wave-radar-guided missile. JAGM also will replace the BGM-71 TOW, and AGM-65 Maverick missiles for launch from Army AH-64 Apache attack helicopters, the Army MQ-1C Gray Eagle UAV, the Navy MH-60R helicopter, and the Marine Corps AH-1Z Viper attack helicopter. The Hellfire missile weighs 106 pounds, and has high-explosive variants designed to destroy tanks and other armored vehicles, and blast fragmentation versions designed to destroy trucks, antenna sites, concentrations of enemy troops, and other soft targets.

# A bird's

## Counter-UAV technologies for perimeter security

Military services rely on a variety of RF and microwave, electro-optical, electromagnetic warfare, and even acoustic sensors to help bring enemy unmanned aerial vehicles.

BY **Megan Crouse**

Technologies to counter unmanned aerial vehicles (UAVs) for perimeter security offer a broad spectrum of capabilities and niches. As drones become more inexpensive to deploy, the defenses protecting military bases or other critical facilities must be multi-layered, adaptable and reliable.

In particular, perimeter security means no person — or no autonomous or human-controlled drone — can get in or out of the borders of a facility. Because of their small size and construction materials and flight altitude, some UAVs literally fly under the radar of conventional air defense systems.

Drones can carry a variety of different threats, such as conventional attacks like explosives, spying, or cyber security threats. The defenses against them run the gamut of intelligence; kill and disable; and electronic attacks as well. This effort is known either as counter-unmanned aerial vehicle (C-UAV) or counter-unmanned aerial system (C-UAS).

While creating effective perimeter defenses against drones has been a concern since unmanned aircraft first were designed, recent years have seen efforts within the U.S. Department of Defense (DOD) to formalize and consolidate the available tools, technologies, and strategies.

# eye view

## A rapidly changing threat

For context, look at the guidelines released in 2018 by the U.S. Department of Homeland Security. One useful resource in those guidelines is the National Urban Security Technology Laboratory (NUSTL) guide to questions to ask when researching C-UAV purchases. These include capability considerations: What types of drones will your system need to detect? Do you require the ability for it to detect the ground station from which the adversary is operating the drone as well? What sensor modalities and software features do you have or need? Can it handle multiple detections at a time? Along with providing some guidelines for potential purchases, this document provides an overview of the variety of systems available.

It's important to ask these questions because drones are increasingly common. This growing UAV industry presents new challenges to military and commercial perimeter security concerns. In terms of non-military installations, drone security may be a useful layer of protection for commercial airports, sporting events, prisons, law enforcement facilities and more.

In 2022, DOD leaders say they plan to spend at least $636 million on counter-UAV research and development, and at least $75 million on C-UAV procurement. That's a $134-million increase from 2021, according to the Congressional Research Service.

**Photo: Counter-UAV demonstrations at Yuma Proving Ground, Ariz., last April show the effectiveness of RF jamming and electromagnetic warfare to take down enemy UAVs.**

## State of the industry

"What we are seeing in terms of companies with autonomous vehicles is the recognition that not only are we creating counter-UAV to protect from our enemies but our enemies are doing the same," says Robin Wessel, CEO of data security company CDSG in Vancouver, Wash. "The data on those assets is very, very important. There is a lot of focus on ensuring, for example, if a drone was to get knocked out by a countermeasure behind enemy lines

**Military counter-UAV experts focus on low-collateral effects interceptors to counter a growing unmanned system threat.**

that its data is secure and protected. Basically it requires utilizing multiple layers. When these assets — say, a drone — is recovered by the enemy, that data may be encrypted and they usually have all the time in the world to crack it … It's potentially a ticking time bomb for customers or users. Our technologies incorporate multiple layers to ensure that they might infiltrate one of the safeguards but to get becomes exponentially more difficult. I like to think of it as a moat behind a castle. We draw the drawbridge up."

In 2016, Military & Aerospace Electronics magazine wrote about "the dawn" of counter-drone technologies. Six years later, we've come to a morning filled with options. As CDSG's Wessel points out, although the technology is moving very quickly, the military tends to be relatively slow in adoption. However, today there are a wide variety of different types of anti-drone countermeasures.

"UAV is a constantly evolving threat because it is the fusion between software (cyber) and physical threats," Wessel says. It faces "Requirements for constant code updates that can defeat RF solutions that profile drone data streams, swarming technologies that can easily overwhelm current C-UAV technologies and fully autonomous UAV threats that don't depend on RF C2 (command and control) links to execute their mission."

## Inside and outside military applications, the counter-UAV market

divides into three segments: critical infrastructure, which includes patrolling airports or other facilities; gathering intelligence information about adversary capabilities and locations; and complex situations such as tracking active threats and investigating possible conspiracies to commit harm either inside the U.S. or internationally.

Perimeter security could contain elements of all of these, depending on where the base of operations is located. The first step to choosing a product is to know what use case you need it for, and counter-UAV can apply to a wide variety of them.

Civilian applications, such as a private company that wants protection from UAV principally from cyber and espionage threats, can't use C-UAV technologies because of FCC, FAA, and other regulations, Wessel points out.

For another example, Northrop Grumman Corp. of Falls Church, Va., advertises layered defense including kinetic and non-kinetic effects, aerial and ground sensors, and the battle-hardened, proven and deployed Forward Area Air Defense Command and Control (FAAD C2). The FAAD C2 project was selected by the DOD in 2020 as the interim joint common command and control system for future C-UAV procurements.

There also is some crossover in this field with high-energy lasers, which are being tested by the U.S. Navy and by other branches of the U.S. military. They are being proposed as a cost-effective way to counter UAVs.

## Armed forces seek technology demonstrations throughout 2021

2021's technology demonstrations were just the latest in a line of exploration between the military and industry. The April 2017 Army Techniques Publication 3-01.81, Counter-Unmanned Aircraft System Techniques, outlines various methods. It also places U-UAV within the Army's six-layer air and missile defense tiers.

In 2019 several DOD organizations demonstrated component technology in Black Dart, a C-UAV exercise intended to assess and validate these systems in the real world. Following that, a January 2021 DOD strategy document about C-UAV outlined the results of studying 10 different technologies across the armed forces. This was in part an effort to cut down on redundancy, in which each branch worked on separate systems.

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**Members of the 380th Expeditionary Security Forces Squadron demonstrate an RF and microwave GPS signal jammer to counter small unmanned aerial systems on Al Dhafra Air Base in the United Arab Emirates.**

One of the results was a technology demonstration at the Yuma Proving Ground, Ariz., in April 2021. A collaboration between the Air Force, the Joint Counter-sUAS Office (JCO), and the Army Rapid Capabilities and Critical Technologies Office (RCCTO), it provided industry an assessment from the armed forces about how well each technology performed. In particular, the demonstration sought technologies able to defend against drones with minimal damage to the area or personnel around the conflict — particularly in urban settings.

"This was the first of many industry opportunities as we look to synchronize solutions and counter the small UAV threat," said Lt. Gen. L. Neil Thurgood, director of Hypersonics, Directed Energy, Space and Rapid Acquisition, which includes the RCCTO. "Events like this demonstration at Yuma Proving Ground will help identify new approaches, focus our efforts, and allow us to leverage innovation quickly."

Out of 30 companies that responded to the call for participants, three — Aurora Flight Sciences of Manassas, Va. (a Boeing company), ELTA North America of Annapolis Junction, Md., and XTEND, which has its U.S. headquarters in Fort Walton Beach, Fla. — were invited.

Aurora makes the Modular Intercept Drone Avionics Set (MIDAS), an artificial intelligence (AI)-enabled, multi-rotor small UAV. Its autonomous solution takes cues from ground radar and locks on with an onboard sensor. It's equipped with optical sensors and designed to defeat several small UAVs per flight with low-collateral effects.

"Demonstrating MIDAS's differentiated Counter-UAV capabilities in such a challenging environment was invaluable," says Kel Jackson, Counter-UAV program manager for Aurora Flight Sciences.

ELTA North America also emphasized work in the autonomy space in their statements to the RCCTO.

"We all know warfighters are wearing multiple hats as it is, so having something connected to the network that is fully autonomous is crucial," says Dean Nohe, senior director of business development for ELTA North America. The company's

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Drone-Kill-Drone system "takes the network or sensor feed and assigns the right drone to the right threat. Once it gets close to the target, there's on-board processing and on-board AI that enables an optical target lock and continues the autonomous guidance to the drone until interception."

This system "uses a combination of on-board processing, autonomous flight control, and optical target lock to strike the target while in flight," incorporating an entanglement net. It can also be integrated with other effector payloads, drone detection sensors or C2 systems.

As for XTEND, they demonstrated SKYLORD GRIFFON system, an augmented-reality-based system designed for operators with no previous flight experience after three days of training.

Ido Baron, vice president of business development and sales for XTEND, emphasized that most of the cost of the system is contained in the cost in the C2 system and software, which remains relatively protected on the ground.

"The CUAS system flies by C2 but once it comes within range of the drone, the operator takes control so they can investigate the target to either intercept it or follow it," according to the materials from RCCTO.

## Detection

There are several ways to detect incoming or local UAVs in the field, whether at a commercial airport or a military base. Radar is the obvious choice, but UAVs may be too fast or too small to produce a signature radar can detect. Visible-light cameras, infrared sensors, or acoustic sensors all have their own advantages and disadvantages when used as C-UAV.

A microphone or array of microphones can roughly triangulate a UAV based on sound, and can detect drones closer to the ground than some other comparable sensors. However, audio clutter means this technique doesn't work well in noisy environments like airports, and it has a short range of 300 to 500 meters.

Visible-light cameras have the ability to record and store images easily for forensic evidence or other review later. However, they need to work with the right software or expert personnel to tell a drone from a bird or other small aircraft. To this day, many have high false-alarm rates. Naturally, they also can have limited capacity in the dark or in bad weather, depending on the camera's capabilities.

Radio frequency sensors like radar can detect the wireless signals that control the drones. However, RF becomes useless if the UAV is truly autonomous and isn't sending or receiving any signal from an operating base. Like microphones, it's also less useful in urban settings because of RF interference from radios, cell phones, and other wireless devices.

Effective counter-UAV operations not only require the ability to detect an object, but also to identify it. Is it a drone or a bird? So, most tools for detection must also include some kind of identification element.

## Effectors

Under the category of effectors falls technology that can disable or destroy a drone before it completes its mission. These can be as varied as guns, other aircraft, or nets, or even trained birds such as eagles.

Depending on the tool or technology, there are a combination of options in terms of letting the operators either kill or simply observe drones. For example, the Marine Corps Marine Air Defense Integrated System (MADIS) employs jamming and weaponry. The Marines demonstrated MADIS in July 2019 when crew members aboard the amphibious assault ship USS Boxer neutralized an Iranian UAV.

The MADIS radar and electronic warfare array can mount on a vehicle,

**U.S. Army explosive ordinance disposal technicians, setup a remotely controlled robot during a counter-UAV, training exercise at Erbil Air Base in the Kurdistan Region of Iraq, April 24, 2020.**

but effectors can come in a variety of sizes, weights, and footprints from hand-held anti-drone net guns to ground emplacements. It includes components such as the joint light tactical vehicle (JLTV) from Oshkosh Defense in Oshkosh, Wis.; the RPS-42 light air-search radar from RADA in Germantown, Md.; the MODI II electronic warfare system from Sierra Nevada Corp. in Sparks, Nev.; and electro-optical sensors from Lockheed Martin Corp. in Bethesda, Md.

Jamming devices that can break the link between the UAV and the operator can be a useful asset here. These devices can be portable, often 5 to 10 pounds, or as heavy as hundreds of pounds. The Navy also is exploring dazzlers to counter UAV sensors.

Another important element of this is command and control and other digital or electronic effectors. The Army and Navy have partnered with the Pentagon's Defense Digital Service in Washington to help work on cyber defense in this area.

Cyber security efforts are important to combat enemy drones on a digital level as well as to secure friendly systems in the case of their capture or incomplete destruction.

"In the near future, we'll essentially have a network of flying computers in the sky, and just like the computers we use today, drones can be hacked if not secured properly," says Amir Husain, CEO and founder of SparkCognition and SkyGrid, both located in Austin, Texas.

Their product protects drones from zero-day attacks by using an airspace management system with artificial intelligence. SparkCognition's DeepArmor and SkyGrid's airspace management system, AeriosOS, work together, and can be mounted on drones with limited processing power and without network connectivity.

"Unlike traditional anti-malware reliant on signatures of known threats, our AI models don't require an existing threat database," Husain says. "However, it's still important to store data from a threat once it's detected. This will allow our models to learn the DNA of each threat and detect similar threats that may emerge."

### Kill/disable

The DOD is investigating conventional weaponry and high-energy lasers to develop an efficient and cost-effective defense screen against drones.

**Army soldiers discuss where they saw a drone during an unmanned aerial system training exercise in the Kurdistan Region of Iraq.**

Another more unusual effort is a collaborative electromagnetic pulse weapon, as demonstrated by the Leonidas project — a collaborative effort Northrop Grumman and Epirus Inc. in Los Angeles. This C-UAV EMP electromagnetic warfare system can work in static or mobile conditions, Northrop Grumman officials say, and incorporates solid-state commercial semiconductor technology. EMP and electromagnetic warfare destroy or disable UAVs by destroying their guidance electronics.

The Leonidas system is a high-power microwave system that can integrate with the DOD-approved FAAD C2. There also are plans to integrate it with the Northrop Grumman's Integrated Air and Missile Defense Battle Command System (IBCS) command-and-control (C2) systems. This type of attack is versatile, since the beam can be tightened to target individual UAVs or widened for what Northrop Grumman calls a "forcefield-like effect." It also has a 30-minute setup time and exceeds current High-Power Microwave Transportability Requirements for Highway, Rail, Air (C-130, C-17, helicopter sling), and Marine.

## Command and control

Also critical in this area is the command and control (C2) element. Irrespective of technology, the Pentagon is working on a unified approach to C-UAV.

"What all the services have truly embraced is the common command-and-control standards that are being developed as part of this process, which is going to allow the plug-and-play of industry's emerging technologies," says U.S. Army Maj. Gen. Sean Gainey, head of the Pentagon's Joint Counter-Small Unmanned Aircraft Systems Office (JCO).

This is in response to a tension between the number of possible solutions being developed and making sure different tools and tactics can work well with one another. After all, different services and commands buying multiple expensive defenses is not a cost-effective way to counter $100 drones.

By 2020 the armed forces had three different — but compatible — C2 systems in place. Industry can work with JCO for more information about common technical standards that apply across services and technologies. The end goal is a "plug-and-play" approach bringing the variety of technologies available into a common system such as the Army's FAAD-C2 or a compatible C2 network such as the Air Force's MEDUSA.

Even further consolidation came about with a January 2021 Counter-Small Unmanned Aircraft Systems Strategy from the Pentagon, the first department-wide framework for counter-small UAV technology.

## What else is in the field now?

The next frontier for counter-UAV may be about tracking and effecting not just single drones, but many at a time. Defending against swarms — large numbers of small drones networked together but physically unobtrusive enough to slip through most defenses — has been and continues to be a priority. One way being explored to do this is with "suicide drones," or human-guided missiles intended to break up swarms.

In 2020, the U.S. Army tapped Syracuse Research Corp. (SRC) in North Syracuse, N.Y., for development, production, deployment, and support of the Expeditionary-Low, Slow, Small Unmanned Aircraft System Integrated Defeat System (E-LIDS). This $425.9 million five-year project will be designed to defend against drone-mounted explosives and more sophisticated uses such as cyber

warfare or intelligence gathering facilitated by small drones.

The Army also contracted the Leonardo DRS Land Systems segment in St. Lewis, MO in 2020 for a $189.8 million five-year contract to develop and build the Mobile-Low, Slow, Small Unmanned Aircraft System Integrated Defeat System (M-LIDS) to counter weaponized versions (specifically improvised explosive devices) of inexpensive drones like commercial quadcopters.

In total, the JCO has endorsed seven defensive systems and one standard architecture for C2.

**Army soldiers conduct a counter-UAV, exercise at Al Asad Air Base, Iraq, Jan. 29, 2020.**

### What's next?

CDSG's Wessel predicts that improved C-UAV technologies will see the rise of sensor fusion and AI based profiling. They'll also come to be in an age with increased legislation, mandated UAV product technology requirements, and integration of traffic management with C-UAV. The latter is essential to minimize the threat of bad actors using COTS UAV solutions such as the FAA's Unmanned Aircraft System Traffic Management (UTM).

Overall, counter-UAV is still a growing and changing area. As evidenced by the 2021 guiding documents from the Pentagon, the process of making drone defenses widely applicable and also compatible with each other and across services is an ongoing challenge. In the broad sense, it faces the same challenges as any other military technology: keeping pace with technology, fitting into existing doctrine and maximizing the effectiveness of missions and efforts.

"We don't see the counter-UAV problem set as one enduring solution, we see it as a range of capabilities integrated into a common … [command-and-control system] that gives you the ability to address threats across the range of threats out there, and have the ability to keep up with the pace of" evolving challenges, The JCO Gainey says.

In the future, JCO will host biannual industry days similar to the 2021 Yuma Proving Ground demonstrations, Gainey says.

## WHO'S WHO IN COUNTER UAV TECHNOLOGY

**Aurora Flight Sciences**
Manassas, Va.
*https://www.aurora.aero*

**CRU Data Security Group (CDSG)**
Vancouver, Wash.
*https://cdsg.com*

**ELTA North America**
Annapolis Junction, Md.
*https://www.eltanorthamerica.com*

**Epirus**
Los Angeles
*https://www.epirusinc.com*

**Leonardo DRS Land Systems**
St. Louis
*https://www.leonardodrs.com*

**Lockheed Martin Corp.**
Bethesda, Md.
*https://www.lockheedmartin.com*

**Northrop Grumman Corp.**
Falls Church, Va.
*https://www.northropgrumman.com*

**Oshkosh Defense**
Oshkosh, Wis.
*https://oshkoshdefense.com*

**RADA USA**
Germantown, Md.
*https://radausa.com*

**Sierra Nevada Corp.**
Sparks, Nev.
*https://www.sncorp.com*

**SkyGrid**
Austin, Texas
*https://www.skygrid.com*

**SparkCognition**
Austin, Texas
*https://www.sparkcognition.com*

**Syracuse Research Corp.**
North Syracuse N.Y.
*https://www.srcinc.com*

**XTEND**
Fort Walton Beach, Fla.
*https://xtend.me*

# Is thermal management up to the high-performance computing challenge?

Embedded computing designers squeeze the most out of conduction, convection, and liquid cooling, and look to the future of disaggregated architectures and 3D printing.

BY **John Keller**

The byproduct of waste heat is the scourge of high-performance embedded computing; the faster the processors, the more heat they produce, and the more difficult it can be for systems designers to keep their designs within temperature limits to avoid compromising performance.

Unfortunately, it's a vicious cycle. Those who specify processing for demanding systems like electronic warfare (EW), surveillance and reconnaissance, image processing, and artificial intelligence continually want more capability. There's no end in sight to the need to remove ever-increasing amounts of waste heat from powerful processing.

Fortunately there are solutions for today's electronics cooling and thermal management challenges that range from conduction cooling, to forced-air cooling, to hybrid implementations of forced-air and conduction cooling, and finally to liquid cooling. Many of today's thermal design decisions hinge on specific applications and projections for system and growth and upgrades. Embedded computing designers have adequate tools at their disposal — at least for now.

**General Micro Systems is using the second generation of the company's RuggedCool thermal management technology to squeeze every bit of heat possible out of conduction-cooled circuit boards.**

## Thermal management issues

Embedded computing power has been increasing at a dizzying pace over at least the past decade, which complicates efforts to keep electronics cool. "Ten years ago we started with Intel server-class processors that dissipated about 60 Watts per processor," explains Michael Shorey, director of mechanical engineer at Mercury Systems in Andover, Mass.

"Then Sandy Bridge [second-generation Intel Core i7, i5, and i3 microprocessors], which was 70 Watts per processor," Shorey continues. "The Xeon processor was 75 to 80 Watts, and right after that two or three years ago the next-generation processors were 125 Watts. The next generation will be 150 Watts per device." Exacerbating the challenge is the growing use of general-purpose graphics processors (GPGPUs), which can run at 200 Watts per device.

The escalating design problem doesn't just involve waste heat, but also includes the growing size of powerful microprocessors, which can complicate efforts to reduce size, weight, and power consumption (SWaP). "It's a big jump, not just in thermal power, but also in the real-estate on the card," says Shaun McQuaid, director of product management at Mercury Systems. "Thermal solutions tends to grow with it."

Further complicating the picture are the shrinking sizes of embedded computing enclosures and backplanes, coupled with the growing size and power of the processing components inside. "Think of an ATR box, a conduction-cooled vehicle-mount box, or avionics box with flow-though cooling, with modules inside," says Chris Ciufo, chief technology officer of General Micro Systems (GMS) in Rancho Cucamonga, Calif.

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"They just keep adding more horsepower, or the system needs more FPGAs [field-programmable gate arrays] and GPGPUs for artificial intelligence, and we just keep putting more and more in this ATR box and the things get hotter and hotter," Ciufo says. "At some point, something's got to give. How do we get the heat out of these high-density systems? There's got to be a better way."

Demand is growing for artificial intelligence capability, which necessitates ever-more-powerful processors. "Demand for smaller systems that do more continues to grow," echoes Kevin Griffin, senior mechanical engineer at embedded computing chassis specialist Atrenne Computing Solutions, a Celestica company in Brockton, Mass. "Our customers are coming to us for new system designs and legacy upgrades with increased performance needs and want them to be smaller, lighter, and support increased heat loads. Power density is a major factor to consider when designing a system. As systems' physical sizes are reduced and compute power increases, there is less mass that can be utilized to sink and remove heat. The power density keeps increasing as SWaP requirements continue. This trend is expected to continue into the foreseeable future."

There's no end in sight for these trends. "The challenge is that power density just keeps escalating, with fewer slots, and the ability to package and do things in fewer boards, and it is a challenger to dissipate that heat in smaller enclosures," says Ram Rajan, senior vice president for engineering, research, and development at embedded computing chassis designer Elma Electronic in Fremont, Calif.

Thermal challenges will be there, and power densities continue to rise, agrees Ivan Straznicky, chief technology officer of advanced packaging at the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va. "Most of the really high-power digital electronics are sensor-processing modules with FPGAs and GPGPUs, and other really hot chips."

## Conduction cooling

So what is an electronics thermal management designer to do? Solutions vary from traditional to the exotic. For aerospace and defense embedded computing applications designers typically start with conduction cooling, or channeling heat to the sides of circuit cards out of the enclosure through the enclosure's walls. Designers sometimes blend pure conduction cooling and forced-air cooling to increase heat removal from the chassis.

For many applications where extreme heat is not a driving concern, "the solution primarily is going to be conduction cooling," says GMS's Ciufo. "We're all using copper and aluminum. GMS is taking a couple of different vectors to solve this problem."

Many of the company's conduction-cooled designs involve the GMS patent-pending RuggedCool technology that enables systems using Intel-based microprocessors with a maximum junction temperature of 105 degrees Celsius to operate in an industrial temperature environment of -40 to 85 C at full operational load without throttling the microprocessor. Throttling refers to a processor that reduces its capability as it reaches its maximum operating temperature.

Instead of using thermal gap pads to conduct heat from the microprocessor to the system's interface to a cold plate, RuggedCool uses a corrugated alloy slug with an extremely low thermal resistance to act as a heat spreader at the processor die. Once heat spreads over a large area, a liquid silver compound in a sealed chamber transfers the heat from the spreader to the system enclosure. "We can use Intel Core i7 processors without throttling," Ciufo says.

GMS is moving to a second generation of RuggedCool technology to remove even more heat. "We had a seventh-generation Intel Core i7 processor, which was so hot that first-gen RuggedCool could not cool it at the 85 C limit without throttling it. Rugged Cool 2 solves that."

This approach repurposes a thermal-management approach that GMS developed previously for high-performance VME embedded computing systems called Floating Wedgelock. "The typical wedgelock contacts the chassis in only two of three dimensions," Ciufo says. "Our Rugged Cool 2 contacts it on three surfaces." GMS is making RuggedCool technology available for industry-standard Modular Open Systems Approach (MOSA) and Sensor Open Systems Architecture (SOSA) designs.

### Heat sinks

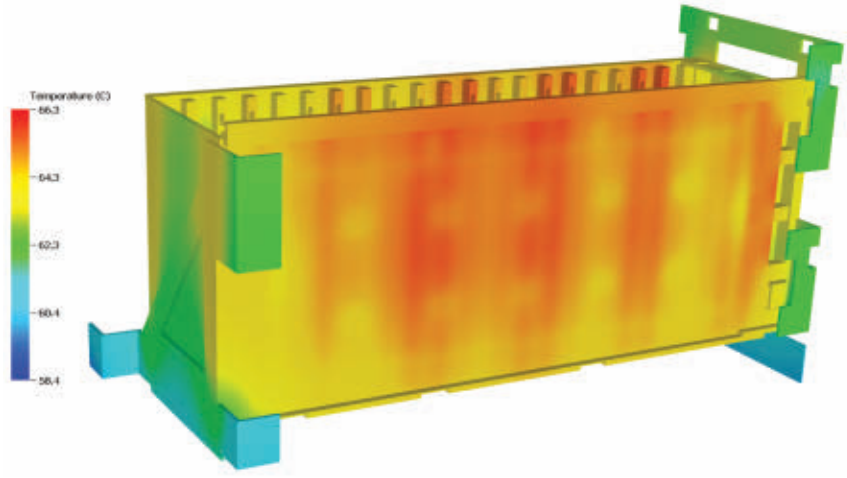
Often an important component of conduction are heat sinks, which are passive heat exchanger that transfers heat from microprocessors or other hot electronic components to a metal structure with closely space spikes to increase the heat sink's surface area as large as possible. Embedded computing systems often place a heat sink underneath or on top of hot processors to conduct heat away quickly to cold plates or flowing air.

Conduction-cooled embedded chassis can have specially designed heat sinks that are part of or on top of chassis walls to speed heat removal once wedgelocks, heat pipes, or other thermal channels move heat off of circuit boards and to outside chassis walls. Designing the right kind of heat sink that fits into compact spaces and removes a great deal of heat can be a major design challenge.

### Heat pipes

Related to conduction cooling are heat pipes, which use sealed liquid like water to transfer heat from hot spots in embedded computing systems, such as high-performance microprocessors by using thermal conductivity and phase transition. At the hot interface of a heat pipe, the liquid essentially boils and turns to vapor as it absorbs heat from that surface. The vapor then travels along the heat pipe to the other end near a cold interface and condenses back into a liquid, releasing its heat. The liquid then returns to the hot interface through either capillary action, centrifugal force, or gravity and the cycle repeats.

"We use heat pipes where the heat sink on the chassis or the air flowing over the chassis is insufficient," Ciufo explains. "Heat pipes use vapor phase exchanges to

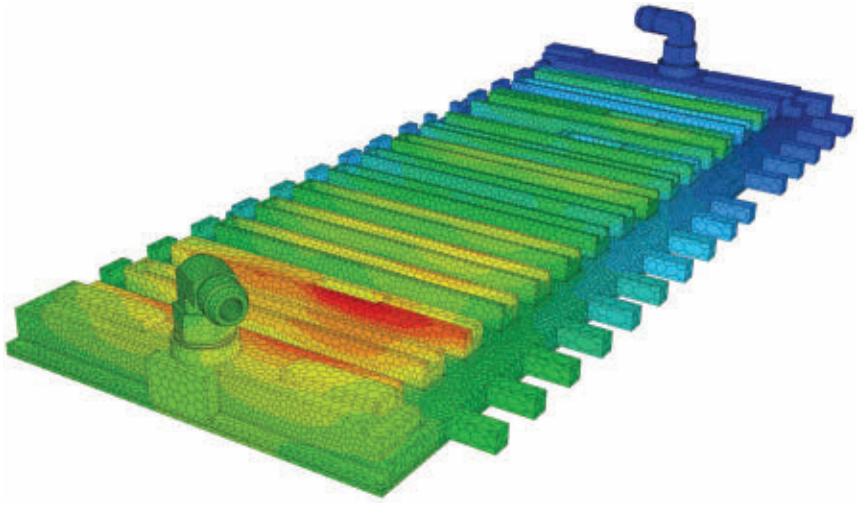



**Embedded computing chassis designers use advanced simulation and analysis design and development tools to determine the hottest spots in subsystems where advanced cooling is most needed.**

remove heat. We have worked with heat pipe suppliers to buy a degree or two of cooling."

Elma chassis designers also rely on heat pipes in conduction-cooled architectures when necessary. "Heat pipes are fairly common," says Robert Martin, mechanical engineering manager at Elma Electronic. "We use them in applications where we need to distribute the heat load in conduction cooling to a cold plate. We also use them in commercial applications. Our largest competitive advantage is our ability to customize solutions, and we can suggest custom heat sink solutions, different materials like copper, and heat pipe solutions."

Heat pipes are particularly effective in designs with intensely hot point loads — especially in small-form-factor embedded computing systems like 3U VPX, which pack a lot of computing performance into a small, hot space. "We have several pure conduction-cooled systems, and there the heat sink becomes very critical," says Elma's Rajan.



**Advanced computing systems are using special ducts to channel air and liquid throughout circuit boards to cool today's hot processors, FPGAs, and GPGPUs.**

### Convection cooling

Convection cooling is similar to conduction cooling, but uses fan-driven air flow to enhance cooling. PC and laptop computers typically cool internal hot components by exhausting hot air out of the computer using fans.

Convection cooling, however, can have several drawbacks in aerospace and defense electronic systems. First, it can introduce contaminants like dust and dirt that can damage sensitive components and interconnects. Second, raised circuit boards and raised components on the boards can partially block air flow and compromise cooling.

To overcome problems like these, military embedded systems designers often combine conduction and convection cooling to get the best of both worlds. The VITA Open Standards and Open Markets trade organization in Oklahoma City offers two standard design approaches that combine conduction and convection cooling in the popular OpenVPX embedded computing form factor: VITA 47.7 Air Flow-By cooling, and VITA 47.8 Air Flow-Through cooling.

"Air Flow-Through is gaining more acceptance because it is less complicated than liquid cooling," says Curtiss-Wright's Straznicky. "It's a very good choice for rotorcraft because they don't have a liquid cooling loop."

VITA 48.8 describes an approach to designing with air-flow-through-cooled plug-in modules using 3U and 6U VPX circuit cards while retaining the VPX connector layout. It helps reduce weight and cost for high-density, high-power electronic systems by eliminating wedgelocks and ejector handles. ANSI/VITA 48.8 subsystems permit air inlets at both card edges, as well as on the top circuit card edge opposite the VPX

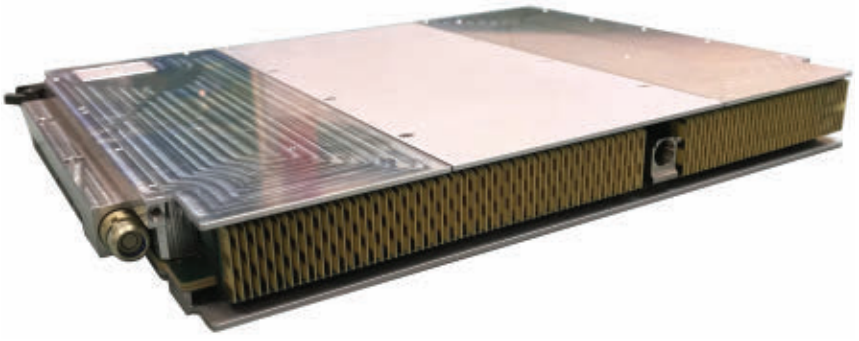
connectors. It also can promote use of polymer or composite materials to reduce chassis size and weight.

The ANSI/VITA 48.8 design approach enabled avionics engineers at the Lockheed Martin Corp. Rotary and Mission Systems segment in Owego, N.Y., to reduce the size and bulk of the avionics computer aboard the Lockheed Martin Sikorsky S-97 experimental high-speed helicopter.

"Board manufacturers are engineering innovative designs based on VITA 48.8 that move air through the boards versus moving air around and through a heat sink," explains Atrenne's Griffin. "Each board contains its own cooling air plenum. However, there are limits, as Moore's Law drives the ever increasing processing power and with it power consumption. With limitation to what can be done with a board, the chassis designers and manufactures are bearing the responsibility of thermally efficient designs."

GMS has introduced air-cooled designs that are inspired by VITA 48.8, but involve proprietary technologies that do not meet the VITA 48.8 standard, says GMS's Ciufo. "We adapted our conduction-cooled chassis such that we fit them with air-cooled radiators. When you cannot attach it to a big cold plate, we have air cooled radiations with integral fans inside them, and that radiation now becomes the 'cold plate' but blows air through the radiators and blows the heat out the back, while still keeping a sealed enclosure.

GMS engineers are working to enhance these designs with improved radiator technology and improved air flow, Ciufo says. "We make a nod to VITA 48, including their finely managed air, and applied that to this air-cooled system. It is not VITA 48-compliant, but is inspired by air cooling from VITA 48. We also take inspiration from laptop computers that use a heat pipe. It moves heat from place to another place where the heat can be exhausted."



**The Curtiss-Wright dual Xeon-based CHAMP-XD2 digital signal processor 6U OpenVPX module is shown in a Liquid-Flow-Through (LFT) configuration.**

## Liquid cooling

One of the biggest debates surrounding embedded computing thermal management involves liquid cooling. This approach seeks to circulate heat-absorbing liquid over circuit cards, between cards, over chassis

## WHO'S WHO IN EMBEDDED COMPUTING THERMAL MANAGEMENT

**Aavid Thermal Division of Boyd Corp.**
Lancaster, Pa.
*https://www.boydcorp.com/thermacore.html*

**Abaco Systems**
Huntsville, Ala
*https://www.abaco.com*

**Advanced Cooling Technologies Inc. (ACT)**
Lancaster, Pa.
*https://www.1-act.com*

**Advanced Thermal Solutions Inc.**
Norwood, Mass.
*https://www.qats.com*

**Aitech Defense Systems Inc.**
Chatsworth, Calif.
*http://www.rugged.com*

**Atrenne Computing Solutions, a Celestica company**
Brockton, Mass.
*https://www.atrenne.com*

**Behlman Electronics Inc.**
Hauppauge, N.Y.
*http://www.behlman.com*

**Crane Aerospace & Electronics**
Lynnwood, Wash.
*http://www.craneae.com*

**Crystal Group Inc.**
Hiawatha, Iowa
*https://www.crystalrugged.com*

**Curtiss-Wright Defense Solutions**
Ashburn, Va.
*https://www.curtisswrightds.com*

**Data Device Corp.**
Bohemia, N.Y.
*http://www.ddc-web.com*

**Elma Electronic**
Fremont, Calif.
*https://www.elma.com*

**Extreme Engineering Solutions (X-ES) Inc.**
Verona, Wis.
*https://www.xes-inc.com*

**General Micro Systems Inc.**
Rancho Cucamonga, Calif.
*https://www.gms4sbc.com*

**Kontron America Inc.**
San Diego, Calif.
*https://www.kontron.com*

**Meggitt Defense Systems Inc.**
Irvine, Calif.
*https://www.meggittdefense.com*

**Mercury Systems Inc.**
Andover, Mass.
*https://www.mrcy.com*

**Milpower Source Inc.**
Belmont, N.H.
*https://milpower.com*

**Parker Hannifin Corp. Aerospace Group**
Alexandria, Va.
*https://www.parker.com*

**Vicor Corp.**
Andover, Mass.
*http://www.vicorpower.com*

walls, or a combination of those. An important industry standard is VITA 48.4 Liquid Flow-Through Cooling.

Some embedded computing experts contend that liquid cooling is too complicated, expensive, and questionably reliable to be a mainstream thermal-management solution. "Liquid Flow-Though will continue to have niche applications on platforms with liquid cooling on board," says Curtiss-Wright's Straznicky.

Others, however, argue that liquid cooling not only is a thermal-management technology whose time has arrived, but also that represents the future of thermal management for high-performance embedded computing.

"We are seeing more liquid cooling applications, depending on how cold you can get your fluid," says Elma's Martin. "We offer VITA 48.4 Liquid Flow-Through, and we have introduced our development platform that is designed to meet 48.4. I'm not seeing too many product releases with VITA 48.4."

Elma is working together with embedded computing expert Kontron America Inc. in San Diego to integrate Elma's VITA 48.4 development platform as a payload into a chassis.

Mercury Systems also is on the leading edge of embedded computing liquid cooling for its performance, reliability and ability to reduce electronics junction temperatures, says Mercury's Shorey. Transistor junction temperature is the highest operating temperature of a semiconductor in an electronic device.

"We see a large shift to liquid cooled systems," Shorey says. "We always used liquid in military aircraft operating at extreme altitudes where air or conduction cooling is not practical. For pluggable cards liquid is the trend."

Echoes Mercury's McQuaid, "We are seeing a major trend is the cards themselves are liquid cooled, as well as the chassis being liquid cooled at the walls. We are making sure that those liquid cooling technologies are matured, and that's why we have an increasing customer acceptance of liquid cooling. Now we are seeing it on ground-mobile and ground-fixed locations, as well as well as airborne applications."

## Future trends

Despite incremental advanced in conduction, convection, and liquid cooling, it's not clear if these approaches — individually or together — will be adequate to overcome the inevitable increases in heat generated by aerospace and defense electronics systems.

Two new design approaches at the subsystem level — distributed architectures and 3D printing — may offer the next revolutionary breakthrough in electronics thermal management.

"We are introducing a new paradigm of distributed computing architectures to mitigate heat," declares GMS's Ciufo. "We say you need to take that ATR box and break it down into smaller chunks with the functions in that box, like processor, disk drives, FPGAs, I/O, and GPGPUs."

Disaggregating the traditional air transport rack, or ATR box, not only would ease the cooling of individual chunks, but also would be individually upgradable, Ciufo points out. "The challenge of disaggregating your system is how do they talk to each other when they are separated? We have a mechanism for doing that. We have filed 12 different patents to go along with this disaggregated architecture, and we have customers champing at the bit to learn more about it."

Another promising trend involves additive manufacturing — better-known as 3D printing. This involves making three-dimensional solid objects from a digital file. It creates an object — in this case electronics chassis — by laying down successive layers of material, with each layer seen as a thinly sliced cross-section of the object. It enables designers to produce complex shapes using less material than traditional manufacturing methods.

3D printing also enables designers to be far more precise in tiny details of a chassis than traditional manufacturing methods do. This has revolutionary implications for future chassis with integrated air and liquid channels for cooling complex embedded computing systems.

"Over the next five years we can use additive manufacturing to optimize cooling and optimize liquid flow paths," says Mercury's Shorey. "We can design for eddies, and increase turbulence, which optimized heat transfer. It will help us squeeze ever last bit out of forced conduction and liquid cooling. Now can do very very complex design to additive manufacturing."

3D printing will help embedded computing designers build systems like never before. "You can't do complex geometries without additive manufacturing," says Mercury's McQuaid. "We can do it reliably, safely, and with advanced thermal performance. The next step is to optimize that design."

Echoes Shorey, "It is just a matter of time before additive manufacturing becomes the staple. It will open all sorts of new opportunities in thermal management. We are coupling systems-on-chip with 3D scanning to optimize thermal interface materials. Additive manufacturing will help us add complexity without adding cost."

# Alliant moves to initial production of AARGM-ER radar-killing missile

BY **John Keller**

**PATUXENT RIVER NAS, Md.** — U.S. Navy aerial warfare experts are moving forward with developing a new and advanced radar-killing missile designed to enable U.S. jet fighter-bombers suppress enemy air defenses preceding bomber attacks.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., has announced a $41.2 million contract to Alliant Techsystems Operations LLC, a wholly-owned subsidiary of Northrop Grumman Corp. in Northridge, Calif., for low-rate initial production lot one of the AGM-88G Advanced Anti-Radiation Guided Missile - Extended Range (AARGM-ER).

The AARGM-ER is an advanced and extended-range version of the High-Speed Anti-Radiation Missile (HARM). It is a new variant of the AGM-88E missile that equips Navy carrier-based fighter-bombers and electronic warfare jets. HARM was a replacement for the AGM-45 Shrike anti-radiation missile, which was in service from 1965 to 1992.

Low-rate initial production happens when engineering and manufacturing development is finished and the designer starts building a small quantity of missiles to establish an initial production base from which production rates gradually increase.

**Photo (above): The AARGM-ER is an extended-range version of the High-Speed Anti-Radiation Missile (HARM) that equips Navy carrier-based fighter-bombers and electronic warfare jets.**

This contract calls for Alliant Techsystems to build 22 AARGM-ER missiles — 16 all-up rounds and six captive air training missiles. The company started AARGM-ER engineering and manufacturing development in early 2019.

The AARGM offers advanced signal processing and improved frequency coverage, detection range, and field of view, compared to earlier versions of the HARM system. It has time-critical standoff strike with supersonic GPS/INS point-to-point or point-to-millimeter-wave-terminal guidance.

The contract also calls for Alliant Techsystems to provide four common munitions BIT reprogramming equipment plus interface devices, initial spares, supplies, and support.

AARGM is a supersonic, medium-range, air-launched tactical missile for U.S. and allied strike aircraft. The

AARGM-ER missile features several upgrades to the AGM-88E that focus on extending the weapon's operational range and survivability.

The AARGM-ER replaces the missile's rocket motor and tail to increase its range, while keeping the sensors and electronics of the AARGM-88E, which are being upgraded in a separate project. The new missile is especially well suited for the F/A-18E/F Super Hornet jet fighter-bomber and EA-18G Growler electronic warfare jet.

The Navy F-35C carrier-based stealthy joint strike fighter also can carry the AARGM-ER inside its internal weapons bay. Northrop Grumman Innovation Systems predecessor Orbital ATK began developing the AARGM-ER in January 2018.

The AARGM-ER missile is scheduled to achieve initial operating capability (IOC) and start being fielded to Navy squadrons in 2023.

AARGM provides the U.S. Navy, U.S. Marine Corps, and Italian air force with a weapon system for engaging and destroying enemy air defenses and time-critical, mobile targets. The AARGM also has precise Global Positioning System (GPS)/inertial navigation system (INS) guidance and network-centric connectivity.

It also has missile impact zone control to prevent collateral damage through tightly coupled, digital terrain elevation database-aided GPS/INS, as well as counter-emitter shutdown through active millimeter-wave-radar terminal guidance.

In early 2018 Orbital ATK engineers started upgrading the sensors and embedded computing components of the AGM-88E to help mitigate existing missile cost and production issues. This project involved building the executive processor circuit card assembly for the missile's advanced digital anti-radiation homing sensor and its millimeter wave radar terminal seeker.

These upgrades were to support Naval Air Systems Command's Direct and Time Sensitive Strike program office. Upgrades were to mitigate cost and production issues, as well as incorporate hardware for future expansion.

*On this AARGM-ER EMD contract Alliant Techsystems will do the work in Northridge and Ridgecrest, Calif.; and Rocket Center, W.Va., and should be finished by March 2024. For more information contact Northrop Grumman online at www.northropgrumman.com, or Naval Air Systems Command at www.navair.navy.mil.*

# Air Force asks industry to develop space electromagnetic warfare operating location

BY **John Keller**

**EL SEGUNDO, Calif.** — U.S. Air Force space warfare experts are reaching out to industry to find companies able to develop a system to plan and carry out space electromagnetic warfare operations.

Officials of the Air Force Space Systems Command at Los Angeles Air Force Base, Calif., issued a sources-sought notice (SP-2020-05) for the Space Electromagnetic Warfare Operating Location (SEWOL) project.

The SEWOL will be the Air Force's consolidated operating location for the planning, tasking and execution of space electromagnetic warfare operations.

Electromagnetic warfare uses focused high-intensity bursts of electromagnetic energy called electromagnetic pulse (EMP) to disable or destroy sensitive electronics like computers, networks, and sensors.

**Electromagnetic warfare, which involves a new generation of electromagnetic pulse (EMP) weapons, may be headed for space.**

EMP is a well-known byproduct of a nuclear explosion, which destroys electronics inside a wide radius by overwhelming it with high-energy electromagnetic pulses. This essentially fries electronics. Electromagnetic warfare seeks to focus and control these energy bursts to avoid widespread collateral damage.

The SEWOL will provide four primary functions. First, it seeks to create a space electromagnetic warfare common operating picture that displays information to system operators and on-site commanders.

Second, SEWOL seeks to create mission planning, execution, command, and control infrastructure and applications to refine tactical orders, plan for targets and weapons, and enable automated control of several different subsystems using one operator.

Third, the project seeks to create a remote space electromagnetic warfare physical and cloud computing infrastructure to operate a scalable number of subsystems remotely.

Finally, SEWOL seeks to create a mission resiliency and assurance infrastructure that not only will enable continuity of operations across all phases of conflict, but also use development, security, and operations (DevSecOps) to integrate cyber security and trusted computing.

The SEWOL initial baseline will include the space electromagnetic warfare common operating picture; secure communications for receipt of high-level tasking orders; local weapon system control; and remote weapon system control.

The SEWOL will have an initial operating location within the Continental U.S., which eventually will expand to several geographically dispersed operating locations.

The common operating picture will provide a visual, searchable, and interactive near-real-time picture of current global space electromagnetic warfare activities.

The SEWOL will provide the infrastructure, cloud based, or bare-metal necessary to manage and remotely operate electromagnetic warfare systems from several geographic locations. This includes network infrastructure (NIPRnet, SIPRnet, and JWICS), processing infrastructure for space electromagnetic warfare systems, and a common operating interface.

Companies interested were asked to email 10-page statements of capabilities by 21 Oct. 2021 to the Air Force's Doreen Barnett at doreen.barnett@spaceforce.mil; Clifford Johnson at clifford.johnson.6@spaceforce.mil; and Grace Machado at grace.machado@spaceforce.mil.

*More information is online at https://sam.gov/opp/a4b67f8e42414a02b0bc34e4bf5b5c96/view.*

# Honeywell to provide combination GPS/INS avionics for F/A-18 combat jets

BY **John Keller**

**PHILADELPHIA** — U.S. Navy aviation navigation experts are asking Honeywell Inc. to build the Embedded Global Positioning System Inertial Navigation System (EGI) avionics that combines GPS and inertial technologies under terms of a $9.4 million contract.

Officials of the Naval Supply Systems Command Weapon Systems Support activity in Philadelphia are asking the Honeywell Aerospace segment in Clearwater, Fla., to build additional EGI systems for the F/A-18 jet fighter-bomber.

The EGI, manufactured by Honeywell and the Northrop Grumman Corp. Electronic Systems segment in Woodland Hills, Calif., is a navigation system that combines a GPS receiver card with an inertial navigation system (INS) in one 20-pound unit that measures 7 by 11 by 12 inches. The navigation systems are for helicopters and fixed-wing aircraft as upgrades to existing systems or as replacements for older and less capable systems.

The EGI is an Army/Navy/Air Force program that developed a small, reliable, lightweight navigation and guidance

**The EGI lightweight navigation and guidance unit contains position service GPS on one standard electronic module, plus a ring laser gyro inertial navigation system.**

## DARPA boosts contract to Lockheed Martin for Blackjack communications

The U.S. Defense Advanced Research Projects Agency (DARPA) Arlington, Va., has increased the contract to Lockheed Martin Corp. for satellite integration work for the Blackjack program by $25.3 million. The Lockheed Martin Corp. Space Systems segment in Sunnyvale, Calif., is the satellite integrator for Blackjack, a project to demonstrate the capabilities of small satellites in low Earth orbit for military communications, missile warning and navigation. The company had previously received contracts for $13.1 million and $27.3 million. The new modification brings the total value of the contract to $65.8 million. The agency ordered 10 buses from Blue Canyon Technologies and two from Telesat for the Blackjack project. Several companies, including Raytheon, SEAKR Engineering and SA Photonics are supplying payloads that Lockheed Martin integrates with the buses and the Pit Boss autonomous data processor.

## Quantum radar to accelerate electrons to detect stealth aircraft like B-2 and F-35

Chinese researchers say they are developing quantum radar that could detect stealth aircraft by creating a small electromagnetic storm. This isn't the first time researchers from China have made big claims about a functional quantum radar, and many experts from other countries contest the very feasibility of such devices. Conventional radars have a fixed or rotating dish, but the quantum radar design more closely resembles a gun, and accelerates electrons nearly to the speed of light. Once they pass through a winding tube exposed to strong magnetic fields, the electrons could generate a vortex of microwaves that swirl forward like a horizontal tornado. The novel quantum radar system would outclass any radar system of the past, but that's still a big if. Still, the potential benefits are worth the hard work. If the system really works, it could become a significant advantage.

unit that contains precise position service GPS on one standard electronic module.

EGI provides three navigation solutions: GPS only, inertial navigation only, or a blended GPS/INS navigation solution. The system has been in production since the late 1990s.

The Honeywell EGI family includes the H-764, in use on military aircraft, and the FALCN, providing all the features and performance of the H-764 in a smaller package. The H-764 legacy uses a larger chassis to maintain commonality with legacy military aircraft.

These systems provide linear and angular acceleration, linear and angular velocity, position, attitude (roll, pitch), platform azimuth, magnetic and true heading, altitude, body angular rates, time tags, and coordinated universal time (UTC) synchronized time.

The systems meet DO-178 and DO-254 standards, and support features like automatic dependence surveillance-broadcast (ADS-B), required navigation performance (RNP)/area navigation (RNAV), and wide area application services (WAAS).

*On this order Honeywell will do the work in Clearwater, Fla., and should be finished by April 2023. For more information contact Honeywell Aerospace online at http://aerospace.honeywell.com, or the Naval Supply Systems Command Weapon Systems Support-Philadelphia at www.navsup.navy.mil/public/navsup/wss.*

## U.S. Space Force tests software for tracking orbiting satellites

The U.S. Space Force is testing software that not only could improve the accuracy of its current system for tracking satellites and dangerous junk in space, but also enable actual tracking in near real time to keep tabs on adversary spacecraft seeking to hide from prying eyes. The software package was developed at MITRE Corp. in McLean, Va., and moved to Space Systems Command (SSC) in July for operational prototyping after two years of internal MITRE development and testing, says MITRE senior systems analyst Bob Carden. The Sensor Network Autonomous Resilient Extensible (SNARE) software "improves positional awareness of objects in space," Carden says. The MITRE SNARE test against 1,000 randomly chosen orbiting targets show it could provide an average improvement of the accuracy of space objects of 0.8 to 3 kilometers. SNARE also cut six hours out of the average time it takes current systems to re-find an object after it maneuvers.

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ENDEAVOR BUSINESS MEDIA

Digital twins could help explore the capabilities and missions of future unmanned undersea vehicles and help researchers understand how intermittent undersea communications could influence the design approach.

# Digital twins to analyze intermittent communications on unmanned undersea vehicles

BY **John Keller**

**ARLINGTON, Va.** — U.S. military researchers are asking industry to determine the feasibility of using digital twins to explore the capabilities and missions of future unmanned undersea vehicles (UUVs) — especially to help researchers understand how sometimes-unreliable and intermittent undersea communications could influence this design approach.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a small business innovation research (SBIR) opportunity (HR001121S0007-24) for the Defining and Leveraging Digital Twins In Autonomous Undersea Operations (DELTA) project.

A digital twin is a virtual representation of a system that spans its life cycle, updates from real-time data, and uses simulation and modeling, machine learning, and reasoning to help decision making.

This undersea effort is to determine the feasibility of extending digital twins to autonomous undersea vehicles, and determine the effects of undersea intermittent communications on digital twins under the ocean.

Although digital twins have been useful in manufacturing, product development, and design customization, their use in defense and maritime applications have been limited. The DELTA project seeks to determine if digital twins can add value to unmanned undersea missions, and if so, how researchers should employ digital twins.

This effort also will investigate the feasibility of translating digital twins to UUVs; the traditional use of digital twins relies on robust and continuous communications, which are not always available in undersea operations.

A chief aim is to address and overcome intermittent or low-rate data communications, and evaluate the number and size of UUVs will be necessary to realize operational efficiencies, or the kind of maintenance that this approach would require.

Ultimately, researchers believe that digital twins could help Navy commanders understand what their UUVs are doing — particularly in times of reduced or no communications.

The project's first phase will demonstrate in-depth knowledge of digital twins in undersea vehicle fleets, and the second phase will define the system, and capitalize on phase-one information to build a functional prototype.

*Companies interested were asked to submit proposals by 12 Oct. 2021 to the DOD SBIR/STTR Electronic Submission website at www.dodsbirsttr.mil/submissions. Email questions or concerns to DARPA at HR001121S0007@darpa.mil, with BAA HR001121S0007-24 in the subject line. More information is online at https://sam.gov/opp/2435dcb17e1b4ef59845f040f800858c/view.*

# Navy eyes minesweeping sensor payload using high-temperature superconducting magnetic materials

BY **John Keller**

**ARLINGTON, Va.** — U.S. Navy counter-mine warfare researchers are asking the defense industry to develop an advanced minesweeping sensor payload composed of a high-temperature superconducting magnetic source with an advanced acoustic generator for deployment aboard an unmanned mine warfare boat.

Officials of the U.S. Office of Naval Research (ONR) in Arlington, Va. issued a special notice last Friday (N00014-21-S-SN12) for the Magnetic and Acoustic Generation Next Unmanned Superconducting Sweep (MAGNUSS) project.

The advantage of using a high-temperature superconducting magnet in a minesweeping sensor is the ability to run at very high electrical currents with near-zero resistance. The magnet could sweep magnetic influence mines when coupled to an acoustic generator.

ONR has been developing an advanced closed-loop minesweeping system using a high-temperature superconducting magnet coupled with an acoustic source to generate underwater acoustic energy.

Now ONR researchers need industry to integrate the high-temperature superconducting magnet and acoustic generator systems together for deployment aboard the Mine Countermeasure Unmanned Surface Vehicle (MCM-USV), a long endurance semi-autonomous diesel-powered aluminum boat that deploys from the Navy's Littoral Combat Ship.

ONR wants to integrate a high-temperature superconducting magnet and a non-towed and low-drag underwater acoustic generator as one payload deployable aboard the MCM- USV.

The Navy has been moving mine countermeasures operations from traditional legacy systems to the Littoral Combat Ship and its MCM-USV.

This effort will involve procurement of a high-temperature superconducting magnet and an acoustic generator; integrating mechanical, electrical, and command and controls (C2) systems; integrating the complete payload with the MCM USV and its hull, mechanical, electrical, and C2 interfaces; testing; and an at-sea demonstration of the payload aboard the MCM-USV.

*Companies interested should email full proposals no later than 19 Nov. 2021 to ONRG.GrantProposals@mail.mil. Email technical questions or concerns to the Navy's Brian Almquist, Program Officer, Ocean Battlespace and Expeditionary Access, ONR Code 321, at brian.almquist@navy.mil. Email business questions or concerns to Matthew Murray, contracting officer, at matthew.murray1@navy.mil. More information is online at https://sam.gov/opp/ddd803b6d03e42e9b6dbcde611800317/view.*

**The Mine Countermeasure Unmanned Surface Vehicle (MCM-USV) — a long endurance semi-autonomous diesel-powered aluminum boat — is a prime candidate for new minesweeping sensor payloads.**

### Army takes hand in developing machine autonomy for unmanned ground vehicles

Experts at the U.S. Army Research Laboratory in Adelphi, Md., are developing their own machine autonomy technology stack to speed development of autonomous vehicles. A technology stack consists of all the layers of technology that support applications and development; it doesn't depend on a contractor. Owning the autonomy technology stack for unmanned vehicles enables Army researchers to take more control over their Scalable, Adaptive and Resilient Autonomy (SARA) program to improve how robots drive themselves. The one-year SARA program kicked off last year, working with eight collaborators from across the country, each to handle one part of the machine autonomy project for unmanned vehicles. Areas of research range from obstacle classification to navigating narrow passageways. The eight collaborators faced separate problems, and uploaded their software to the technology stack so that Army engineers could share it with other teams.

### U.S. and India may work together to build unmanned aerial vehicles and avionics

Breaking Defense reports the air forces of the U.S. and India have signed a new agreement to cooperate on developing unmanned aerial vehicles (UAVs), Pentagon officials say. The goal is to design and build prototype small UAVs, avionics, payload power, propulsion, and launch systems for the Indian and U.S. air forces." The cost will be more than $22 million, and will be split 50/50, in what the Pentagon bills as the "largest-ever" research effort among the U.S. and Indian militaries. India's procurement cycle is famously slow and often changes mid-stream. Still, defense companies have shown a willingness to put up with the chaos, and with good reason: India was the second largest importer of defense goods in 2020 at around 9.5 percent of all global weapon buys.

### Russian navy to replace manned scout helicopters with long-range UAVs

Russia wants to replace the manned scout helicopters on its existing surface warships with longer-range drones. This new concept wants to have a drone launch a drone from a ship. The process, in theory, starts with a cyclocopter, an unmanned aerial vehicle (UAV) that flies without rotors or traditional wings. Resting on the cyclocopter as a platform, a fixed-wing scout drone would be carried into the air. Then, with the cyclocopter flying forward, the fixed-wing drone would take off from it like it was on a runway, with the platform drone dropping away. For landings, the process would reverse, with the fixed-wing drone catching a ride on a moving platform, and then descending back to the ship. This technological turducken uses a novel style of drone to overcome the limited space constraints. Not all ships have room for aircraft, and even when they do, only dedicated aircraft carriers have room for more than a couple of helipads. That's the constraint that this concept is aiming to address—finite space that can at best accommodate vertical takeoff and landing by small aircraft.

# DARPA eyes reconfigurable optical communications to link satellite constellations

BY **John Keller**

**ARLINGTON, Va.** — U.S. military researchers are approaching industry to develop a reconfigurable multi-protocol intersatellite optical communications terminal to connect satellite constellations that otherwise would not be able to communicate.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a solicitation (DARPA-PS-21-01) for two technical areas of the Space-Based Adaptive Communications Node (Space-BACN) project.

Space-BACN seeks to develop an intersatellite optical communications terminal that is low size, weight, power, and cost (SWaP-C); easy to integrate; and operate on platforms in low Earth orbit (LEO). The project involves space-based communications, optical intersatellite links, reconfigurable modems, modular components, and space command and control.

Space-BACN aims to overcome today's lack of on-orbit interoperability among current and future space communications. There is yet no standardization of communications or optical intersatellite links in this domain, researchers point out.

New satellite constellations in different stages of acquisition are procuring single-waveform cross-link communication systems that only interconnect their own constellation, but not with other constellations. These single-waveform systems consist almost exclusively of custom-made components, and have little to no reconfigurability.

While most waveforms operate within the same wavelength band, they differ in wavelengths, polarization, clock rate, spatial acquisition sequence, modulation format, framing, and error correction coding. As each constellation acquires its own proprietary communications links, satellite communications (SATCOM) become severely fragmented with only isolated islands of connectivity.

Instead, the Space-BACN program seeks to create a reconfigurable space-to-space optical communications terminal that can connect heterogeneous constellations that operate on different optical intersatellite link specifications that otherwise would not be able to communicate with one another.

**Photo (above): Military researchers are asking for industry's help to connect current and future constellations of orbiting satellites in the Space-BACN project.**

The Space-BACN terminal should support most current and future single wavelength waveforms in space to speeds of 100 gigabits per second; use less than 100 Watts of power; and cost less than $100,000; and integrates easily into most satellites.

The Space-BACN program consists of three technical areas — two of which are part of this solicitation: A modular, low SWaP-C optical aperture to separate the front end of the optical intersatellite link from the signal processing via single-mode fiber; and a reconfigurable modem able to support several optical waveforms

as fast as 100 gigabits per second on one wavelength.

The optical aperture will include an overall terminal controller, responsible for pointing, acquisition, and tracking (pointing, acquisition, and tracking) functions; terminal command and telemetry; and transmit optical amplification and optional receive low-noise optical amplification.

The aperture will couple light into an single-mode fiber to achieve the coherent processing necessary for flexible high-rate optical communications.

Key challenges include focusing and stabilizing light over variable thermal, shock, and vibration environments; operating on any pair of transmit and receive wavelengths within the specified optical bandwidth; and accommodating any of several pointing, acquisition, and tracking sequences.

Traditional diffraction-limited optical apertures for space typically are incredibly expensive and only producible in small quantities because they are engineered, tuned, and hardened. Instead, Space-BACN aims to simplify the design and automate assembly and tuning of the optical components.

The reconfigurable modem will capitalize on advanced integrated technologies like A/D and D/A converters that sample at rates faster than 50 gigabits per second; narrow-linewidth tunable lasers; optical in-phase and quadrature (IQ) modulators; and equalizers.

To date, reconfigurable communications systems have been demonstrated only in RF, not in optical. Recent advances in optical communications and digital signal processing technologies, however, have made a 100-gigabit-per-second reconfigurable space terminal within reach. Commercial data communications applications have led to volume-manufacturable integrated photonic circuits for ubiquitous, low SWaP-C, high-rate data transceivers.

The reconfigurable modem will support several waveforms within the limits of sampling rate, where a specific single-wavelength waveform includes the details of symbol amplitude and phase, modulation, framing, and forward error correction.

Companies interested were asked to email three-page abstracts by 4 Oct. 2021 to DARPA at DARPA-PS-21-01@darpa.mil. Those submitting promising abstracts will be invited to make oral presentations and submit formal proposals.

*Email questions or concerns to DARPA at DARPA-PS-21-01@darpa.mil by 28 Sept. 2021. More information is online at http://www.fbodaily.com/archive/2021/09-September/15-Sep-2021/FBO-06130406.htm.*

### Elbit uses AI in infantry rifle to display graphics in electro-optical sight

When soldiers look through the sights of their assault rifles with the Elbit System new artificial intelligence (AI) data platform, their view transforms to resemble a first-person shooter video game. Layers of data from the Assault Rifle Combat Application, or ARCAS, display alongside a soldier's view of the environment — a mock urban landscape and dark tunnel in the case of the company's recent rifle sight demonstration in a rural area in central Israel. Shooters push buttons on a grip to toggle among layers of information about their surroundings, including motion detection, range, ammunition levels and more data that's just a click away. ARCAS incorporates a microprocessor in the weapon to display information in the rifle's electro-optical sight and through an optional helmet-mounted eyepiece. The demo used ARCAS systems mounted on M-4 rifles, with testers shooting at stationary targets.

### Pilots to control unmanned aircraft with tablet computer via data link

A major U.S. defense contractor conducted a demonstration to show how combat pilots in fourth- and fifth-generation jet fighters will work together with advanced semi-autonomous loyal wingman-type unmanned aircraft in the future. Researchers at General Atomics Aeronautical Systems in Poway, Calif., enabled a pilot in a specially configured Beechcraft King Air twin-engine turboprop to issue commands to a stealthy Avenger unmanned jet aircraft through software app loaded onto the pilot's tablet computer. The test, over southern California on 25 Aug., shows how Avengers, or other loyal wingman-type drones, might operate while networked together via data link with manned fighters to conduct aerial combat missions. The drones would provide increased sensor range and coverage across a broad area for the entire group, and their sensor data could fuze together with information from other offboard sources to give fighter pilots significantly increased battlespace awareness and help them determine the best courses of action to attack or avoid threats.

# Lockheed Martin to build laser-guided Hellfire II air-to-ground missiles

BY **John Keller**

**REDSTONE ARSENAL, Ala.** — U.S. Army missile experts are asking Lockheed Martin Corp to build AGM-114 laser-guided Hellfire II missiles, which can be launched from manned and unmanned aircraft, surface ships, and military ground vehicles.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced a $101.3 million contract Friday to the Lockheed Martin Missiles and Fire Control segment in Orlando, Fla., to provide Hellfire II missiles.

The AGM-114R is the latest Hellfire II variant, and is equipped with semi—active laser seekers to defeat many kinds of targets. The AGM-114R can be launched from several different kinds of fixed-wing aircraft and helicopters, surface ships, and military ground vehicles.

Hellfire II also is the missile of choice for several kinds of unmanned aerial vehicles (UAVs) such as the MQ-1B Predator, MQ-9 Reaper, and MQ-1C Grey Eagle. Eventually these missiles may arm U.S. military unmanned helicopters.

The Hellfire II will be replaced early this decade by the Lockheed Martin AGM-179 Joint Air-to-Ground Missile (JAGM) semi-active-laser-and millimeter-wave-radar-guided missile. JAGM also will replace the BGM-71 TOW, and AGM-65 Maverick missiles for launch from Army AH-64 Apache attack helicopters, the Army MQ-1C Gray Eagle UAV, the Navy MH-60R helicopter, and the Marine Corps AH-1Z Viper attack helicopter. The Hellfire missile weighs 106 pounds, and has high-explosive variants designed to destroy tanks and other armored vehicles, and blast fragmentation versions designed to destroy trucks, antenna sites, concentrations of enemy troops, and other soft targets.


**The AGM-114R Hellfire II missile uses a semi-active laser guidance system and an integrated blast fragmentation sleeve warhead to attack targets.**

The AGM-114R Hellfire II Romeo RX missile uses a semi-active laser guidance system and an integrated blast fragmentation sleeve warhead to engage targets that previously needed several Hellfire variants to destroy.

These missiles can seek out their targets autonomously or with designation from remote laser designators. The missile has a three—axis inertial measurement unit to enable it to attack targets from the side and behind.

The AGM-114R can be launched from higher altitudes than previous variants because of its enhanced guidance and navigation capabilities. With its multi—purpose warhead, the missile can destroy hard, soft, and enclosed targets.

Originally developed as an anti-tank missile for the Army's AH-64 Apache attack helicopter, the Hellfire homes-in on the reflected light of a laser designator. Other versions of the Hellfire are radar-guided fire-and-forget weapons.

Development of the AGM-114R Hellfire missile became necessary after the Pentagon cancelled the Joint Common Missile (JCM) project, which was to replace Hellfire, as well as the AGM-65 Maverick air-to-ground missile.

*On this order Lockheed Martin will do the work in Orlando, Fla., and should be finished by September 2024. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa*

The SCIFiRE effort seeks to advance air-breathing hypersonic technologies into full-size prototypes that are affordable and provide a flexible long-range capability.

# Raytheon to develop hypersonic missile for existing jet fighter and bomber aircraft

BY **John Keller**

**EGLIN AIR FORCE BASE, Fla.** — Hypersonic weapons designers at Raytheon Technologies Corp. are moving forward with a project to advance air-breathing hypersonic technologies together with experts in Australia under terms of a $28 million order.

Officials of the U.S. Air Force 96th Test Wing at Eglin Air Force Base, Fla., awarded the order to the Raytheon Missiles & Defense segment in Tucson, Ariz., for the Southern Cross Integrated Flight Research Experiment (SCIFiRE) Project first-phase preliminary design review.

The order is a modification to a $33.7 million contract to Raytheon last June to kick off the first phase of the SCIFiRE project to mature a solid-rocket-boosted, air-breathing, hypersonic conventional cruise missile able to be launched from existing jet fighter and bomber aircraft.

The SCIFiRE effort aims cooperatively to advance air-breathing hypersonic technologies into full-size prototypes that are affordable and provide a flexible long-range capability. A hypersonic munition flies at five or more times the speed of sound.

The program will culminate in realistic missile flight demonstrations, and will pursue potential co-production opportunities among the U.S. and Australia. The project capitalizes on U.S. and Australian collaborative hypersonic activities conducted over the last 15 years, namely the Hypersonic International Flight Research Experimentation (HIFiRE) program.

SCIFiRE continues collaborative research efforts that involve the U.S. Air Force, U.S. Navy, the Royal Australian Air Force, and Australian Defence Science and Technology Group.

SCIFiRE is the second effort announced under the Allied Prototyping Initiative, which launched in 2019 to capitalize on new and existing cooperation in research and development.

*On this order Raytheon will do the work in Tucson, Ariz., and should be finished by September 2022. For more information contact Raytheon Missiles & Defense www.raytheonmissilesanddefense.com, or the Air Force 96th Test Wing at www.eglin.af.mil/Units/96th-Test-Wing.*

SENSORS

## Raytheon picks FPGA-equipped fiber-optic gyros from EMCORE for airborne targeting


Fire control experts at Raytheon Technologies Corp. needed fiber-optic gyros for use in airborne targeting systems. They found their solution from EMCORE Corp. in Alhambra, Calif.

Officials of the Raytheon Intelligence & Space segment in Arlington, Va., have awarded a $4.1 million supplement to a long-term fiber-optic gyroscope contract to EMCORE to supply high-performance FOG modules for use in airborne optical targeting systems. EMCORE manufactures fiber-optic gyros (FOGs) that include the company's EG-120, EG-200, and EG-1300.

The EMCORE Hawkeye series EG-120 FOG module is an ultra-compact closed-loop system with field programmable gate array (FPGA) electronics that deliver increased performance and reliability combined with low cost.

It is for medium accuracy platform stabilization applications such as camera systems used in aircraft, unmanned aerial vehicles (UAVs), and gun stabilization systems, and supports a variety of other guidance, navigation, and aeronautics applications.

EMCORE's EG-200 Fiber Optic Gyro features EMCORE-Hawkeye integrated optics and electronics, and has suitable weight and form-factor for tactical applications. It incorporates integrated FPGA electronics to improve optical drift stability, environmental flexibility, and linearity compared to competing technologies.

The EG-200 can be calibrated internally for better thermal effect and has digital and analog outputs to accommodate tactical applications like UAV and missile guidance, aeronautics and aviation, and robotics.

The EMCORE-Hawkeye EG-1300 FOG offers advanced integrated optics and closed-loop FPGA for accuracy, efficiency, and low noise. it can be calibrated internally for better thermal effect, has digital and analog outputs, and separation of the electronics from the FOG's sensing coil.

EMCORE has delivered more than 1,200 units of its custom-designed, closed-loop FOGs to Raytheon, and company officials say they expect to deliver the additional units for this add-on contract through February 2022.

In 2018, EMCORE was awarded a long-term $18 million contract by Raytheon for custom single-axis tethered FOGs with separate electronics and sensor modules that accommodate a wide variety of installation parameters.

The performance specifications of these FOGs are for platform stabilization in camera systems used for optical targeting in aircraft, UAVs, and gun systems. For more information contact EMCORE Corp. online at www.emcore.com, or Raytheon Intelligence & Space at www.raytheonintelligenceandspace.com.

UNMANNED VEHICLES

## Navy taps MZA Associates for portable laser weapons for counter-UAV operations

Laser weapons experts at MZA Associates Corp. in Albuquerque, N.M., are adding their expertise to U.S. military efforts to develop portable high-energy lasers to damage or destroy unmanned aerial vehicles (UAVs) that are violating the airspace of military bases or other sensitive installations.

Officials of the U.S. Office of Naval Research (ONR) in Arlington, Va., have announced an $18.7 million contract to MZA Associates to develop the counter unmanned aerial vehicle (C-UAS) High Energy Laser Weapon System (HELWS).

MZA engineers will design, develop, deliver, integrate, test, and demonstrate a compact, portable, low-cost and reliable C-UAS HELWS using the latest available commercial components.

Such a system potentially could enable U.S. Marines on the ground or sailors aboard surface warships to destroy, disable, or discourage potentially hostile UAVs flying too closely to Marine ground units, ships, or forward-deployed bases.

MZA Associates specializes in modeling, analysis, design, development, integration, and testing of high-energy laser and advanced optical systems in support of advanced beam-control systems, atmospheric characterization, and optical systems engineering.

MZA provides expertise in wave-optics modeling; adaptive optics; and scientific data acquisition, analysis, and management. The company developed the WaveTrain wave-optics analysis tool for the analysis of optical atmospheric propagation and adaptive optics systems.

MZA joins the Raytheon Technologies Corp. Intelligence & Space segment in McKinney, Texas, in efforts to develop portable and mobile laser weapons for anti-UAV warfare.

Raytheon is providing the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, with counter-UAV high-energy laser weapons for counter-drone operations. The company won a $13.1 million order in late 2019 to build a HELWS for six months of in-field evaluation against enemy UAVs.

The Raytheon prototype HELWS combines a solid-state laser weapon with a Raytheon multi-spectral targeting system. The unit mounts to a military RZR all-terrain vehicle from Polaris Inc. in Medina, Minn. This results in an advanced, lightweight, and adaptable weapons system that enables military mobile light forces to defend against enemy UAVs in a wide variety of conditions and terrain.

The Office of Naval Research is supporting development of directed-energy weapons that cause physical damage that degrades, neutralizes, defeats, or destroys enemy capabilities such as UAVs.

ONR is supporting research potentially leading to naval laser subsystems, beam directors, and fire-control architectures, including advanced design power architectures for low-duty cycle and continuous-wave laser applications with reduced size, weight, and power consumption, and cooling (SWAP-C).

ONR researchers particularly are interested in laser components that offer high brightness, high power-beam-combining technologies, and controlled micro-channel optical component cooling methods that reduce thermal distortions for enhanced beam quality.

ONR also is sponsoring research in directed-energy weapons system tracking sensors, target illuminators, and automated target recognition components -- especially those that offer tracking through intermittent or partially obscured maritime viewing conditions.

On this contract MZA Associates will do the work in Albuquerque, N.M., and Dayton, Ohio, and should be finished by August 2023. With options, the project could continue through August 2025. For more information contact MZA Associates online at www.mza.com, or the Office of Naval Research at www.onr.navy.mil.

MACHINE AUTOMATION

## Two companies to develop mission planning autonomy for manned-unmanned teaming

WRIGHT-PATTERSON AFB, Ohio — U.S. Air Force researchers are looking to two companies to develop enabling technologies to help automate air force missions from the planning stages to post-mission analysis.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have awarded contracts to Systems & Technology Research LLC Woburn Mass.; and to RBR Technologies in Odenton Md., for the Science and Technology for Autonomous Teammates (STAT) program.

The STAT program seeks to develop and demonstrate machine autonomy technologies for multi-domain command and control; intelligence, surveillance, recognizance, and processing exploitation, and dissemination; and manned/unmanned combat teaming through human-machine teaming and autonomous decision making.

Systems & Technology Research won an $8.9 million contract on 17 Aug. 2021, and RBR Technologies won an $8.3 million contract on 9 July 2021 for the STAT program.

This project should result in technology demonstrations that could improve the Air Force's capability to conduct missions in different environments while minimizing the risks to airmen, and enable the Air Force to operate inside of the enemy's decision loop, researchers say.

STAT will develop and apply autonomy technologies to enhance mission planning, mission execution, and post-mission analysis. The project emphasizes multi-domain command and control, manned-unmanned teaming, and information analytics.

This effort will demonstrate modular, transferable, open-systems autonomy architectures with software algorithms that will ingest and understand mission taskings and commander's intent; respond appropriately to human direction and orders; and respond intelligently to dynamic threats and unplanned events.

Technologies will enable airman-machine teaming to reduce workloads without compromising mission effectiveness or deadlines; enable autonomous systems to understand a commander's mission

requirements and adapt to changing circumstances; and enable autonomous and unmanned systems to integrate safely and efficiently into Air Force operations.

The STAT project revolves around eight research areas: mission planning and debrief; flight operations; communications and datalinks; human interfaces; multi-domain mission operations; executive functions; systems integration; and test and evaluation.

For more information contact Systems & Technology Research online at www.str.us, RBR Technologies at www.rbr-technologies.com, or the Air Force Research Laboratory at www.afrl.af.mil.

FIRE CONTROL

## Lockheed Martin to provide electro-optical fire-control systems for Apache helicopters

Lockheed Martin Corp. will provide the U.S. Army with an electro-optical fire-control system that helps AH-64 Apache attack helicopter crews fire weapons accurately and navigate safely in bad weather and at night.

Officials of the U.S. Army Contracting Command at Redstone Arsenal, Ala., have announced a $10.8 million order to the Lockheed Martin Missiles and Fire Control segment in Orlando, Fla., for the Modernized Target Acquisition Designation Sight/Pilot Night Vision Sensor (M-TADS/PNVS) system and its subcomponents for the Boeing AH-64D/E Apache helicopter.

M-TADS/PNVS is the advanced electro-optical fire-control system for the Boeing AH-64D Apache Longbow and AH-64E Apache Guardian attack helicopter that crews use for targeting and pilotage in day, night, and bad weather.

Fielded in 2005, M-TADS/PNVS increases standoff ranging for U.S. and allied forces while providing air crews with greater resolution for pilotage and targeting, enhancing situational awareness, compared to previous versions of the system, Lockheed Martin officials say.

The Modernized Day Sensor Assembly (M-DSA) of the M-TADS/PNVS enables crews of Apache helicopters to see color and near-infrared high resolution imagery on cockpit displays to help identify targets at standoff ranges. The M-DSA offers narrow field of view and extended-range picture-in-picture capability.

On this order Lockheed Martin will do the work in Orlando, Fla., and should be finished by December 2024. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa/.

REAL-TIME SOFTWARE

## Green Hills to provide real-time software for next-generation GPS receiver navigation

Navigation and guidance experts at Raytheon Technologies Corp. needed a real-time software operating system for the company's Military Global Positioning System User Equipment (MGUE). They found their solution from Green Hills Software in Santa Barbara, Calif.

Officials of the Raytheon Intelligence & Space segment in El Segundo, Calif., are choosing the Green Hills INTEGRITY-178 tuMP real-time operating system (RTOS) for the Raytheon Military Global Positioning System User Equipment (MGUE) Increment 2 Miniature Serial Interface (MSI) with Next-Generation Application Specific Integrated Circuit (ASIC).

Raytheon designers are developing one MSI card for aviation and maritime navigation systems and another for ground-based systems, and will use INTEGRITY-178 tuMP will be used in both solutions running on the Arm processor-based application-specific integrated circuit (ASIC).

Raytheon selected the INTEGRITY-178 tuMP RTOS based on the company's use in previous programs and for its ability simultaneously to meet safety and security requirements such as DO-178C design assurance level (DAL A) and the NSA-defined separation kernel protection profile (SKPP) for high robustness security.

The MGUE is the GPS receiver for the modernized GPS Enterprise. It can receive military code (M-Code) from newer satellites, including GPS-III. M-Code is a more robust and jam-resistant form of GPS that also uses more modern and flexible encryption methods to resist RF spoofing.

For more information contact Green Hills Software online at www.ghs.com, or Raytheon Intelligence & Space at www.rtx.com/our-company/our-businesses/ris.

TEST AND MEASUREMENT

## Oscilloscope software for DisplayPort test offered by Teledyne LeCroy

Teledyne LeCroy in Chestnut Ridge, N.Y., is introducing the QualiPHY DisplayPort 2.0 source and sink compliance and DisplayPort AUX DME (Decode, Measure & Eye Diagram) oscilloscope software options for DisplayPort test and measurement. Systems designers are asking for virtual reality and PC display resolution as high as 16,000 pixels, and fast refresh rates, which require fast data transfer from the CPU to the display. To enable these fast refresh rates, DisplayPort 2.0 supports ultra-high bit rates as fast as 20 gigabits per second over four lanes, which is more than twice the bit rate offered in DisplayPort 1.4. High bit rates add complexity, resulting in longer test times. QualiPHY DisplayPort 2.0 source and sink compliance options for Teledyne LeCroy oscilloscope products have been developed in response to these new DisplayPort 2.0 test challenges. When used with a LabMaster 10 Zi-A oscilloscope, the multi-lane analysis capability helps reduce PC output test times. The LabMaster 10 Zi-A performs stressed signal calibration and BERT at the display input using the Anritsu MP1900A. For more information contact Teledyne LeCroy online at https://teledynelecroy.com/displayport-phy-test/.

COMPUTER NETWORKING

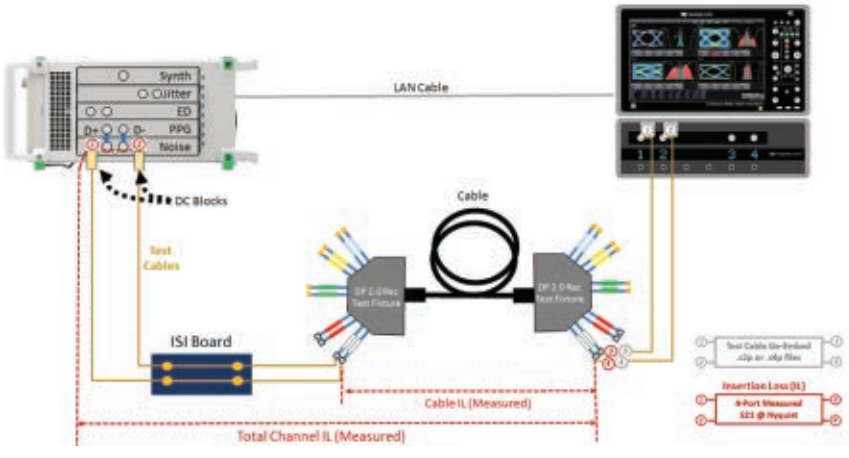
## Rackmount computer networking for artificial intelligence (AI) introduced by WIN

WIN Enterprises Inc. in North Andover, Mass., is introducing the PL-84020 2U rackmount high-performance computer networking system for edge computing and artificial intelligence (AI) applications. The system supports dual AMD EPYC 7003/7002 (Milan/Rome) processors. Based on AMD's new Zen 3 processor, the unit supports as many as 64 processing cores, a 256-megabyte cache, and 128 PCI Express Gen 4 lanes. The high-performance network computer system supports eight channels of DDR4 RDIMM memory and maximum memory capacity as much as 4 terabytes per socket. With 64 forward facing PCI Express Gen 4 lanes, PL-84020 supports as many as eight network expansion modules; and several Ethernet module bays. The maximum capable Ethernet port is as fast as 64x 1 Gigabit Ethernet, 64x 10 Gigabit Ethernet, 32x 25 Gigabit Ethernet, 8x 100 Gigabit Ethernet ports. The 8x PCI Express Gen4 x8 Expansion bay supports newly designed 2x 2.5-inch U.2 NVMe solid-state drive tray, and GPU/FPGA add-on card swappable tray. I/O elements of PL-84020 rackmount networking computer includes 2x management ports; a console port; a graph LCD module with keypad; LEDs for power; and HDD/2 x GPIO. In addition, the PL-84020 supports two 2.5-inch SATA hard- or solid-state hot-swappable drives, one mSATA, and two M.2 2280 slots for basic network storage applications. For more information contact WIN Enterprises online at www.win-ent.com.

CONNECTORS

## Modular connectors for power and signal applications introduced by Powell

Electronics distributor Powell Electronics in Marlborough, Mass., is offering Scorpion modular connector system from Positronic, an Amphenol company in Springfield, Mo. The components can be configured for use as power connectors of 16 to 120 amps; signal level connectors; or as a combination of the two in several different power- and signal-contact configurations. The modular tooling provides several keying options, yet still provides a one-piece insulator for use in the finished connector. Positronic's Scorpion series includes more than 35 modules available



in standard-profile 14.6 millimeter height and low-profile 8.2-millimeter-height versions. Blank module options enable design engineers to space power and signal contacts to meet creepage and clearance values necessary for different applications. The Scorpion series includes board-to-board, cable-to-cable or board and panel-to-cable or board versions. An outlet hole enables air cooling onto a power contact. Termination options are solder PCB mount, crimp, and press-fit. Available mating alternatives are blind mating, float mount, panel mount, and cable connector with a locking system. The precision formed and solid machined contacts feature shielded, high voltage and hyperboloid contact versions. For more information contact Powell Electronics online at www.powell.com, or Positronic at www.connectpositronic.com.

EMBEDDED COMPUTING

## SOSA-aligned 3U VPX embedded computing card introduced by Concurrent Technologies

Concurrent Technologies in Colchester, England, is introducing the TR K9x/6sd-RCx 3U VPX plug-in card (PIC) designed in alignment with the Sensor Open Systems Architecture (SOSA) Technical Standard. This I/O intensive processor is for situational awareness and intelligence, surveillance and reconnaissance (ISR) applications that need a combination of general-purpose processing augmented with image processing and artificial intelligence (AI) acceleration. TR K9x/6sd-RCx embedded computing system is based on an 11th Gen Intel Core processor which has as many as four CPU cores mated with 16 gigabytes of soldered DDR4 DRAM with in-band error correction code for high-performance general-purpose compute tasks. The Intel Iris Xe graphics integrated into the product adds as many as 96 execution units for AI and acceleration when used by an OpenCL, oneAPI, or OpenVINO application. Extra processing or I/O in the SOSA-compliant architecture can be included within one slot via the onboard XMC site, which means that the product can be reconfigured for different application needs. One of the advantages SOSA alignment is definition of the rear I/O connections on the backplane. For more information contact Concurrent Technologies online at www.gocct.com.

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CABLING AND CONNECTORS

## Waterproof cables to protect against moisture and tampering introduced by Amphenol RF

Amphenol RF in Danbury, Conn., is introducing waterproof IP-rated and tamper-resistant cable assemblies with TNC and RP-TNC configurations for applications like remote outdoor enclosures, portable radios, handheld devices, and industrial equipment. These cable assemblies are designed using 1.13-millimeter micro coax cable and feature the ultraminiature AMC4 connector on one end for applications where systems may be compromised through exposure to the elements or external tampering. Waterproof sealed solutions are engineered to protect from outside elements and are tested to IP67 specifications in the mated and unmated condition. RF lines are designed to meet interface performance specifications, with the addition of internal and external sealing features. For more information contact Amphenol RF online at www.amphenolrf.com.

BOARD PRODUCTS

## Safety-certifiable SOSA 3U OpenVPX embedded computing module introduced by Mercury

Mercury Systems Inc. in Andover, Mass., is introducing the SBC3515-S safety-certifiable 3U OpenVPX avionics module to streamline avionics subsystem development and platform safety certification. The rugged processing, video, storage, and power SOSA-aligned module is aligned to the Sensor Open Systems Architecture (SOSA) technical standard, and feature BuiltSAFE proven, modular, commercial-off-the-shelf (COTS) elements complete with hardware and software artifacts to deliver smooth performance and simplify integration. The DO-178-certifiable developmental board support packages (BSPs) support Green Hills Software, Lynx Software Technologies, Wind River and other real-time operating system (RTOS) software to streamline integration and the certification process. For more information contact Mercury Systems online at www.mrcy.com.

CHASSIS AND ENCLOSURES

## Open-architecture chassis to help design SOSA systems introduced by Elma

Elma Electronic Inc. in Fremont, Calif., is introducing the 3U VPX slimline CompacFrame development chassis to accelerate the design and testing of open-architecture embedded computing systems. Elma's slimline CompacFrame is the next-generation platform to accelerate development and testing of plug-in cards aligned to the Sensor Open Systems Architecture (SOSA) technical standard. The platform features a card cage tilted upwards by 5 degrees for easy access and accommodates up to two one-slot power and ground-only VPX backplanes or up to a four-slot OpenVPX backplane. Various card guide installation options are available to accommodate different plug-in card cooling schemes, including VITA 48.1 convection, VITA 48.2 conduction ,and VITA 48.8 air flow-through. The unit ships standard with a 300-Watt ATX fixed power supply. For more information contact Elma Electronic online at www.elma.com.

TEST AND MEASUREMENT

## PXI/PXI Express multiplexer for MIL-STD-1553 test offered by Pickering Interfaces

Pickering Interfaces in Clacton-On-Sea, England, is introducing the model 40/42-739 PXI/PXI Express multiplexer module optimized for MIL-STD-1553 test and measurement applications. With a differential bandwidth of 450 MHz — far exceeding the requirements of MIL-STD-1553 — the model 40/42-739 is available in single or dual 4:1, 8:1 or 16:1 differential configurations. Using telecommunications-grade electromechanical relays, the 40/42-739 PXI/PXI Express multiplexer has a minimal initial signal path resistance of less than 450 milliohms. The 40/42-739 PXI/PXI Express multiplexer module is supported by the Pickering Interfaces eBIRST diagnostic tool for ease of maintenance and fault-finding. The inclusion of a spare relay enables customers with applicable SMT rework training to effect on-site repair, minimizing system downtime. Pickering also offers a range of standard and custom interconnect accessories supporting the 40/42-739 family. For more information contact Pickering Interfaces online at www.pickeringtest.com.

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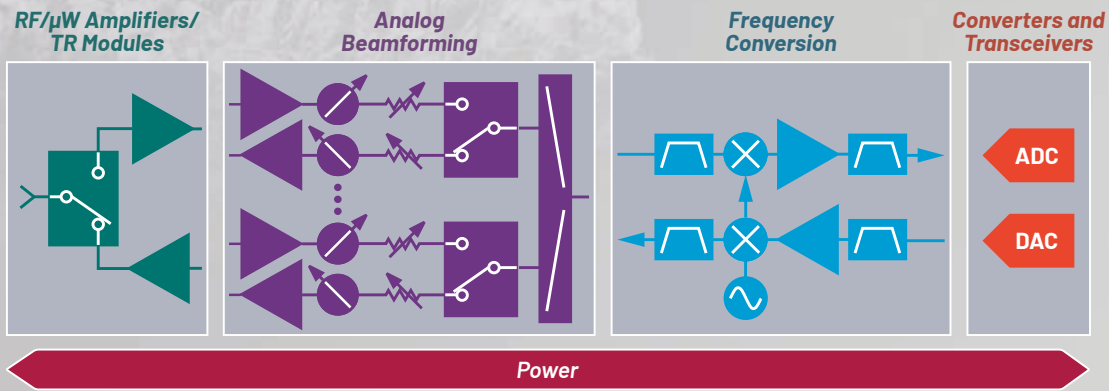


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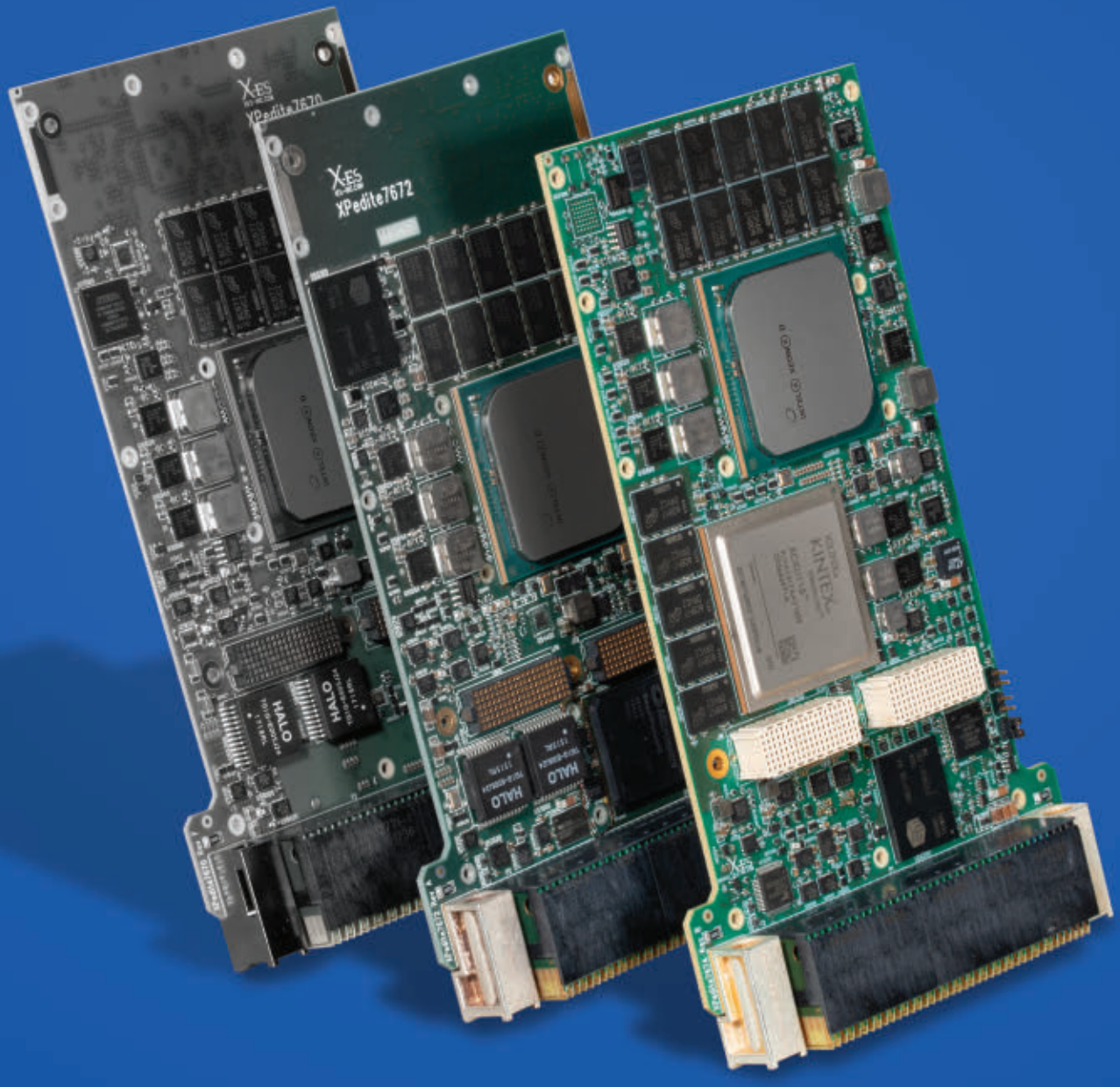


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