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Electronics thermal management

Enabling technologies for electronics cooling expand, as designers demand high performance, standards-based approaches, and reduced size and weight. **PAGE 22**

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*Sensors, unmanned vehicles, and human intelligence to keep the nation's waterways safe. **PAGE 14***

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Contracts show the Pentagon is getting serious about unmanned surface vessels

THE MIL & AERO COMMENTARY U.S. military leaders are getting serious about developing unmanned surface vessels for jobs like the global transport of military cargo, moving troops and support personnel, anti-submarine warfare, maritime surveillance, and even offensive operations against enemy ships.

U.S. Department of Defense (DOD) agencies awarded two significant contracts last month to develop enabling technologies for unmanned surface vessels (USVs) able to operate independently for long periods over vast ocean areas — even in rough seas and high waves.

The two September contracts involve the U.S. Navy's Large Unmanned Surface Vehicle (LUSV), and the Sea Train project of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.

The Navy has awarded contracts to six companies to take the first steps in determining what the service's LUSV will look like. The LUSV's missions would include anti-surface and strike warfare. The LUSV will offer autonomy, endurance, precision navigation, and command-and-control.

the Navy has announced \$42 million in LUSV preliminary studies. The contractors are Austal USA in Mobile, Ala.; Huntington Ingalls Industries in Newport News, Va.; Fincantieri Marinette Marine in Marinette, Wis.; Bollinger Shipyards in Lockport, La.; Lockheed

Martin Corp. in Bethesda, Md.; and Gibbs & Cox Maritime Solutions in Arlington, Va.

These surface drones, operating together with surface ships, undersea drones, aerial drones, and submarines, promise to change the character of maritime warfare, Navy officials say.

The DARPA Sea Train project, meanwhile, will develop enabling technologies to make it easier for military forces to cross oceans by using a system of connected unmanned surface vessels that would act as trains across the seas.

DARPA awarded a \$13.9 Sea Train contract in September to Applied Physical Sciences Corp. in Groton, Conn. The potential value of the contract is as much as \$31.3 million. Applied Physical Sciences experts will focus on enabling extended transoceanic transit and long-range naval operations by capitalizing on the efficiencies of a system of wave-resistant connected vessels using a distributed fleet of tactical unmanned ships.

The idea is to deploy lines of medium-sized unmanned ships that could help reduce the forces of waves. DARPA researchers say the sea trains could be formed by physically connecting vessels loosely, or by sailing vessels in formations.

Leaders of the U.S. Navy and Marine Corps are trying to shift from centralized operations on a few large manned surface ships to a distributed fleet of relatively small and low-risk vessels

for safe ocean transit.

A key limitation of unmanned ships is their limited ranges because of the effects of large ocean waves on medium-sized vessels. At-sea refueling, heavy-lift ships, strategic airlift, and increased overall vessel size all are solutions to this limitation, but are vulnerable to enemy submarines, surface warships, and combat aircraft.

The connected sea train has a physical connection between four or more vessels during transit to form a long parallel mid-body for the vessel to decrease the vulnerability to waves, while enabling the vessels to be disconnected from time to time to conduct tactical missions.

The formation sea train involves four or more vessels moving together in groups formed closely front and back, and side to side, to exploit wave interference between the vessels.

The Sea Train project seeks to design a hull that makes the most of drag reduction; control surfaces for maneuvering and seakeeping; ways to connect to several medium-size unmanned ships; and low-drag propulsion.

DARPA experts envision the Sea Train's control architecture with real-time networked computers able to share information among vessels — especially by linking weather forecasts with path planning and seakeeping; and ways to monitor vessel performance. ←

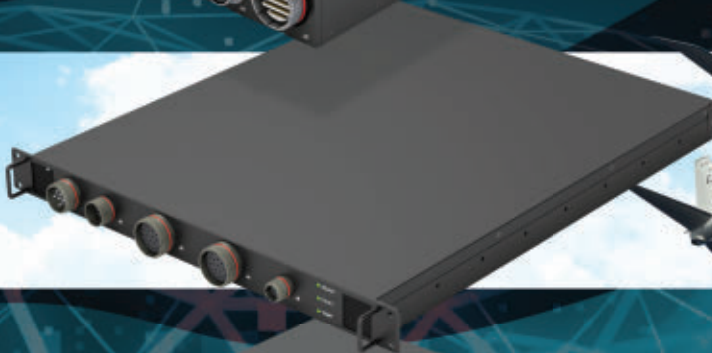
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The next-generation U.S. intercontinental ballistic missile will be named the Ground Based Strategic Deterrent (GBSD), and is to replace the nation's fleet of Minuteman III ground-based missiles.

Northrop Grumman to design next-generation nuclear ballistic missile

BY John Keller

HILL AIR FORCE BASE, Utah — U.S. Air Force strategic weapons experts are choosing Northrop Grumman Corp. to design the next-generation U.S. intercontinental ballistic missile (ICBM) to replace the Minuteman III under terms of a \$13.3 billion contract announced in September.

Officials of the Air Force Nuclear Weapons Center at Hill Air Force Base, Utah, are asking Northrop Grumman to design the Ground Based Strategic Deterrent (GBSD). Northrop Grumman will provide engineering and manufacturing development (EMD) for the GBSD at a newly built facility in Roy,

Utah, adjacent to Hill Air Force Base.

The effort will take 8.5 years and include weapon system design, qualification, test and evaluation, and nuclear certification, Northrop Grumman officials say. The Air Force wants the new missile to be operational by 2029. The EMD award follows a three-year technology maturation and risk reduction phase-one effort under the GBSD competition.

The Northrop Grumman GBSD team includes Aerojet Rocketdyne in El Segundo, Calif.; Bechtel Corp. in Reston, Va.; Clark Construction Group in Bethesda, Md.; the Collins Aerospace

segment of Raytheon Technologies Corp. in Cedar Rapids, Iowa; General Dynamics Corp. in Reston, Va.; HDT Global Inc. in Solon, Ohio; Honeywell International Inc. in Charlotte, N.C.; Kratos Defense and Security Solutions Inc. in San Diego; L3Harris Technologies in Melbourne, Fla.; Lockheed Martin Corp. in Bethesda, Md.; and Textron Systems in Providence, R.I.

Also on the Northrop Grumman GBSD team are hundreds of small- and medium-sized companies from across the defense, engineering, and construction industries, Northrop Grumman officials say.

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The GBSD ICBM is the follow-on to the aging LGM-30G Minuteman III ICBM and first became operational in 1970. The GBSD ICBM will have increased accuracy, enhanced security, and improved reliability.

The GBSD will have a 300-kiloton W87 Mod 0 thermonuclear warhead of unknown yield, capable of air- or ground-burst detonation. The silo-launched missile will have three-stage solid-fuel rocket propulsion with inertial and GPUS guidance.

The GBSD will replace the U.S. Minuteman III fleet, which constitutes one-third of the nation's nuclear weapons deterrent. Other U.S. nuclear warheads are on submarine-launched ballistic

missiles and on manned jet bombers.

Each Minuteman III missile is 60 feet tall, 5.5 feet in diameter, and powered by three solid rocket motors that can launch the 80,000-pound missile to altitudes of 700 miles to deliver nuclear warheads as far away as 6,500 miles. Each missile contains as many as three independently targeted warheads in separate reentry vehicles.

The U.S. maintains Minuteman III missiles at 450 missile sites in Colorado, Montana, Nebraska, North Dakota, and Wyoming. The missiles themselves are in underground silos and are ready for launch on very short notice.

The Minuteman III originally was equipped with a Rockwell Autonetics

D37D flight computer, but as of 2008 had been upgraded as part of the Minuteman-III Guidance Replacement Program (GRP).

On the GBSD contract Northrop Grumman will do the work in Roy and Promontory, Utah; Huntsville and Montgomery, Ala.; Colorado Springs, Colo.; Bellevue, Neb.; San Diego and Woodland Hills, Calif.; Chandler, Ariz.; Annapolis Junction, Md.; and at other U.S. locations. ←

For more information contact Northrop Grumman online at www.northropgrumman.com/gbsd, or the Air Force Nuclear Weapons Center at www.afnwc.af.mil.

HRL Laboratories to refine millimeter-wave GaN integrated circuits for RF applications

BY John Keller

ARLINGTON, Va. — U.S. military researchers are asking integrated circuit experts at HRL Laboratories LLC in Malibu, Calif., to refine RF and microwave circuitry for aerospace and defense applications.

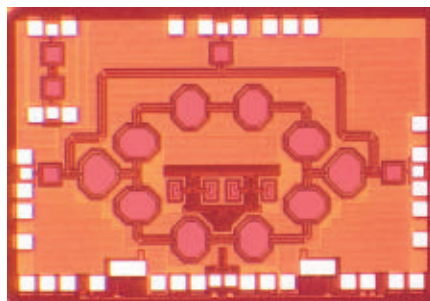
Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced an \$8.4 million contract modification to HRL for phase-two of the Millimeter Wave GaN Maturation (MGM) program.

This initiative seeks to improve RF and microwave semiconductor technologies to improve device yield, reduce process cycle time, and demonstrate key millimeter wave power amplifiers and mixed-signal circuits in multi-project wafer runs (MPWs).

MGM is making strategic yield and reproducibility improvements that cap-

italize on standard evaluation circuits (SEC), process control monitors (PCM), and short-loop fabrication to identify process step improvements.

In the project's first phase, HRL



HRL Laboratories will improve RF and microwave semiconductor technologies to improve device yield, reduce process cycle time, and demonstrate key millimeter wave power amplifiers and mixed-signal circuits in multi-project wafer runs (MPWs).

experts began maturing their RF and millimeter-wave gallium nitride (GaN) semiconductor technologies that they demonstrated during the DARPA Nitride Electronics NeXt-Generation Technology (NEXT) program a decade ago.

The goal of the project's second phase is to reduce the fabrication cycle time, improve the RF yield and reliability, improve device models and the process design kit, and increase the manufacturing readiness level (MRL) of GaN millimeter-wave circuitry.

HRL experts will mature this GaN technology by making targeted process step improvements. They will use process control monitors; make several multi-project wafer (MPW) runs; and improve monolithic microwave integrated circuit (MMIC) design capa-

bilities at the company's their Malibu, Calif., facility.

As a performer on the DARPA NEXT program HRL developed state-of-the-art GaN transistors with scaled gate lengths of 40 nanometers and demonstrated f_t/f_{max} of 200/400 GHz.

The NEXT program sought to develop a revolutionary nitride transistor technology with an extremely high-speed and high-voltage swing of Johnson Figure of Merit (JFoM) larger than 5 THz in large-scale circuit integrations of at least 1,000 transistors.

The project sought to develop fabrication processes that are manufacturable, high-yield, high-uniformity, and highly reliable. The program focused on demonstrating the ability to combine these devices into a small logic circuit of about 10 transistors, and then work

up to about 1,000 transistors.

During the MGM project's first phase, HRL updated design kits to support several computer-aided design (CAD) tools, supported multi-project waver runs, and reduced overall fabrication cycle time to support U.S. military users. ←

This contract modification brings the total value of the MGM contract to HRL to \$18.8 million.

HRL experts will do the work in Malibu, Calif., and should be finished by September 2022.

For more information contact HRL Laboratories online at www.hrl.com, or DARPA at www.darpa.mil.



The Joint Standoff Weapon (JSOW), shown above, will have a new secure radio data link from trusted computing experts at Raytheon Missiles & Defense.



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Raytheon to provide data link cryptography modernization for smart munitions

BY John Keller

PATUXENT RIVER NAS, Md. — U.S. Navy airborne weapons experts needed modernized cryptography for a tactical data link radio designed to keep smart munitions on target. They found their solution from the Raytheon Technologies Corp. Missiles & Defense segment in Tucson, Ariz.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a \$10.2 million order to Raytheon for the cryptographic modernization of the Tactical Air Command Network 1.0 and 1.1 weapon data link radio for the Navy AGM-154C-1

Joint Standoff Weapon (JSOW).

Raytheon will provide non-recurring engineering for integrating the modified Cryptographic Modernization Tactical Air Command Network 1.0 data link radio onto the AGM-154C-1 missile.

The AGM-154 JSOW is a medium range precision guided glide bomb to attack defended targets from outside the range of standard anti-aircraft defenses.

The Collins Aerospace segment of Raytheon Technologies in Cedar Rapids, Iowa, designs and manufactures the TacNet weapon data link to make

guided weapons into network-enabled weapons. The weapon data radio provides weapon tracking, fire control, and situational awareness.

The Collins Aerospace TacNet uses industry-standard interfaces to reduce integration and life cycle costs, as well as advanced NSA Type 1 programmable crypto to adapt to future threats. ◀

On this order Raytheon will do the work in Tucson, Ariz., and should be finished by August 2022. For more information contact Raytheon Missiles & Defense online at www.rtx.com.

Air Force eyes improved electronic intelligence processing enabling technologies

The U.S. Air Force is looking for new ways to process electronic intelligence signals used to detect threats in support of its reconnaissance platforms, according to a broad agency announcement (BAA) published last month. This research will help the Air Force find ways to keep up with increased complexity and volume of the electronic intelligence battlespace and improve intelligence gathering. The BAA asks for high-risk research related to threat detection and prosecution at the Air Force Research Lab's Information Directorate in Rome, N.Y. The Air Force is looking for new methods for signal processing. Researchers are looking for technology that are hard-

ware-agnostic and have unlimited data rights. The Air Force needs technologies that demonstrate automated, real-time signal detection, processing, exploitation, and reporting capabilities.

Northrop Grumman to develop secure, jam-resistant ESS military SATCOM spacecraft

Northrop Grumman Corp. received a \$298 million contract to develop an anti-jam military satellite to supplement and eventually replace the existing Advanced Extremely High Frequency (AEHF) satellites made by Lockheed Martin. The Space and Missile Systems Center announced the contract award Sept. 16 for the Evolved Strategic Satellite Communications program, known as Evolved Strategic SATCOM (ESS). The

satellite is to be completed by May 2025. The ESS program continues the strategic satellite communications (SATCOM) mission of the AEHF constellation — providing survivable, global, secure, protected, and jam-resistant communications for high-priority military operations and national command authorities. ESS satellites will interoperate with, and eventually replace, AEHF's mid-latitude system capability, extending communications capability to the North Polar region.

Six companies to start preliminary designs for Large Unmanned Surface Vehicle

The U.S. Navy has awarded contracts to six companies to take the first steps in determining what the

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Leidos is developing adaptive radar countermeasures for the L3Harris AN/ALQ-214A EW system aboard Navy F/A-18 carrier-based jet fighter-bombers.

Leidos to develop EW adaptive radar countermeasures software for Navy combat jets

BY John Keller

PATUXENT RIVER NAS, Md. — Electronic warfare (EW) experts at Leidos Inc. are developing ways to spoof adaptive radar, which uses digital technology to change its characteristics dynamically to adapt to changes in its environment.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a \$58.9 million order to Leidos in Reston, Va., to develop adaptive radar countermeasures hardware and software for the L3Harris AN/ALQ-214A EW system aboard Navy F/A-18 carrier-based jet fighter-bombers.

The Navy wants adaptive radar countermeasures capability for the AN/ALQ-214A to help F/A-18s survive in the presence of sophisticated enemy

radar-guided surface-to-air missiles. Adaptive radar is being designed to counter the effects of EW countermeasures and other RF interference.

Leidos experts have been developing adaptive radar countermeasures technologies for at least the last eight years. The company was among several U.S. defense companies to win contracts in March 2013 for the Adaptive Radar Countermeasures (ARC) program of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.

In January 2016, Leidos won a \$12.9 million follow-on contract for the DARPA ARC program. Leidos has been working with L3Harris Space & Airborne Systems segment in Clifton, N.J.,

on the ARC project. Leidos originally worked with Exelis Inc., which now is part of L3Harris.

In addition to Leidos, other DARPA ARC contractors include Vadum Inc. in Raleigh, N.C.; Helios Remote Sensing Systems Inc. in Rome, N.Y.; Michigan Tech Research Institute (MTRI) in Ann Arbor, Mich.; BAE Systems Electronic Systems in Merrimack, N.H.; and Systems and Technology Research (STR) in Woburn, Mass.

L3Harris has demonstrated Leidos software algorithms with an L3Harris EW hardware-in-the-loop test environment as an enhanced capability to electronically defend against emerging radar threats.

The goal of the DARPA ARC program has been to develop ways to counter adaptive radar threats quickly based on over-the-air observable signals.

Today's airborne EW systems are proficient at identifying analog radar systems that operate on fixed frequencies, experts say. Once they identify a hostile radar system, EW aircraft can apply a preprogrammed countermeasure technique. Yet the job of identifying modern digitally programmable radar variants using agile waveforms is becoming more difficult. Leidos and the other ARC contractors worked to enable systems to generate effective countermeasures automatically against new, unknown, or ambiguous radar signals in near real-time.

Key challenges to countering adaptive radar are how to isolate signals clearly amid hostile, friendly, and neutral signals; figuring out the threat the signal poses; and jamming the signal. Modern enemy radar systems, however, are becoming digitally programmable with unknown behaviors and agile waveform, so identifying and jamming them is becoming increasingly difficult.

Leidos has developed processing techniques and algorithms to counter adaptive radar threats through real-time analysis of the threat's over-the-air observable properties and behaviors.

The ARC program developed a closed-loop system with signal analysis and characterization, countermeasure synthesis, and countermeasure effectiveness assessment. The system not only can learn automatically to counter new radar threats, but also will enable human operators to command and receive feedback from the system.

It was among DARPA's original goals for the ARC program to develop software algorithms for existing or planned EW systems, such as the AN/ALQ-214A on the F/A-18. DARPA kicked-off the ARC program in mid-2012. ←

On this order Leidos will do the work in Arlington, Va.; Clifton, N.J.; Goleta, Calif.; St. Louis; Raleigh, N.C.; and Huntsville, Ala., and should be finished by February 2024. For more information contact Leidos online at www.leidos.com, L3Harris Space & Airborne Systems at www.l3harris.com/business-segments, or DARPA at www.darpa.mil/program/adaptive-radar-countermeasures.



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Applied Physical Sciences to enable wave-resistant unmanned ships

BY John Keller

ARLINGTON, Va. — U.S. military researchers needed enabling technologies to make it easier for military forces to cross oceans by using a system of connected unmanned surface vessels (USVs) that would act as trains across the seas. They found their solution from Applied Physical Sciences Corp. in Groton, Conn.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced a \$13.9 contract to Applied Physical Sciences for the Sea Train project. The potential value of the contract is as much as \$31.3 million.

This program seeks to enable extended transoceanic transit and long-range naval operations by capi-



Applied Physical Sciences will develop enabling technologies for the DARPA Sea Train, an unmanned convoy of unmanned surface ships that can withstand waves and high seas.

talizing on the efficiencies of a system of wave-resistant connected vessels using a distributed fleet of tactical unmanned ships.

The idea is to deploy lines of medium-sized unmanned ships that could help reduce the forces of waves. Sea trains could be formed by physically

connecting vessels loosely, or by sailing vessels in formations.

Sea Train has two technical areas: an integrated design of unmanned vessels; and a control and monitoring architecture to make the most of efficiencies.

Leaders of the U.S. Navy and Marine Corps are trying to shift from centralized operations on a few large manned surface ships to a distributed fleet of relatively small and low-risk vessels for safe ocean transit.

A key element of this operational shift is the growing application of unmanned surface ships for surveillance, logistics, electronic warfare (EW), expeditionary warfare, and offensive operations.

A key limitation of unmanned ships is their limited ranges because of the

Continued from page 8

service's Large Unmanned Surface Vehicle (LUSV) will look like. After adjusting its acquisition approach to adhere to congressional code, the Navy today announced \$42 million in contracts for LUSV studies, with Austal USA in Mobile, Ala.; Huntington Ingalls Industries in Newport News, Va.; Fincantieri Marinette Marine in Marinette, Wis.; Bollinger Shipyards in Lockport, La.; Lockheed Martin Corp. in Bethesda, Md.; and Gibbs & Cox Maritime Solutions in Arlington, Va. Each contractor won about \$7 million to kick off work on the program. The Navy anticipates the companies finishing the work

by August 2021, but options could extend the work to May 2022. The contracts' total value with options is \$59.5 million. The LUSV studies will refine requirements, explore alternative design approaches, find ways to improve reliability, and plan for electronics, electrical and mechanical systems.

AMERGINT eyes acquisition of space-based optics business from Raytheon Technologies

AMERGINT Technologies, Inc. in Colorado Springs, Colo., has completed the purchase of the Collins Aerospace space-based optics business from Raytheon Technologies

Corp. C4ISRnet reports. The newly acquired business, which provides electro-optical systems for the U.S. Defense Department, will be renamed Danbury Mission Technologies. The acquisition was one of the major divestitures required by the U.S. Department of Justice when it approved the merger of defense contracting giants United Technologies Corp. and Raytheon in March. Along with the space-based optics business, the government mandated Raytheon Technologies sell its military airborne radios business and UTC's military GPS business. The terms of the AMERGINT deal were not disclosed.

effects of large ocean waves on medium-sized vessels. At-sea refueling, heavy-lift ships, strategic airlift, and increased overall vessel size all are solutions to this limitation, but are vulnerable to enemy submarines, surface warships, and combat aircraft.

The first technical area of the Sea Train project involves developing an integrated design composed of a hull form, hull connector, propulsion, and gap mitigation between the vessels. The second technical area involves developing a control architecture to monitor environmental conditions; handle multi-vessel alignment, spacing, and structural loads.

The project has three potential approaches: a connected sea train; a connectorless sea train; and a formation sea train.

The connected sea train has a physical connection between four or more vessels during transit to form a long parallel mid-body for the vessel to decrease the vulnerability to waves, while enabling the vessels to disconnect from time to time to conduct tactical missions.

The connectorless sea train uses compressive forces to keep four or more vessels together in a long parallel mid-body for the vessel to decrease the vulnerability to waves, while enabling the vessels to disconnect to conduct tactical missions.

The formation sea train involves four or more vessels moving together in groups formed closely front and back, and side to side, to exploit wave interference between the vessels.

DARPA researchers discourage the use of drag-reduction technologies, such as polymer injection; energy creation, harvesting, or storage technologies; systems that require fuels other than marine diesel systems that

require human intervention during connecting and disconnecting; nuclear power and propulsion; and systems that experiment using live animals.

Sea Train sensors should include techniques that perceive sea conditions for path planning and route optimization identify vessel spacing and

orientation identify structural loads; handle vessel autonomy; and decision algorithms for propulsion and fuel consumption. ←

For more information contact Applied Physical Sciences, a General Dynamics company, online at www.aphysci.com, or DARPA at www.darpa.mil.



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Enabling technologies for port and harbor security

Blending electro-optical sensors, radar, sonar, unmanned vehicles, and good old-fashioned human patrolling represent the latest approaches to keeping the nation's waterways safe from terrorism, spying, and sabotage.

BY J.R. Wilson

The United States has always depended on water transport to import, export, and distribute goods. As the nation expanded from 13 East Coast colonies to a nation ranging from Maine and the

U.S. Virgin Islands in the East to Alaska and Guam in the West, the movement of goods by ocean and rivers became even more important — and remains so to this day.

America has 25,000 miles of navigable rivers, 159 ports responsible for moving more than 99 percent of annual U.S. import/export goods and 1,500 harbors (all ports are harbors, but only a fraction of harbors are ports). These cover a distance of roughly 9,500 miles East to West and 3,000 miles North to South — or 28,500,000 square miles.

Given the size of the area that encompasses the nation's ocean waters, rivers, lakes, ports, and harbors — and their importance to the U.S.

Editor's note: J.R. Wilson, our Western bureau chief, has been hospitalized for an emergency medical condition, and is not physically able to write this month's special report feature on border and perimeter security. Instead, we are reprinting J.R. Wilson's 2019 feature on enabling technologies for port, harbor, and river security. We wish J.R. Wilson a speedy recovery.

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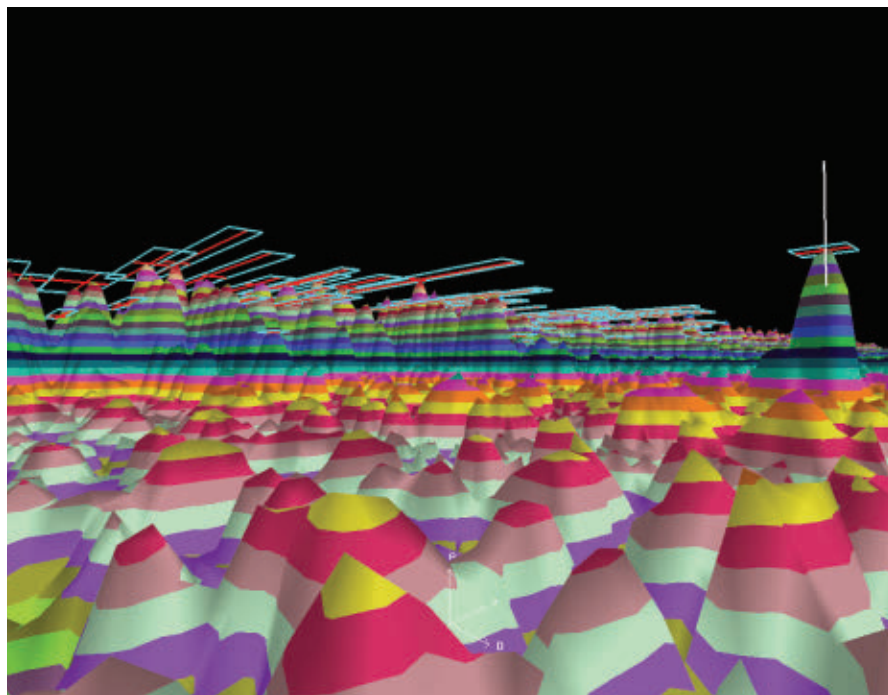
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The Blighter C400 series coastal security radar has a built-in sea clutter filter to adapt automatically to changing sea states and wave conditions to remove the unwanted radar signals produced by waves using both velocity (speed) and amplitude (height) characteristics.

economy — maintaining their security and continued operations is one of the largest tasks facing America's national security network — especially in an era of increasing terrorist attacks.

Because many of these waterways, such as the Great Lakes, Gulf of Mexico,

and the Caribbean also border Canada and Mexico, this effort requires international cooperation and coordination.

Leading the U.S. security system for navigable waterways, ports, and harbors is the U.S. Coast Guard, which is the 12th largest naval force and 7th



The Blighter C400 series radar can detect a small wooden boat, panga, or dory with a radar cross-section of one square meter at ranges as far as 6.8 miles, day and night, in heavy rain, dense fog, or even rough seas.

largest naval air force in the world. Although it is one of the nation's seven uniformed services, it is part of the U.S. Department of Homeland Security, not the U.S. Department of Defense (DOD). Portions of the Coast Guard, however, can be assigned temporarily to DOD, under the U.S. Navy, in wartime or for special assignments, such as anti-piracy patrols around Africa.

"The Coast Guard has a mandate for providing maritime security and has a research and development center in Groton, Conn.," points out Lt. Cmdr. Blair Sweiggart, chief of the Coast Guard's enforcement division in the Puget Sound, Wash., sector.

Coast Guard concerns

Among the Coast Guard's chief national security concerns is identifying and tracking small boats and so-called "dark" vessels — those that operate without radar transponders, or that disable transponders by reporting false identities or locations. "For the last two years, we have been working with our counterparts throughout DHS, as well as the Royal Canadian Mounted Police, looking at radar contact on small and dark vessel detection, Sweiggart says.

"We've been most focused at Puget Sound on a shared radar feed providing maritime situational awareness. It allows us to identify and track small and non-admitting vessels. In this region, we routinely see more than 30,000 vessels crossing a year between the U.S. and Canada, the vast majority of which are legal and completely authorized. But a lot of illicit activity in this region is designed to blend into legitimate activity, so we need better ways to identify activity that may be illegal."

Rapidly evolving technology has become a critical force multiplier; unmanned aircraft, surface vessels,

and submarines and short-range surface-search radars can provide 24/7 on-site physical data to high-speed processors incorporating machine learning that alert human security personnel to confirmed or potential problems.

Such systems are just being deployed or still in testing, but their influence already is being seen. “What we’ve already seen, on our radar system, is enhancing our maritime situational awareness allows us to be smarter about where we deploy our manned resources, which serves as a force multiplier,” Sweiggart says. “From a security standpoint, we can retain the required level of awareness while keeping our manned assets in garrison or using them for other missions. Any waterway is exploitable. We certainly see that along the maritime border here, where we have about 135 miles of border, over much of which no one agency has the manpower to have constant access.”

Technology is the key enabler to maintain situational awareness. “That is true throughout the ports and harbors in this region, which comes down to really good partnerships,” Sweiggart continues. “Those waterways also are where some softer targets are, such as the Washington State Ferry System, which is the largest ferry system in the world. Working with our partners, using risk-based modeling and coordinated schedules and facilities, allows us to more efficiently counter those threats.”

International concern

Waterway security is an international concern, with some of the leading security system and equipment providers located in Europe, the Middle East, and Asia. One such is Blighter Surveillance Systems in Great Chesterford, England, which produces elec-

tronic-scanning (e-scan) ground radar systems for counter-drone, perimeter security, wide-area surveillance and coastline security applications.

Blighter Chief Technology Officer Mark Radford says his company’s radars look for small, slow-moving targets, while traditional coastal radars typically scan for larger boats and ships further from shore.

“[Blighter uses] Doppler radars, so they detect the movement of objects; they also are frequency-modulated, continuous wave, which allows us to detect targets at very short ranges, as close as 10 meters,” Radford explains. “Traditional radars are blind for up to 500 meters, some up to seven kilometers. Our short range means we can detect a small boat that may have a radar cross-section as small as one



Mark Radford, co-founder and CTO at Blighter Surveillance Systems

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Sailors assigned to Coastal Riverine Squadron 3 Mark VI patrol boats are underway during high value asset security exercise as part of unit level training conducted by the Coastal Riverine Group 1 training evaluation unit.

square meter. We can detect it close to the shore and when the occupants get out and start walking on the beach, we can continue to follow them.

Other technologies help give the Blighter radar a tight focus on close-in vessels. "As with all radars, they need to be placed on towers or high hills," Radford says. "That creates a 'shadow'

area, a blind spot close to the radars. We solved that by using a shadow boost technology, which boosts the short-range capability to detect targets within that shadow area."

Ku band radars provide an all-weather, day/night capability and typically pair with long-range daylight cameras and thermal imaging cam-

eras at night. Blighter's system, originally was designed as a ground radar, then modified for use over water, also can detect low-flying UAVs, especially in a cluttered environment.

"It is key to integrate with sonar systems to cover underwater activities," Radford points out. "For instance, in South Korea, we have more than 100 of our units along the DMZ, most on land, but also along islands just offshore that the DMZ extends to. With that, we have been able to detect swimmers coming from North Korea."

Blending information from several different sensors key be key in harbor and waterway security. "Today's primary port, harbor and river security technologies are radars, cameras, thermal imagers and sonar, a combination of electromagnetic and acoustic spectrums," Radford explains. "With a port or perimeter area, you also would have a [physical] wall or fence line. All of the sensor systems ultimately link into a command and control center that allows you to set up alert zones on the mapping system."

Enhancements to all of those, along with the deployment of new or advanced technologies still under development, will improve coastal and river security significantly in the next five years, he adds.

Blending sensors

"The key driver we're seeing is the move from individual single-function sensors, such as coastal protection or ground radars, and combining them into one radar system. We can now do mixed sea and ground sensing, as well as low-flying UAVs, which have changed the challenge from 2D to 3D," Radford says.

"UAVs often are used to do surveillance prior to making a major move.



The Blighter AUDS system combines electronic-scanning radar target detection, electro-optical (EO) tracking/classification, and directional RF inhibition capability.

The radar systems are being used to detect those, but are very costly and out of the reach of most potential users. But it is a trend I think we will see become more prevalent in years to come.”

Of the three waterway domains, many consider harbors — generally larger targets than developed ports — to be the most vulnerable to terrorist attacks. As natural formations, often used for centuries, they are more defined by the land enclosing them, making them more difficult to protect in a cost-effective manner. Natural curves in their environment create shadows and large areas that are unprotected because local authorities cannot afford the additional radars that would be required. Smaller, less expensive short-range radars can create a day/night, all-weather defense to enhance harbor protection significantly, especially when combined with other mechanisms, such as UUVs and electronic fences.

U.S. and allied installations overseas have been the targets of thousands of aggressive UAV operations in recent years. Officials say such incidents may be stand-alone efforts to

penetrate maritime and land defenses — or distractions supporting other illegal activities on or under water, in the air or on land.

“So your radar and sensor system needs to do more than one thing, not just tracking a drone in the air, but continuing to monitor water and land activities” Bligher’s Radford warns. “Short to medium range [radar] surveillance capabilities — looking out for low-flying drones, monitoring air, land and sea simultaneously — really need to be integrated with other system sensors to provide a complete situational awareness in all three domains.”

Other sensors include day/night, all-weather EO/IR (electro-optical/infrared) devices that automatically and continuously scan surrounding maritime and land zones for unauthorized activities. Their use in port and harbor security includes:

- creation of an over-water virtual fence to detect small boats and swimmers before they reach the port/harbor boundary;
- creation of an overland virtual fence to detect land intruders before they

reach the fence;

- observation of intruders detected by other means;
- identification and tracking of intruders and direction of security forces;
- scanning of waters within the port/harbor boundaries for unauthorized activities;
- surveillance of all ships and boats within the protected area; and
- surveillance of all land fences within the protected area

Arctic protection

A growing area of concern for the U.S. is the vast Arctic, where the U.S. Territorial Waters and Exclusive Economic Zone covers 1 million square miles. The value of this region includes:

- a \$3 billion economic impact on Alaska’s Arctic seafood industry;
- 90 billion barrels of undiscovered oil reserves and an estimated 30 percent of the world’s undiscovered natural gas; and
- \$1 trillion in rare earth minerals, which otherwise are located largely in countries with which the U.S. has tenuous relationships, such as China.



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The CONTOP TORNADO-ER provides a panoramic infrared image, automatic detection of moving maritime targets, and multi-target tracking capability, covering dense maritime areas and detecting swimmers at short ranges and vessels out to 12 kilometers.

There have been significant changes in the region since release of the 2013 Arctic Strategy, increasing security demands on U.S. capabilities already stretched thin and, in many cases, underdeveloped for the Arctic's harsh environment.

Although it has no border on the region, China has declared itself a "near-Arctic state" and the region, into which it is making more and more expeditions, a strategic priority. That includes being the origin or destination for 40 percent of the vessels that carried a million tons of goods — such as gas, oil, grain and coal — through the Northern Sea Route in 2017.

Russia, which is a major Arctic nation, also has been extremely active, building large icebreaker surface vessels at a faster rate than other nations and establishing six new military bases in the Arctic zone since 2013.

Its size and strategic position are major reasons for President Donald Trump's interest in the U.S. buying Greenland from Denmark, another of the eight Arctic Nations, which consist of Canada, Russia, Denmark, the U.S., Norway, Swe-

den, Iceland, and Finland. Becoming a U.S. territory would enable the development of additional security facilities and the placement of advanced technologies on the Eastern side of the Arctic.

Each of the Arctic Nations has been working hard to increase surveillance capabilities — especially underwater/under-ice — to defend and enhance their position in the region. For example, Canada, recognizing the importance of cross-domain situational awareness, has created the Canadian Arctic Underwater Sentinel Experimentation (CAUSE) project to investigate new technologies for wide area underwater and under-ice surveillance in the Canadian Arctic.

Norway and the U.S. recently signed a bilateral maritime arrangement calling for advanced maritime threat-response collaboration between the two countries to address a wide-ranging list of Arctic challenges.

New tactics

The threat to border security for the U.S. and Canada has led to new tactics and procedures designed to strengthen cooperation and lessen the restrictions on armed U.S. maritime operations on the Great Lakes established after the War of 1812. Under those restrictions, U.S. Coast Guardsmen boarding vessels along the water-line border had to disarm if the vessel drifted into Canadian waters. And U.S. vessels were restricted to one small (even by 1812 standards) cannon.

The Coast Guard considers one of the biggest successes for international border security to be the Ship Rider program, a joint effort between the U.S. and Canada that sends Coast Guard and RCMP officers to the DHS Federal Law Enforcement Training Center in South Carolina. On graduation, the RCMP officers are classified as U.S. law enforcement and Coast Guard personnel as Canadian. An RCMP vessel would have one such Coast Guardsman and three RCMP officers and, if operating in U.S. waters, would be considered a U.S. vessel, with the three Canadian officers carrying out the duties of U.S. Border Patrol officials. The same, in reverse, would be true for Coast Guard vessels in Canadian waters.

"That essentially erases what is the imaginary line in the water that could be easily exploited if we didn't have strong programs, such as Ship Rider, in effect on all navigable waterways between the two nations," the Coast Guard's Sweigart notes.

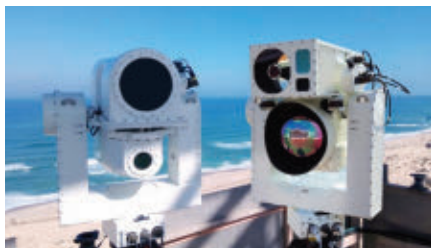
There is a much smaller maritime component in maintaining security along the Southern border, but

new technologies have greatly aided Coast Guard efforts in the Gulf of Mexico, Caribbean, and South Atlantic — especially coastal Florida and Puerto Rico.

The Coast Guard and its partner agencies will need to employ all of those — short-range over-water radar, UUVs, UAVs, USVs, and electronic fences — to counter the activities of criminal organizations that have them outfunded, outgunned and outnumbered.

The shared responsibility for security involves not only international partners, but U.S. federal, state and local agencies — and whatever technologies they may have to offer — as well. That includes the Customs and Border Patrol Air and Marine Operations (AMO), local sheriff offices and police departments, state patrols, port and harbor police and patrols, etc., as well as commercial port and industry partners.

With approximately 1,800 federal agents and mission support personnel, 240 aircraft and 300 marine vessels operating throughout the United States, Puerto Rico and the U.S. Virgin Islands, AMO is the world's largest civilian aviation and maritime law enforcement organization. It employs a variety of cutting edge technologies



The SPEED-ER is a long-range observation system that is cued to those targets which have been detected by the TORNADO-ER, enabling users to explore the targets and their contents, and providing highly accurate locational details.

to conduct its missions.

Larger ports, such as Seattle, Long Beach, San Diego, Miami, and New York, have significant security systems of their own, yet the sheer volume of vessels and goods moving through these facilities every week means their technologies must operate cooperatively with federal, state and local agencies to ensure the most comprehensive coverage to detect and curtail terrorist and criminal activities.

"The maritime transportation system is still the most prevalent method of moving goods and services in the world. Attacks are for political purposes, disruption, to incite fear, etc. For border security, it's a much more fundamental consideration that there is usually a [criminal] financial incentive to move things from one side of the border to the other — drugs, money, people, etc.," the Coast Guard's Sweiggart explains. "We see the involvement of organized groups and activity stemming from organized crime and cartels from around the world."

Port and harbor security can be difficult today, and is becoming more complex all the time. "The array of threats against the maritime domain is complex and different actors are looking to exploit different aspects," Sweiggart says. "Part of the role of all the partner agencies responsible for border security is to remain vigilant against that array of threats, continually assess what those threats are and come up with ways to counter them. We're certainly on the lookout for the domestic as well as international threat. As we all look at threats like active shooters, international groups coming with a specific attack versus domestic, typically lone wolf shooters, both are threats we have to be ready for." ◀

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Electronics cooling boosts capabilities to match performance upgrades

Enabling technologies for electronics and embedded computing thermal management are expanding, as systems designers demand higher performance, standards-based cooling, and reduced size and weight.

BY John Keller

Here's the good news: electronic and electro-optic subsystems for aerospace and defense applications progressively are becoming higher performance, smaller sized, and lighter weight. Now here's the bad news: all those benefits have a major system tradeoff: a growing amount of waste heat.

It's a fact of life that aerospace and defense systems designers can't escape: the higher the performance and the smaller the size, the greater the amount of heat that designers must confront. It's not as though electronic components can be designed econom-

ically that can tolerate huge amounts of heat. Instead, designers have to find ways to cool these ever-hotter electronic components, and they must do it affordably, and in small, lightweight packages.

"We are seeing higher heat densities year after year," points out Bryan Muzyka, manager of sales and marketing at Advanced Cooling Technologies Inc. in Lancaster, Pa. "The intelligence and defense contractors are trying to build electronic systems in smaller packages, so the waste heat is going up."

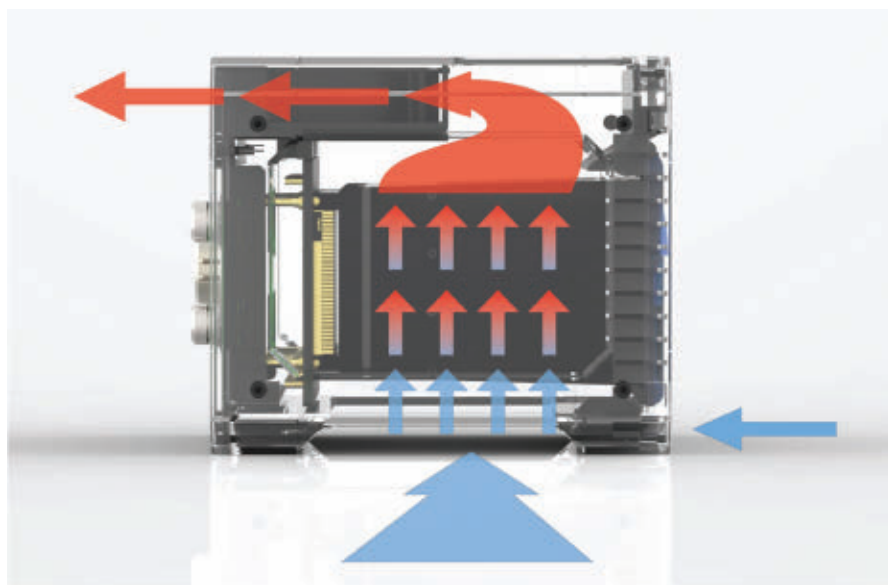
How to deal with waste heat in electronics can be as much of an art as it is a science. Designers have many options with which to attack the problem, ranging from industry-standard approaches to custom designs, depending on the customer's needs and budget. Almost always, however, the designer must strike a delicate balance among capability, ruggedness, component size and weight, and costs.

Essentially the challenge of electronics cooling and thermal management boils down to three choices: conduction cooling, air cooling, and liquid cooling. Each of these options varies in cost, complexity, and in the amount of heat they can eliminate.

Conduction cooling

Perhaps the most widespread and best-known thermal management approach for rugged aerospace and defense applications is conduction cooling. These systems typically are sealed against airborne contaminants like dust and salt spray, and conduct heat outward from hot components inside the chassis to cold walls or ambient outside air. It's relatively simple, reliable, and affordable, and has been a thermal management go-to for decades.

Conduction cooling often calls for wedge-lock devices along the edges



This illustration shows how VITA 48.8 air-flow-through cooling can increase heat dissipation in high-performance embedded computing.

of circuit cards to help transfer heat from the card, along rails, through the chassis, and eventually to the outside of the chassis where it is dissipated.

“Conduction cooling is by far the biggest cooling approach in terms of COTS hardware out there,” says Ivan Straznicky, chief technology officer of advanced packaging at the Curtiss-Wright Corp. Defense Solutions segment in Ashburn, Va. “Still, as power goes up, it becomes more difficult for conduction-cooled modules to handle cooling.”

Despite increasing power consumption in embedded cooling, designers won’t be writing-off conduction cooling any time soon. For many applications, its capacity to control system temperatures is perfectly adequate, and systems designers are finding new ways to stretch the limits of conduction cooling in increasingly hot systems.

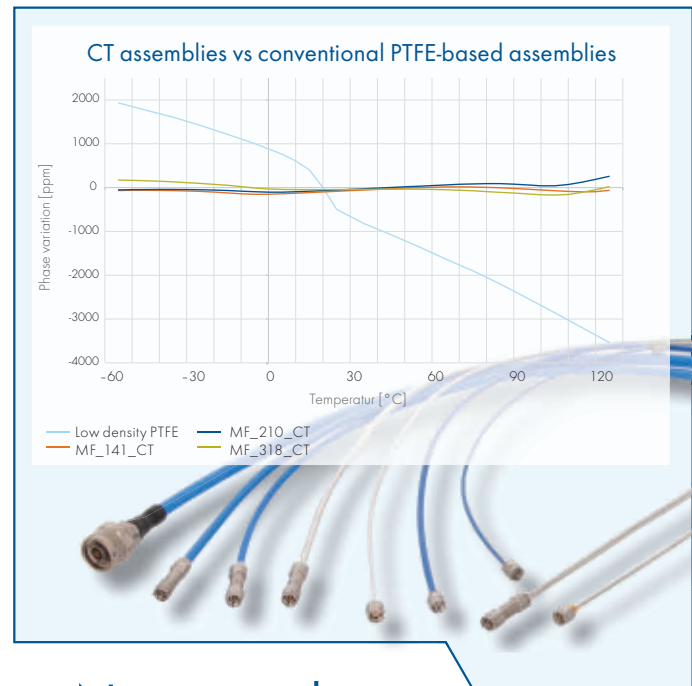
Curtiss-Wright’s Straznicky, for example, says his company is using conduction cooling for embedded computing modules today that dissipate as much as 200 Watts of waste heat, whereas only a few years ago conduction cooling reliably could remove perhaps half that amount of heat.

Other designers have similar experiences. “Four years ago we looked at 80 Watts for a 3U conduction-cooled card, and now we are up to 100 Watts,” says Brian Hoden, principal mechanical engineer at Abaco Systems in Huntsville, Ala. “We are pushing the limitations in traditional conduction cooling.”

Among the reasons for the enduring popularity of conduction cooling are relatively low costs and its inherent



Curtiss-Wright’s Air-Flow-Through (AFT) cooling technology can dissipate more than 100 Watts per 3U OpenVPX slot.

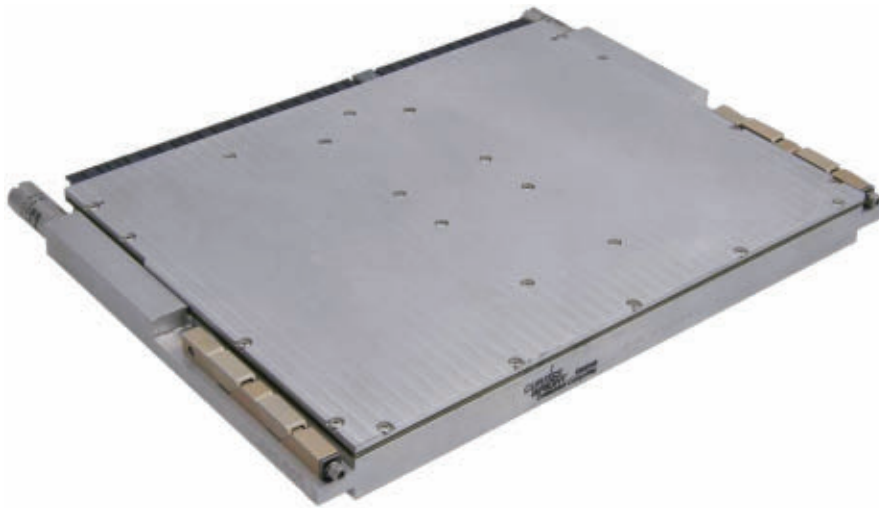


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The VITA 48.8 thermal management design approach enabled avionics engineers at the Lockheed Martin Corp. Rotary and Mission Systems segment in Owego, N.Y., to reduce the size and bulk of the avionics computer aboard the Lockheed Martin Sikorsky S-97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

rugged design. Conduction cooling has no moving parts, as opposed to air and liquid cooling. No moving parts means fewer parts at risk of failure, and the card-edge wedge locks that go along with conduction cooling can protect sensitive electronics from the ill effects of shock and vibration.

One well-known and often-followed open-systems industry standard for embedded computing conduction cooling is the VITA 48.2 standard, set forward by the VITA Open Standards,

Open Markets trade organization in Oklahoma City (formerly the VME International Trade Association).

VITA 48.2 applies to 3U and 6U VPX embedded computing modules, and defines the dimensions of plug-in units for conduction-cooled applications and connector-mounting details, as well as key sub-rack interfaces, to facilitate two-level maintenance and interoperability among different vendors.

A big part of pushing the limitations of conduction cooling lies in the innovation that VITA 48.2 allows, says Curtiss-Wright's Straznicki. "It is in the interfaces, but on top of the module, where you can do some things to improve your cooling, such as different cooling materials to improve the thermal interface between the electronics and the frame."

Much of this type of technology innovation, however, remains proprietary to the companies doing the design work, and so cannot be described in detail.

Much of the innovation in conduction cooling, however, involves the card wedge lock, says Abaco's Hoden.

"The wedge lock is an area where we have put a lot of work into for conduction-cooled cards; we have our own wedge lock design," he says. "The card-to-chassis interface is really neglected in our industry, but represents one of the biggest temperature rises in an electronic chassis."

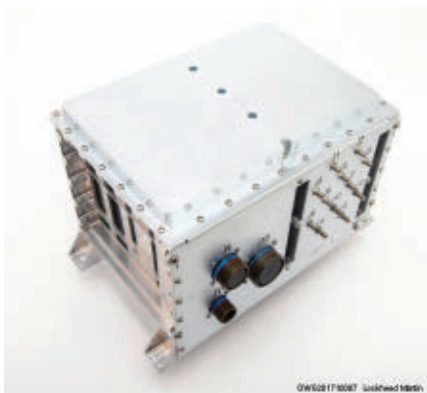
Air cooling

Another common and effective thermal management technique involves using moving air to transfer heat away from sensitive components. This can be as simple as using an internal fan to blow air over hot components, much like people see in laptop or desktop PCs.

While air cooling is relatively inexpensive, however, this approach presents several challenges to the aerospace and defense systems designer — chief among them being reliability. Cooling fans are mission-critical moving parts that can fail at the worst possible time, as many designers have found. Plus, moving air can introduce contaminants like dust and corrosive vapor into the system, which can cause their own problems.

These potential problems with ruggedness and reliability have given rise to new and innovative standard approaches, primarily through the VITA standards organization. Chief among these is VITA 48.8, otherwise known as Air Flow-Through (AFT) cooling for VPX embedded computing designs.

VITA 48.8 is for advanced air-flow-through cooling in high-performance embedded computing and RF and microwave such as military avionics. It describes an approved approach to designing with air-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



This Curtiss-Wright Liquid-Flow-Through (LFT) OpenVPX module is capable of cooling 650 Watts.



This lightweight custom-designed small-form-factor embedded computing chassis from Abaco Systems offers internal air cooling similar to VITA 48.8.

systems by eliminating wedge locks and ejector handles.

The standard permits air inlets at both card edges, as well as on the top circuit card edge opposite the VPX con-

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

Put in practice, 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.

VITA 48.8 improves the efficiency of the thermal path to cool high-performance processors, field-programmable gate arrays (FPGAs), general-purpose graphics processing units (GPGPUs), and other hot components. Unlike tradition air cooling, the standard specifies gasketing to prevent particulate contamination from the moving air.

"This is a big deal because you don't



This commercial off-the-shelf (COTS) rugged embedded computing chassis from Abaco systems is cold-plate cooled.

need wedge locks with VITA 48.8; you use jackscrews," says Abaco's Hoden. "It is still rugged, but you can remove the card with the jackscrews, and is a way of locking-down the card against vibration. You don't need an ejector handle like you do with wedge locks."

The primary design tradeoff of AFT cooling is the need to provide moving

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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>

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>

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Extreme Engineering Solutions (X-ES) Inc.

Verona, Wis.
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air. "Compared to conduction cooling, you need an air source," Hoden points out. "You get better performance with an air-cooled chassis than you do with conduction cooling, but you need an external fan to cool it."

A big advantage to VITA 48.8 is its utility with 6U- and 3U-sized circuit cards, points out Curtiss-Wright's Straznicki. "Air flow through enables you to cool more, and is quite effective for 3U, because you have a short span to blow the air. You can get up to 150 Watts of cooling per module on 3U, and up to 250 Watts for 6U."

Liquid cooling

Just five years ago the notion of liquid cooling for high-performance embedded computing was considered impossible for all but the most demanding and expensive applications. Now liquid cooling is approaching the mainstream.

VITA 48.4 "is a big step in cooling," says Curtiss-Wright's Straznicki. "It took a decade for liquid flow through to gain traction in the COTS world. Now there are several programs using liquid flow through, and we have several

competitors doing the same."

VITA 48.4 liquid cooling does introduce system complexity and cost, but makes up for it with its ability to cool hot high-performance embedded systems. "At some point you take heat away from the modules with liquid, but then that liquid needs to be cooled down, so somewhere in the system you need a liquid heat exchanger," Straznicki says.

It's all about getting cooling liquid to sources of the heat, says Abaco's Hoden. "Liquid cooling allows you to get the liquid down to the hot spots on a board, and that helps immensely. With liquid you have a lot of options. Liquid flow through will be something we will see a lot more of in the future."

ACT offers a cooling technology its engineers call Pumped Two Phase (P2P) Cooling, also known as Pumped Evaporative Cooling, which is active cooling that uses the latent energy of boiling liquid to remove high levels of waste heat efficiently.

Compared with single-phase cooling P2P helps lower liquid flow rate, and reduce system size and power

consumption. P2P systems allows the working fluid, typically a refrigerant, to boil as it passes through the cold plate and removes the heat from the hot surface of the device. this approach removes more heat than single-phase cooling, which does not allow the cooling liquid to boil, ACT's Muzyka explains. "The more heat flow, the better your cooling," Muzyka says. "But the more heat flow, the hotter your fluid becomes."

ACT also offers a single-phase liquid cooling approach called Pump 2, in which the liquid also boils, but contains the boiling liquid within the flow lines "The advantage of boiling is higher heat loads without failing your electronics. All your components run at a very uniform temperature, and we can have smaller pumps and smaller flow rates to enhance SWaP [size, weight, and power consumption]. We are providing the full system: the cold plates, the pumps, and the heat sinks packaged together."

The SOSA standard

One of the most influential open-systems embedded computing standards

in years is the Sensor Open Systems Architecture (SOSA), which offers component interoperability, rapid innovation, quick technology insertion, reduced costs to the taxpayer, and the ability for defense systems to keep up with the cutting edge of commercial computer technology.

SOSA borrows heavily from the VITA OpenVPX standards, and has gained industry appeal by winnowing-down the large number of standards outlined in OpenVPX to a relatively small number manageable to the military.

Among the OpenVPX standards that are becoming part of SOSA are the VITA 48.2 specification for VPX microcomputers using conduction cooling; the VITA 48.4 specification for using VPX liquid flow through cooling; and the VITA 48.8 specification for using VPX

air flow through cooling.

“SOSA starts with VITA 48.2, which is conduction cooling for both 6U and 3U cards,” says Curtiss-Wright’s Straznicki. “The two others that have been accepted into SOSA are VITA 48.8 air flow through, and VITA 48.4 liquid cooling.”

It’s widely expected in the embedded computing industry that SOSA standards will be requirements in the future for aerospace and defense electronics. If companies already are offering VITA 48.2-, VITA 48.4-, or VITA 48.8-compatible products, then they will have at least part of the SOSA requirements checked-off in future procurements.

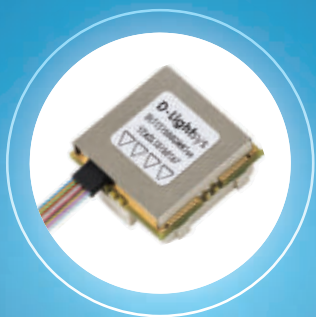
“We are looking at VITA 48.4,” says Abaco’s Hoden. There is some interest in this, especially in SOSA, so we

have cards that are aligned to the SOSA guidelines.”

Not only have the military services voiced their support for SOSA, but each service sends representatives to SOSA standards-formation committees. This gives the military a voice, side-by-side with industry, in how SOSA standards develop.

Many consider SOSA to be the most dominant and influential of these standards not only because of its military-wide support, but also because its administration comes under The Open Group in San Francisco — an industry consortium in place to promote open, vendor-neutral technology standards and certifications. Until SOSA, the latest standards typically have been military service-specific or platform-specific initiatives. ←

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Public-private partnership to launch eLORAN technology to back-up and accompany GPS

BY **Jamie Whitney**

MIDDLEBURG, Va.— Global Navigation Satellite Systems (GNSS) like the Global Positioning System (GPS) and its comparable GNSS systems have revolutionized the way both the military and civilians get from “point a” to “point b.”

While the space-based navigation systems put into orbit by the United States, Russia, China, the EU, India, and Japan were once thought to be relatively safe from harm by opposing

nations, militaries have since shown the ability to shoot down satellites in addition to jamming signals terrestrially. In fact, India joined the U.S., China, and Russia just last year in shooting down one of its own satellites.

“It’s as significant as India’s first nuclear blast,” Saurav Jha, the editor in chief of the Delhi Defense Review, told the New York Times in March 2019. “The militarization of space is underway, whether anybody likes it or not.”

Should GPS be taken offline or somehow interfered by a nefarious actor, the U.S. Department of Defense (DOD) would have to look to its past to ensure navigation, location, and timing functions stay online.

Thanks to a public-private partnership, a much-improved version of a technology that was birthed during World War II can complement GPS and act as a back-up if needed.

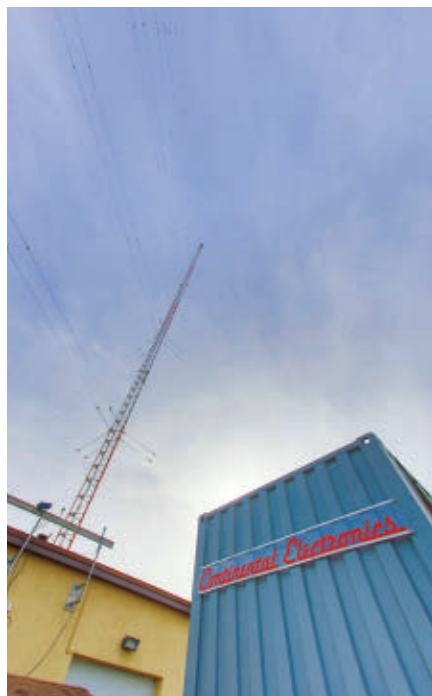
LORAN - or, LOnG RANGE Navigation - got its start during World War II and utilized low-frequency hyperbolic radio navigation to keep convoys on the move across the Atlantic and to aid pilots and ships in the Pacific Theater. This was done by figuring out how long it took to transmit between the “master” radio transmitter and the signal at the second station.

In the intervening years, the

United States Coast Guard took over an improved system, dubbed LORAN-C, starting in 1958. In 2009, amidst the Great Recession, President Barack Obama declared the LORAN program obsolete and announced plans to terminate it. In 2010, the U.S. Coast Guard began shutting down the system.

Just five years later, the U.S. House of Representatives reopened discussions of an enhanced version of LORAN -eLORAN. In 2018, President Donald Trump signed into law the National Timing Resilience and Security Act, as part of the Frank LoBiondo Coast Guard Authorization Act, which mandates the Secretary of Transportation to establish and sustain a land-based timing system to provide a back-up to GPS, namely “to ensure the availability of uncorrupted and non-degraded timing signals for military and civilian users in the event that GPS timing signals are corrupted, degraded, unreliable, or otherwise unavailable.” This law was co-sponsored by Sen. Ted Cruz (R-Texas) and Sen. Ed Markey (D-Mass.) in the Senate and U.S. Rep. John Garamendi (D-Calif.) and U.S. Rep. Duncan Hunter (R-Calif.) in the House.

Bridge Littleton and Daniel Olmes, co-founders and co-presidents of Hel-len Systems, based in Middleburg, Va.,



U.S. military and transportation experts are considering eLORAN to augment GPS in areas where navigation is difficult.

spoke about the efforts their company and public/private partners have made to launch eLORAN.

“Our focus was really building a world-class team to then be able to go and deploy this system through a future partnership with the U.S. government and put the system back on air,” said Hellen’s Littleton. “What we are really focused on is helping the government reconstitute and deploy eLORAN as a resilient co-primary, independent backup for GPS.”

Beyond GPS

Both civilian and military consumers utilize GPS via myriad devices, but as noted, the SATCOM system is vulnerable to interference.

“It’s wonderful,” Littleton says of GPS. “It’s just got this one weakness - it’s 12,000 miles in space. That’s just what it’s going to be. So, what is great about eLORAN is there are no common failure modes between GPS and eLORAN. GPS is space based, eLORAN is terrestrial based. GPS is high frequency, eLORAN is low frequency — it’s 90 to 110 kilohertz. GPS is low power; eLORAN is high power. GPS can’t penetrate buildings and go indoors, eLORAN can because it’s a low frequency wave and its high power. It can penetrate through buildings, can go underground, can go through tunnels, can go under water and is unaffected by space phenomenon.”

According to Littleton and Olmes, the eLORAN signals are three to five million times stronger than GPS/GNSS and have 99.999% availability and reliability. Each tower has a 1,200-mile signal range. Its spectrum of 90-110 kHz is internationally protected, and eLORAN is deployable, so military branches can set up the system at their bases around the world.

For the eLORAN system to cover the contiguous United States, six towers are needed for timing applications and 19 are need for position and navigation.

In addition to positioning, navigation, and timing, the LORAN Data Channel (LDC) acts as a channel within eLORAN and enables one-way data communication over 1,200 miles, with nearly 100% of its strength at that distance. The LCD features include time of day and clock corrections; encrypted, mission specific data messaging/SW updates; authentication of eLORAN broadcasts (anti spoofing); secure, un-jammable command and control; and penetrates all structures in all weather conditions.

Partnering with the United States federal government and Hellen Systems to develop eLORAN is L3Harris Technol-

ogies in Melbourne, Fla.; Microchip Technologies in Chandler, Ariz., Continental Electronics Corporation in Dallas; and NeoTech Natel Epic OnCore in Chatsworth, Calif.

L3Harris is acting as the eLORAN system integrator; Microchip is providing frequency and timing engineering expertise and system hardware solutions; Continental Electronics is providing eLORAN transmitters; and NeoTech is providing eLORAN contract manufacturing services.

In addition, Booz Allen Hamilton in McLean, Va., is providing management services and cyber security as well as adoption integration, and Crown Consulting Inc., in Arlington, Va., is providing training and operation support.

It is envisioned that eLORAN could be a subscription service much like the Automatic Dependent Surveillance-Broadcast (ADS-B) system utilized by the Federal Aviation Administration. ◀

To learn more about the eLORAN system and the public/private partnership, please visit <https://hellensystems.com/>, or contact Hellen Systems by visiting <https://hellensystems.com/contact/>.



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Boeing eyes MUOS SATCOM to improve communications aboard P-8A reconnaissance plane

BY John Keller

PATUXENT RIVER NAS, Md. — U.S. Navy aerial surveillance experts are asking the Boeing Co. to determine the feasibility of integrating the new Mobile User Objective System (MUOS) satellite communications (SATCOM) system aboard the P-8A Poseidon maritime patrol aircraft.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced their intention to award a sole-source delivery order to the Boeing Defense, Space & Security segment in Seattle to investigate MUOS integration aboard the P-8.

The value of the upcoming contract to Boeing has yet to be negotiated. Contract award is expected in early 2021.

MUOS is a UHF communications system that operates at frequencies from 300 MHz to 3 GHz and will replace the legacy UHF Follow-On (UFO) system before that system reaches its end of life. MUOS is intended to provide mobile users with new capabilities and enhanced mobility, access, capacity,

and quality of service.

Boeing, the P-8 designer, will conduct a technical study to determine the feasibility of installing MUOS capability on dual SATCOM channels on the P-8A, while maintaining legacy voice, Link-11, and DAMA/DAMA-IW SATCOM with the current UHF 5 and UHF 6 radio suite on the P-8.

Boeing also will determine if the Multifunctional Information Distribution System (MIDS) Tactical Air Navigation System (TACAN) would be compatible with a MUOS installation aboard the P-8A.

The MUOS operates as a global cellular service provider to support the warfighter with modern cell phone-like capabilities such as multimedia.

It converts a commercial 3G wide-band code division multiple access (WCDMA) cellular phone system to a military UHF SATCOM radio system using geosynchronous satellites in place of cell towers. Operating in UHF

enables warfighters to communicate in difficult areas like forests where trees could attenuate relatively high-frequency signals.

The P-8A is a militarized version of the Boeing 737 single-aisle jetliner hardened for long-range maritime patrol and anti-submarine warfare (ASW) missions. The P-8 is replacing the Lockheed Martin P-3 Orion maritime patrol turboprop aircraft.

Ultimately, the Navy plans to buy 108 P-8A aircraft from Boeing to replace the service's fleet of 196 P-3C Orion maritime patrol aircraft, which are approaching the end of operational life. The P-3 is a version of the Lockheed Martin Electra four-engine turboprop aircraft.

The plane's flight management system and the stores management system have been developed by GE Aviation Systems in Grand Rapids, Mich. The cabin has as many as seven operator consoles.

The Poseidon's MX-20HD digital electro-optical and infrared (EO/IR) multi-spectral sensor turrets come from L-3 Communications Wescam in Burlington, Ontario. The MX-20HD is gyro-stabilized and can have as many as seven sensors, including infrared, CCDTV, image intensifier, laser range-finder, and laser illuminator. ◀



Does the Navy P-8A reconnaissance plane need MUOS satellite communications? Boeing is about to find out.

The P-8A will have the CAE Inc. advanced integrated magnetic anomaly detection (MAD) system. The Navy plans to arm the P-8A with the MK 54 torpedo. For more information contact Boeing Defense, Space & Security online at www.boeing.com, or Naval Air Systems Command at www.navy.mil.



Belgium will receive four MQ-9B SkyGuardian medium-sized unmanned aircraft from manufacturer General Atomics, as well as ground-control stations and sensor payloads.

General Atomics to build MA-9B SkyGuardian UAVs, ground stations, and sensor payloads

BY John Keller

WRIGHT-PATTERSON AFB, Ohio — Unmanned aerial vehicle (UAV) designers at General Atomics Aeronautical Systems Inc. in Poway, Calif., will build four MQ-9B SkyGuardian UAVs for Belgium under terms of a \$188.9 million contract.

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

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

type-certifiable system.

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

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

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

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

On this contract General Atomics will do the work in Poway, Calif., and should be finished by March 2024. For more information contact General Atomics Aeronautical Systems online at www.ga-asi.com, or the Air Force Life Cycle Management Center at www.afcmc.af.mil.

SRC to build counter-drone system to protect expeditionary forces from enemy UAVs

BY John Keller

REDSTONE ARSENAL, Ala. — U.S. Army counter-unmanned aircraft experts are asking Syracuse Research Corp. (SRC) in North Syracuse, N.Y., to build and deploy ruggedized counter-drone systems designed to destroy or disable enemy unmanned aerial vehicles (UAVs).

Officials of the Army Contracting Command at Redstone Arsenal, Ala., has announced a \$425.9 million five-year contract to SRC for development, production, deployment and support of the Expeditionary-Low, Slow, Small Unmanned Aircraft System Integrated Defeat System (E-LIDS).

E-LIDS will shield U.S. and allied expeditionary forces from UAV-based improvised explosive devices (IEDs), as well as from more sophisticated enemy use of UAVs to attack military forces or civilian targets with deliver explosives.

This is the second big contract within a week for vehicle-mount counter-UAV systems. Also last week the Leonardo DRS Land Systems segment in St. Louis won 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 detect, destroy, or disable small, inexpensive unmanned aerial vehicles (UAVs) like commercial quadcopters that are operating as airborne improvised explosive devices (IEDs).

SRC will design E-LIDS to counter enemy armed and intelligence gathering UAV's operating at various speeds and altitudes, which are targeting U.S.

military forces.

SRC has special expertise in counter-UAV systems, and offers the Silent Archer counter-UAS system, which detects, tracks, classifies, identifies, and disrupts low, slow, and small unmanned airborne threats, commonly referred to as drones.

SRC's Silent Archer combines radar and electronic warfare (EW) systems, a camera, and a 3-D user display to defeat hostile drones operating singly or in pairs, as well as in swarms.

Silent Archer first provides spatial, frequency, and optical surveillance capabilities to detect, track, classify and identify the airborne threat, and then applies low-cost electronic methods to disrupt the UAS, such as jamming the communications links between the operator and the aircraft, SRC officials say.

SRC's counter-UAV system is for force protection in contested envi-

ronments; critical infrastructure protection; security for VIPs and high profile events; and urban environment surveillance.

SRC experts have demonstrated the Silent Archer anti-drone system at U.S. government-sponsored counter-UAS test events like the Joint Integrated Air and Missile Defense Organization (JIAMDO) Black Dart counter-drone exercise at Eglin Air Force Base, Fla.; the Army Warfighting Assessment (AWA) technology assessments; Network Integration Evaluation (NIE) events; and Maneuvers and Fires Integrated Exercise (MFIEX) experiments at Fort Benning, Ga., SRC officials say.

Silent Archer comes in three different configurations: expeditionary for use on tactical combat vehicles; fixed site for use at permanent installations; and fly-away kit for quick-deployment use at overseas military operations.

The system's open architecture and sensor-agnostic design supports offers capabilities in direction finding; line-of-bearing information; and wireless networking for communicating among systems and command-and-control centers. ◀



The SRC E-LIDS (above) will shield U.S. and allied expeditionary forces from UAV-based improvised explosive devices (IEDs), as well as from more sophisticated enemy use of UAVs to attack military forces or civilian targets with explosives.

On this contract SRC will do the work at locations to be determined with each order, and should be finished by July 2025. For more information contact SRC online at www.srcinc.com, or the Army Contracting Command-Redstone Arsenal at <https://acc.army.mil/contractingcenters/acc-rsa/>.



The electro-optically guided Javelin anti-armor weapon is designed to destroy main battle tanks, armored personnel carriers, and other armored combat vehicles.

Army orders imaging infrared Javelin anti-armor missiles with tandem warheads

BY John Keller

REDSTONE ARSENAL, Ala. — Missiles experts at Lockheed Martin Corp. and Raytheon Technologies Corp., are building Javelin anti-tank missiles for the U.S. Army, Marine Corps, and Navy under terms of a \$47.2 million order.

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

The electro-optically guided Javelin anti-armor weapon is an infantry fire-and-forget missile with lock-on before launch and automatic self-guidance designed to destroy main battle tanks, armored per-

sonnel carriers, and other armored combat vehicles. The missile also is effective against buildings and enemy helicopters.

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

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

Raytheon produces the command launch unit, missile guidance elec-

tronic unit, and system software at the Raytheon Missiles & Defense segment in Tucson, Ariz. Lockheed Martin, meanwhile, produces the missile seeker and the electronic safe, arm, and fire electronic module in Ocala, Fla., and performs missile all-up-round assembly in Troy, Ala.

On this contract the Raytheon/Lockheed Martin Javelin Joint Venture will do the work in Tucson, Ariz., and should be finished by August 2023. ◀

For more information contact Raytheon at www.raytheonmissilesanddefense.com, or Lockheed Martin at www.lockheedmartin.com/en-us/products/javelin.html.

Raytheon picks SWIR camera from Quantum Imaging for tactical imaging applications

McKINNEY, Texas — Electro-optical surveillance experts at Raytheon Technologies needed a high-definition short-wave infrared (SWIR) camera for tactical imaging applications. They found their solution from Quantum Imaging Inc. in Colorado Springs, Colo.

Officials of the Raytheon Intelligence & Space segment in McKinney, Texas, have awarded a \$13.5 million order to Quantum Imaging for a high-definition SWIR camera for tactical imaging applications.

Quantum Imaging uses on-chip processing and offers resolution of 1280-by-1024-pixels. The camera is based on a sensor designed and manufactured by Quantum Imaging parent company SemiConductor Devices (SCD) in Misgav, Israel.

“Our strategy is to leverage SCD’s cutting-edge sensors to significantly improve the performance of imaging and night vision systems used for both military and commercial applications,” says Mark Fydenkevez, president and CEO of Quantum Imaging.

Raytheon engineers will apply Quantum Imaging SWIR cameras to

enhance a family of products that provides detailed intelligence data from the visual and infrared spectrum to support U.S. military, civilian and allied missions.

Quantum Imaging manufactures the QI-SWIR-HD10 miniaturized high-definition SWIR camera module that images in the spectral range of 0.5 to 1.7 microns. The camera uses an indium gallium arsenide (InGaAs) detector with 10-by-10-micron pixel pitch and integral antiblooming.

On-board correlated double sampling delivers a dynamic range in excess of 70dB with read noise of less than 40 rms electrons in cooled operation making it suitable for light-starved applications.

Available with 16 bit Camera-Link and analog NTSC output, the QI-SWIR-HD10 will run from 30 to 60 frames per second. Automatic gain and exposure control are available to optimize image quality over a large range of imaging conditions.

A proprietary non-uniformity correction NUC provides high quality imagery over -40 to 70 degrees Celsius operating conditions. The camera also operates either in a conventional



Raytheon Technologies will use a high-definition short-wave infrared (SWIR) camera from Quantum Imaging for tactical imaging applications.

SWIR imaging mode, or in asynchronous laser pulse detection (ALPD).

In ALPD mode, the detector serves as a two-dimensional sensor that can capture short-duration laser pulses and provide the x-y position of those pulses during the day and at night. ←

For more information contact Quantum Imaging online at <https://quantumimaging.com>, or Raytheon Intelligence & Space at www.raytheon.com.

U.S. intelligence to make broader use of commercial satellite photos

Starting in 1961, the National Reconnaissance Office has been designing, building, launching, and operating the U.S. fleet of satellites for intelligence imagery. Over the years, that mission has evolved, bolting on new components and missions. Now the NRO is looking to move beyond

the status quo by issuing new contracts late this year to reshape the intelligence community’s relationship with the commercial satellite remote sensing industry. NRO officials, however, say they don’t want any commercial imaging company to exist solely to support government requirements; there should be a real commercial market for

these capabilities, which will help drive down costs for the government. “I think the best philosophy that underpins that is one that says ‘We really are looking to buy everywhere we can and only build what we have to—what’s really not available on the commercial market,’” says Peter Muend, the head of NRO’s commercial imagery efforts.



COMMUNICATIONS

Navy chooses L3Harris to SATCOM terminals for ships, submarines, and shore sites

U.S. Navy communications experts needed a new satellite communications (SATCOM) modem for use aboard surface warships, submarines, and shore installations. They found their solution from L3Harris Technologies Inc.

Officials of the Naval Information Warfare Systems Command (NAVWAR) in San Diego have announced a \$47.6 million contract to the L3Harris Communications Systems-East segment in Camden, N.J., to develop and build the Navy Wideband Anti-Jam Modem (WAM).

The WAM is the Navy's next-generation wideband SATCOM modem that will integrate with the Navy Multiband Terminal (NMT) on ships and submarines, and with the Modernization of Enterprise Terminal (MET) on shore for communications over the Wideband Global SATCOM (WGS) satellite constellation.

The Navy may buy as many as 966 WAM production units over the lifetime of the program. This contract has options that could increase its value to \$83.1 million.

NAVWAR awarded the contract on behalf of the Navy's Program Executive Office (PEO) Command, Control, Communications, Computers and Intelligence (C4I) Communication and Global Positioning System Navigation Program Office (PMW/A 170) at Patuxent River Naval

Air Station, Md.

The Navy Raytheon NMT next-generation SATCOM system provide assured connectivity between a ship's or submarine's computer network and the Global Information Grid. The system is expected to be installed in about 300 U.S. Navy ships, submarines, and shore stations.

NMT will replace several existing SATCOM systems developed in the mid-1980s, and will provide naval commanders and sailors with greater data throughput and improved protection against enemy intercepts.

The U.S. Army L3Harris MET is replacing as many as 80 AN/GSC-52, AN/GSC-39, AN/FSC-78, and other aging strategic SATCOM terminals with new X- and Ka-band terminals to provide internet protocol and dedicated circuit connectivity within the Global Information Grid.

On this contract L3Harris will do the work in Salt Lake City; Camden, N.J.; Tempe, Ariz.; Hanover, Md.; San Diego; Bonita Springs, Fla.; and Chambersburg, Pa., and should be finished by August 2027. For more information contact L3Harris Communications Systems-East online at www2.l3t.com/cs-east, or Navy NAVWAR at www.public.navy.mil/navwar/Pages/default.aspx.

SENSORS

Lockheed Martin to install AN/AQS-22 dipping sonar aboard 39 ASW helicopters

Airborne anti-submarine warfare (ASW) experts at Lockheed Martin Corp. will install 39 AN/AQS-22 Airborne Low Frequency Sonar (ALFS) systems aboard U.S. Navy MH-60R helicopter under terms of a \$181.7 million order.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y., to install the Raytheon AN/AQS-22 ALFS on eight MH-60R helicopters for the Navy, 24 for India, and seven

for Denmark.

The AN/AQS-22 ALFS is the primary under-sea warfare sensor of the MH-60R multi-mission helicopter. This integrated dipping sonar system enables the MH-60R to detect, pinpoint, track, and classify enemy submarines. It also performs acoustic intercept, underwater communications, and environmental data acquisition.

The AN/AQS-22 has multi-frequency capability that enables the system to adapt its performance to varying environmental conditions. With a rapid search rate, the AN/AQS-22 identifies and neutralizes threats quickly, and to cover a large area.

The AN/AQS-22 also permits a long detection range over a wide area, reducing the number of helicopter sorties necessary to perform active airborne ASW screening, Raytheon officials say.

The dipping sonar system weighs 600 pounds, has a strong, safe, and reliable reeling system, and built-in fault monitoring. Raytheon, in partnership with Thales Underwater Systems, produces an average of 20 full-rate AN/AQS-22 production systems per year.

On this order Lockheed Martin will do the work in Brest, France; Portsmouth, R.I.; and Owego, N.Y., and should be finished by December 2024. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or Naval Air Systems Command at www.navair.navy.mil.



SOFTWARE

Kitware to develop algorithms to defeat disinformation from falsified media reports

Intelligence experts at Kitware Inc. in Clifton Park, N.Y., will help U.S. military researchers detect and defeat automated enemy disinformation campaigns launched by manipulating the Internet, news, and entertainment media.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced an \$11.9 million contract to Kitware for the Semantic Forensics (SemaFor) project.

SemaFor will develop technologies to detect, attribute, and characterize multi-modal falsified media like text, audio, images, and video automatically to defend against large-scale automated disinformation attacks. Kitware joins PAR Government Systems Corp. in Rome, N.Y., which won an \$11.9 million SemaFor contract from DARPA last June.

Statistical detection techniques have been successful, yet media generation and manipulation technology is advancing rapidly. Purely statistical detection methods quickly are becoming insufficient for detecting falsified media.

Detection techniques that rely on statistical fingerprints, moreover, often can be fooled with limited additional resources like algorithm development, data, or computers.

Yet existing automated media manipulation and generation algorithms rely heavily on purely data driven approaches and are prone to making semantic errors. Faces generated by the Generative Adversarial Network (GAN), for example, may have semantic inconsistencies such as mismatched earrings, which provide an opportunity for defenders to gain an asymmetric advantage.

A suite of semantic inconsistency detectors would increase the burden on media falsifiers by

requiring the creators of falsified media to get every semantic detail correct, while defenders only need to find one, or a very few, inconsistencies.

SemaFor seeks to develop semantic technologies for analyzing media. Semantic detection algorithms will determine if media is generated or manipulated. Attribution algorithms will infer if media originates from a particular organization or individual. Characterization algorithms will reason about whether media was generated or manipulated for malicious purposes.

The results of detection, attribution, and characterization algorithms can help develop explanations for system decisions, and rank assets for analyst review. These SemaFor technologies will help identify, deter, and understand adversary disinformation campaigns.

On this contract Kitware will do the work in Clifton Park, New York, and Albany, N.Y.; Corvallis, Ore.; Tempe, Ariz.; Urbana, Ill.; and Ann Arbor, Mich., and should be finished by July 2024. For more information contact Kitware online at www.kitware.com, or DARPA at www.darpa.mil.

DISPLAYS

Collins Elbit Vision Systems to build night vision helmet-mounted displays

Combat avionics experts at Collins Elbit Vision Systems (CEVS) in Fort Worth, Texas, will provide the U.S. and allied militaries with head-up helmet-mounted displays for high-performance jet fighter-bomber aircraft under terms of a \$12.9 million contract announced Friday.

Officials of the U.S. Naval Air Warfare Center Aircraft Division at Patuxent River Naval Air Station, Md., are asking CEVS to provide 60 JHMCS night vision devices, 60 JHMCS night display adapters, and 30 JHMCS helmet mounted display test sets (HMDTS) for the U.S. Navy.

In addition the contract calls for CEVS to provide 16 JHMCS HMDTS for Canada; five JHMCS HMDTS for Kuwait; and two JHMCS HMDTS for Malaysia, as well as two Hoffman adapter kits for Australia and one Hoffman adapter kit for Switzerland.

Additionally, this contract provides new and modified support equipment; interim repairs; non-recurring engineering, testing, and techni-

cal data; and other supplies and services necessary to install NVCD systems that are compatible with the F/A-18 series jet fighter-bombers, and EA-18G electronic warfare (EW) jet.

The JHMCS projects symbology and imagery onto the jet fighter-bomber pilot's helmet-mounted visor to help meet the workload of operating the aircraft; detecting, tracking, and engaging targets; and dealing with emergency situations. It enables high-performance jet fighter and bomber pilots to cue weapons and sensors at night.

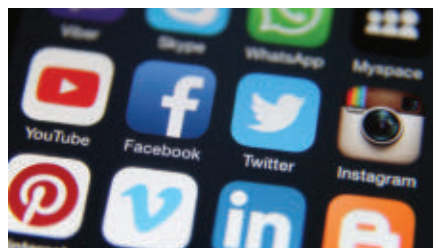
The NVCD portion of the system is designed to enable near daytime tactics at night, while also providing the system's head-up display data over the eye in addition to camera video recording of the pilot's viewpoint.

The NVCD enables aircrews simultaneously to display radar and navigation symbology on the helmet's display and cue short-range air-to-air missiles. This night vision capability helps pilots identify terrain, targets, and other aircraft at night.

The JHMCS and NVCD are mounted on a lightweight HGU 55/P helmet shell that can accommodate the day or night modules. The system offers a 100-by-40-degree field of view or 40 degrees circular, with symbology or video inserted into the night-vision scene.

Collins-Elbit Vision Systems is a joint venture of the Raytheon Technologies Corp. Collins Aerospace segment in Cedar Rapids, Iowa, and Elbit Systems of America in Fort Worth, Texas. On this contract CEVS will do the work in Merrimack, N.H.; Wilsonville, Ore.; Atlanta; and Fort Worth, Texas, and should be finished by July 2022.

For more information contact Raytheon Technologies Collins Aerospace online at www.rtx.com, Elbit Systems of America at www.elbitsystems-us.com, or the Naval Air Warfare Center Aircraft Division at www.navair.navy.mil/nawcad. ←





new PRODUCTS



EMBEDDED TEST

Threshold comparator card for test and measurement introduced by Marvin Test

Marvin Test Solutions Inc. in Irvine, Calif., is introducing the GX3748 series 48-channel threshold comparator card for event monitoring and control. The GX3748 combines 48 voltage comparator channels with windowing and precision level detection. Users can generate triggers based on user programmable voltage threshold levels to enable time-critical response when out-of-limit test conditions occur. Users also can combine several high-density comparator cards in one chassis without sacrificing performance or system response time to expand monitoring capacity to many hundreds of channels. The 50-volt input range is for a wide variety of test and measurement applications, combining 16 channels of comparator window functionality with 32 channels of threshold detection. Users can monitor signal levels on any of the input channels, as well as generate event timestamp, digitize, and store data on one channel per 16 channel group. The GX3748 incorporates a user-configurable Intel/Altera Stratix III field-programmable gate array (FPGA)-based daughter card, enabling the use of Quartus or the license-free Quartus Prime Lite programming tools. For more information contact Marvin Test Solutions online at www.marvintest.com.



POWER SUPPLIES

300-Watt DC-DC converters to power communications introduced by TDK

TDK-Lambda Americas Inc. in San Diego is introducing additional 12.5-amp 300-Watt rated models to the company's i7C non-isolated DC-DC converters for communications, industrial, test-and-measurement, and battery-powered applications. With an input range of 9 to 53 volts DC, users can adjust the output from 5 to 28 volts. The i7C topology enables users to switch from buck (voltage reduction) to boost (voltage increase) operation. The series is for generating additional high power outputs, from existing 12-, 24-, 36-, or 48-volt systems. Efficiencies to 96 percent help minimize power losses in communications and related applications. Under light loads, the i7C's control techniques reduce power dissipation. A 5 milliamps input current draw is typical under zero load conditions. This can be reduced to typically 0.25 milliamps with the remote on-off in standby mode. The basic models include an output voltage adjustment pin, positive or negative logic remote on-off, positive remote sense, plus input under-voltage, over-current and thermal protection. The full-featured models have a power good signal, output current monitoring and the ability to synchronize the operating frequency to minimize system noise. For more information contact TDK-Lambda Americas online at www.us.lambda.tdk.com.

NAVIGATION AND GUIDANCE

Small inertial navigation and guidance units for unmanned vehicles introduced by VectorNav

VectorNav Technologies LLC in Dallas is introducing the VectorNav Tactical Embedded line of inertial products for autonomous pointing and geo-referencing applications like gimballed intelligence, surveillance and reconnaissance (ISR); satellite communications (SATCOM) systems; laser detection and ranging (LiDAR) mapping; and photogrammetry. Featuring a tactical-grade inertial measurement unit (IMU) and a multi-band global navigation satellite system (GNSS) receivers, the Tactical Embedded delivers milliradian attitude accuracy and centimeter-level positioning capability in a 15-gram package. VectorNav's Tactical Embedded line features support for an external selective availability anti-spoofing module (SAASM) GPS for defense applications in ISR, electronic warfare (EW), munitions, and unmanned aerial vehicle (UAV) navigation. The Tactical Embedded is designed and engineered at VectorNav's AS9100-certified facility in Dallas, and includes the VN-110E IMU/AHRS, the VN-210E GNSS-Aided INS, and the VN-310E Dual Antenna GNSS/INS. Highlights of the navigation and guidance products include 0.05-0.1-degree heading; 0.015-degree pitch and roll; 1-meter horizontal and 1.5-meter vertical position accuracy;





1-centimeter real-time kinematic (RTK) positioning accuracy; less than 1-degree per hour gyro in-run bias; less than 10-micro G accel in-run bias; 184 channel L1/L2/E1/E5b GNSS receiver; support for external RTK, post-processed kinematic (PPK), and SAASM GPS; update rates of 800 Hz IMU and 400 Hz navigation; measures 1.2 by 1.2 by 0.4 inches; and uses less than 480 milliamps of power at 3.3 volts. For more information contact VectorNav Technologies online at www.vectornav.com.



in production. The board meets draft Sensor Open Systems Architecture (SOSA) open-systems standards. The SBC3511 is based on the Intel Xeon E-2276ME 6-core/12-thread processor that operates at 2.8 GHz with TurboBoost to 4.5 GHz, and is supported by a Xilinx Ultrascale+ field-programmable gate array (FPGA). The SBC3511 single-board computer has 64 gigabytes of DDR4 RAM and 256 gigabytes of NVMe solid-state data storage. Its IPMI subsystem operates from 3.3 volts of AUX power

only to enhance its alignment with the SOSA standard. The SBC3511 also can have support from the Abaco software suite, including PBIT for early monitoring and reporting; CIBIT for non-intrusive ongoing and on-demand monitoring and reporting; and Health Toolkit, which acts as a system monitor to collect and report the health of all elements in the system. The SBC3511 embedded computing board features a thermal management design that enables deterministic high performance even at the extended temperatures typical of deployment on space-constrained platforms in combat zones. This contrasts less efficient thermal management designs that see a processor's performance throttled back at high temperatures. For more information contact Abaco Systems online at www.abaco.com.

BOARD PRODUCTS

SOSA-aligned Xeon single-board computer introduced by Abaco

Abaco Systems in Huntsville, Ala., is announcing that the company's SOSA-aligned rugged 3U VPX SBC3511 single-board computer is

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RF AND MICROWAVE

Hybrid coupler line for wideband applications to 40 MHz introduced by Pasternack

Pasternack, an Infinite Electronics brand in Irvine, Calif., is introducing 21 new models in a hybrid coupler line for wideband RF and microwave applications. These RF and microwave couplers offer high-frequency operating range as high as 40 GHz, and feature SMA and 2.92-millimeter connectors. They are for RF and microwave applications that require an even split of input and output ports with 90-degree or 180-degree phase shifts while maintaining high isolation between the ports. These hybrid couplers deliver power handling capability to 100 Watts continuous wave, and provide isolation and insertion loss performance with low return loss. The flat phase balance performance spans across the frequency range. Pasternack's high-performance hybrid couplers for wideband applications are in-stock and available for immediate shipping. For more information contact Pasternack online at www.pasternack.com.

AVIONICS

Rugged MIL-STD-1553 dual transceiver for avionics applications introduced by Holt

Holt Integrated Circuits in Mission Viejo, Calif., is introducing the HI-25850 3.3-volt MIL-STD-1553 dual transceiver with integrated transformers for military and commercial avionics applications. The device combines Holt's HI-15850 MIL-STD-1553 transceiver integrated circuit (IC) with the necessary isolation transformers in one package. The HI-15850 is identical to Holt's HI-1585, with the added feature of 1.8-volt, 2.5-volt, and 3.3-volt-compatible digital I/O. Smaller than 15 by 15 millimeters in area and



4.4 millimeters high when mounted, the HI-25850 dual-transceiver MIL-STD-1553 device has a low height and footprint and is suitable for applications using cards with component height restrictions, such as PCI Mezzanine Cards (PMC) and Switched Mezzanine Cards (XMC). Digital I/O enables users to interface the with a broad range of field-programmable gate arrays (FPGAs) and avoid using level shifters and other additional circuitry. This device provides bus tail-off compensation and receiver output pulse extension. These MIL-STD-1553 dual transceiver devices are available that operate in the industrial-temperature range of -40 to 85 degrees Celsius, and the military-temperature range of -55 to 125 C. Samples are available on request. For more information contact Holt Integrated Circuits online at www.holtic.com.

EMBEDDED COMPUTING

PCI Express modules that meet PCI-SIG open-systems standards introduced by VadaTech

VadaTech Inc. in Henderson, Nev., is introducing the PCI124 and PCI125 4th generation PCI Express expansion modules for aerospace and defense applications. Both embedded computing modules include a retimer/conditioner to improve signal integrity for enhanced system performance and reliability across long cables. This removes both random and deterministic jitter from the input signals, eliminating inter-symbol interference and resetting the output jitter budget. This conditioning supports 16 lanes. These embedded computing modules are based on the PCI Special Interest



Group (PCI SIG) specification. PCI-SIG is an industry consortium community responsible for developing and maintaining a standardized approach to peripheral component I/O data transfers. The PCI125 provides x16 expansion via two OCuLink connectors on the front panel. The PCI124 has the dual OCuLink to the rear, making it suitable for additional I/O to PCI597, resulting in data rates to and from field-programmable gate array (FPGA) as fast as 384 gigabits per second. For more information contact VadaTech online at www.vadatech.com.

POWER ELECTRONICS

Wideband high power amplifier for EW applications introduced by ERZIA Technologies

ERZIA Technologies USA in Arlington, Va., is introducing the model ERZ-HPA-3200-3800-40 compact, wideband high power amplifier (WHPA) that provides consistent-output power across Ka-band communications channels. The ERZ-HPA-3200-3800-40 operates in the Ka band from 32 to 38 GHz. In addition to 40 dBm of power, this microwave amplifier also has 49 dB of gain. It is qualified under MIL-STD-810F standards against the effects of temperature, shock, vibration, and acceleration. The small size and modularity of the amplifier supports the rapid development of microwave systems for electronic warfare (EW), avionics, ground radar, satellite communications (SATCOM), 5G telecommunications, and test equipment operating at Ka-band frequencies. These RF and microwave devices can operate in harsh environments while holding output power in place. ERZIA developed these solutions in response to EW designers who are frustrated over power variances in critical wideband applications. For more information contact ERZIA Technologies USA online at www.erzia.com. ←





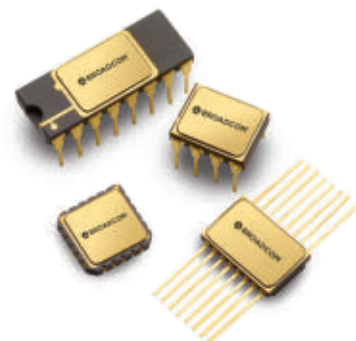
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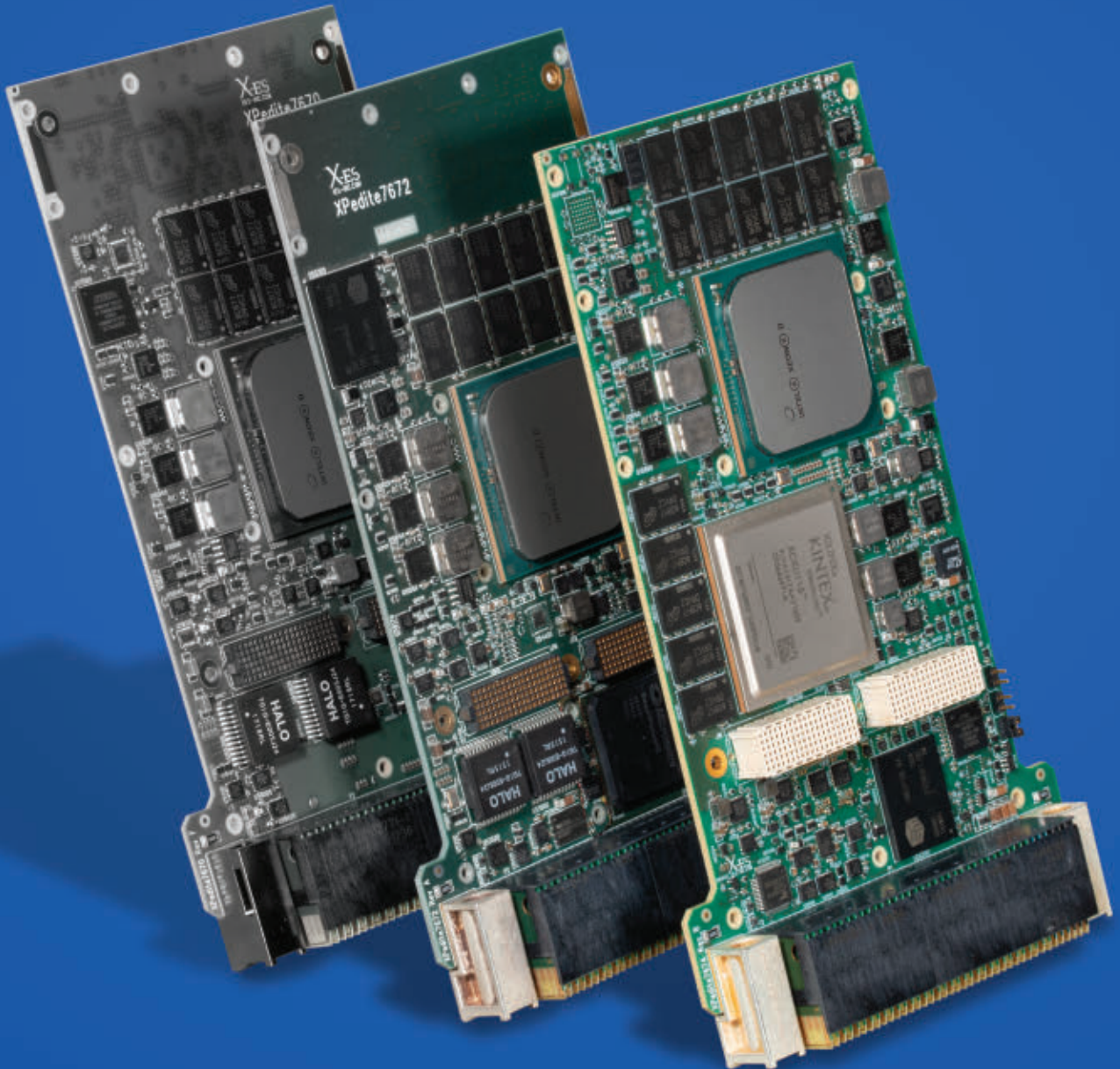
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