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Military & Aerospace Electronics

ENABLING TECHNOLOGIES FOR NATIONAL DEFENSE

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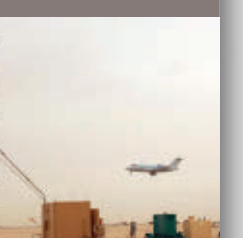
COVER STORY



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BY **JOHN KELLER**, EDITOR IN CHIEF

Russian directed-energy weapon to complicate military strategic planning?

The Russian defense industry reportedly has developed a directed-energy weapon that can destroy or disable sophisticated electronic guidance and navigation systems in manned and unmanned aircraft and precision-guided missiles. This electronic warfare (EW) weapon, which is yet unnamed, also reportedly can take out GPS navigation signals, radio communications equipment, and even orbiting satellites.

"The system will target deck-based, tactical, long-range, and strategic aircraft, electronic means, and suppress foreign military satellites' radio-electronic equipment," says Yuri Mayevsky, CEO of the weapon's developer, Radio-Electronic Technologies Group (KRET) in Moscow.

The weapon, Mayevsky says, will be based on "ground-based, air-and seaborne carriers," which means fixed-based land sites, ground vehicles, aircraft, surface ships, and perhaps even submarines.

Assuming the news reports are true, this development could complicate U.S. military strategic planning, which for the past quarter-century has relied heavily on precision-guided munitions, GPS navigation, and tactical battlefield networking. Such a weapon has the potential to neutralize or degrade the performance of U.S. and allied combat aircraft, cruise missiles, satellite-guided munitions, network-centric warfare setups, and other high-tech military systems.

Russian news agency TASS says Russian military leaders intend the weapon for anti-aircraft warfare, electronic warfare, and to disable satellite communications (SATCOM). Russian commanders say they will use the integrated multifunctional EW system for defensive purposes, and deploy it to defend the country from aircraft, cruise missiles, and ballistic missiles.

"It will suppress communications, navigation, target location, and the use of high-precision weapons," says Vladimir Mikheyev, adviser to the KRET first deputy CEO. "The system will be used against cruise missiles and will suppress satellite-based radio location systems. It will switch off enemy weapons." Field tests are scheduled for the end of this year.

This new weapon — assuming it can be developed into a workable system — raises a host of questions, such as when U.S. or allied military forces might be on the receiving end of a field test.

On the Fourth of July, U.S. jet fighters intercepted separate Russian TU-95 strategic reconnaissance aircraft off the coasts of California and Alaska. These probes of U.S. and allied air defenses have become common occurrences over the past year or two. It makes me wonder when or if those Russian spy planes might use a directed-energy weapon to turn off the avionics of the intercepting jets.

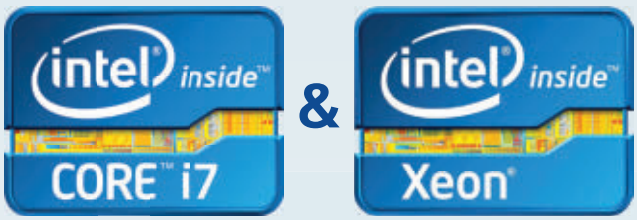
Would it be an act of war if the interceptors were not shot down or seriously threatened? We just might find out, sooner than later. Another question: What is the U.S. military doing to defend against hostile directed-energy weapons? Believe it or not, programs are in place.

The U.S. Office of Naval Research in Arlington, Va., for example, has the Counter Directed Energy Weapons program (CDEW), which is looking for new ways of defending against hostile high-energy lasers, high-power microwaves, and other directed-energy weapons in the maritime domain.

This kind of research is going on in other military services, as well as at research institutions like Georgia Tech in Atlanta. Moreover, the U.S. military is working on its own directed-energy weapons programs that should yield technologies with similar capabilities as the new Russian weapon.

It's all a reminder of the importance of electronic warfare in this day and age — and of the kind of dangerous world we live in.

Featuring



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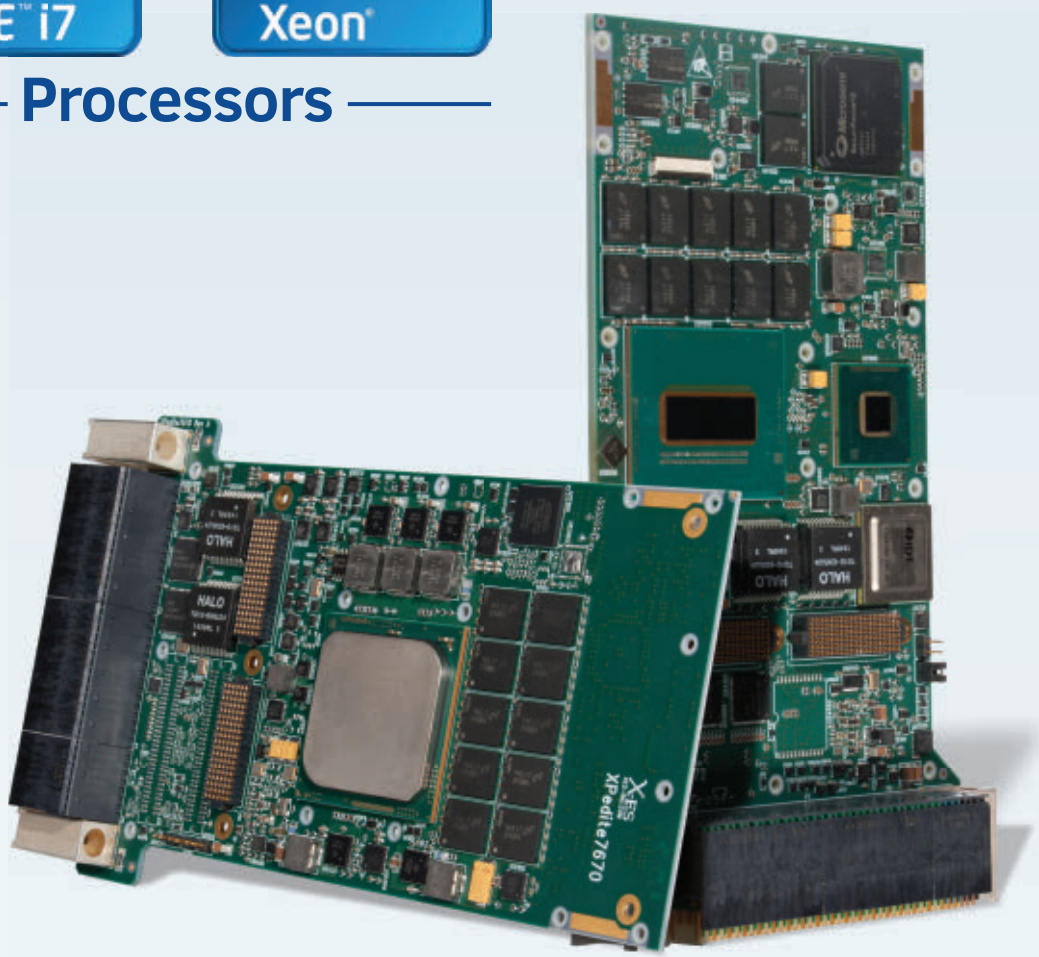

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Black Diamond to provide rugged computers for battlefield airmen

BY JOHN KELLER

WRIGHT-PATTERSON AFB, Ohio—U.S. Air Force close air support control experts are looking to Black Diamond Advanced Technologies LLC in Chandler, Ariz., to provide rugged computers to help battlefield-deployed ground controllers guide attack jets accurately to their targets.

Black Diamond is building rugged computers, data networking, and power distribution for use by Air Force battlefield airmen like tactical air control parties, combat control teams, para rescue, and combat weathermen.

Officials of the Air Force Life Cycle Management Center's Battlefield Airmen Branch at Wright-Patterson Air Force Base, Ohio, announced a $48.1 million contract to Black Diamond in July for the Battlefield Airmen Operational Control System (OCS).

Black Diamond experts will provide operational control system hardware, attrition assets, and software integration support for the OCS. The contract involves the Black Diamond commercial off-the-shelf (COTS) APEx Predator system. The OCS is to be based on COTS components, and will help ground controllers direct attack aircraft to their targets.

The Black Diamond APEx Predator is a modular, wearable system consisting of the Agile Port Expander (APEx) controller for power and data distribution, a COTS rugged tablet computer, and cabling for tactical plate carrier use by warfighters operating on foot. APEx provides connections for several peripheral cables, a system power cable, and a tactical computer or end user device.

The Air Force contract calls for Windows 7-based computing, data and power distribution, and cabling that are compatible with the Harris AN/PRC-152A and AN/PRC-117G radios, Rockwell-Collins DAGR GPS receiver, L-3 TacROVER-p radio, Raytheon Microlight radio, shoulder-mounted, military-grade GPS receivers, and the Vectronix PLRF-15C pocket laser range finder.

The APEx controller intelligently distributes power to connected devices and enables data communication of tactical data radios, video downlink, targeting, and other devices to the computer. It employs 5-gigabit-per-second USB 3.0 on four sealed, circular, military-grade universal peripheral ports that enable the user to connect tactical peripherals to computers, tablets, and smart phones.

IN BRIEF

Lockheed Martin to provide flight computers for MC-130J aircraft

U.S. military microelectronics experts are asking Lockheed Martin to upgrade special-operations flight computers aboard the U.S. Air Force MC-130J Commando II special-operations aircraft. Defense Microelectronics Activity officials in McClellan, Calif., plan to award a task order contract to Lockheed Martin Mission Systems and Training in Owego, N.Y., as part of the Advanced Technology Support Program III program. The contract will ask Lockheed Martin to upgrade the MC-130J Special Mission Processor (SMP) and build a limited quantity of the upgraded SMPs, which improve performance and resolve obsolescence and vanishing vendor issues.

Army orders attack drones

U.S. Army aviation experts are ordering 19 MQ-1C Gray Eagle unmanned aerial vehicles (UAVs) and satellite UAV control stations. Army Contracting Command at Redstone Arsenal, Ala., announced a $121.4 million contract modification to General Atomics Aeronautical Systems in Poway, Calif., for the medium altitude long endurance (MALE) reconnaissance attack drones and satellite communications air data terminals.

In addition to tactical air control parties, users of the OCS will include combat control teams, para rescue, and combat weathermen. Once fielded, these airmen will have the APEx Predator system embedded alongside U.S. Army combat maneuver elements from heavy armor to tier 1 Special Forces units.

Air Force officials are asking the OCS to receive its power from a commonly available BA-5590, BB-2590, or conformal battery, or available AC/DC external power, which can operate the system and recharge internal batteries. The OCS vest will be MOLLE compatible and adaptable to an Eagle, CRYE, or BAE RBAV vest, as well as to a military backpack.

Black Diamond also designs the Forward Air Control - Utility Suite to control close air support aircraft and joint fires accurately and safely to their targets. It can send and receive a variety of messages from 9-lines to friendly points, and maintain awareness of friendly forces, and helps attack aircraft deliver precision strikes while on the move.

It can display full-motion video, and is interoperable with military PRC-117G, PRC-148, and PRC-152; offers mapping capability; and enables the joint terminal attack controller (JTAC) to deliver fires to the battlefield from virtually any asset available, company officials say.

On this contract Black Diamond will do the work in Chandler, Ariz., and should be finished by November 2020.

FOR MORE INFORMATION visit **Black Diamond Advanced Technology** online at *www.bdatech.com*, or the **Air Force Life Cycle Management Center** at *www.wpafb.af.mil/aflcmc*.

Lockheed Martin studies performance upgrades to CBASS submarine torpedoes

BY JOHN KELLER

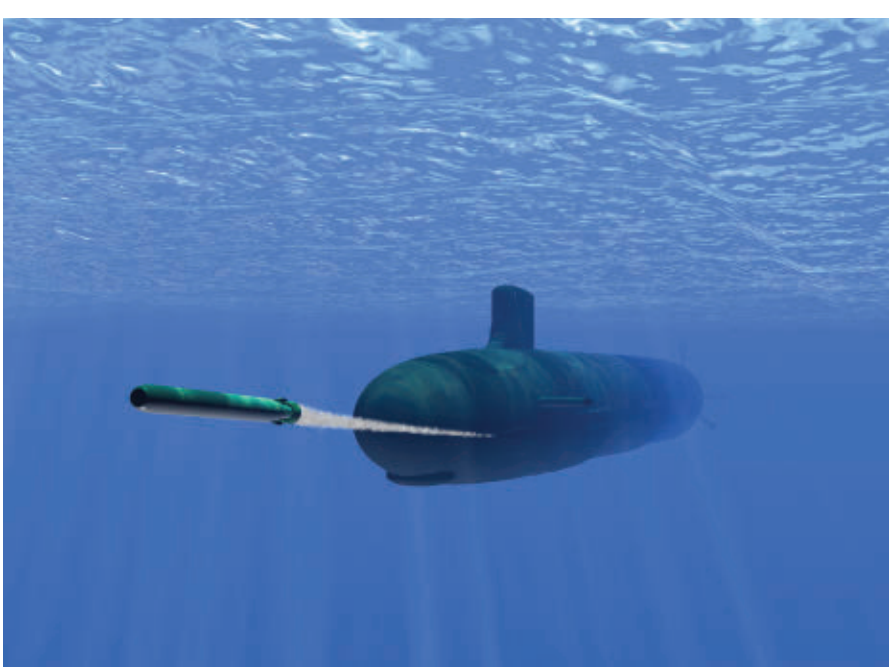
NEWPORT, R.I.—U.S. Navy undersea warfare experts are moving forward with plans to upgrade and enhance the Navy's Common Broadband Advanced Sonar System (CBASS) version of the Mk 48 Mod 7 heavyweight torpedo.

Officials of the Naval Undersea Warfare Center Division-Newport in Newport, R.I., announced a $26.4 million contract to Lockheed Martin Sippican Inc. in Marion, Mass., for services to improve the Navy's fleet of CBASS submarine-launched torpedoes.

The CBASS broadband sonar makes the torpedo more effective against emerging submarine classes in the harshest of acoustic environments, Lockheed Martin officials say. The Mark 48 Mod 7 CBASS torpedo uses modern commercial off-the-shelf (COTS) technologies in an open-architecture computing environment, and can be improved with regular hardware and software upgrades.

This contract is for engineering to support future capability upgrades of the Mk 48 Mod 7 CBASS torpedo, as part of the Naval Undersea Warfare Center Division-Newport's spiral development program.

This includes technology assessment, mechanical and electrical component design analysis, software upgrade development, critical item testing, hardware and software integration, certification and test, in-water validation, and life cycle logistics studies for testing components of torpedoes and subsystems.



Lockheed Martin is finding ways to make the U.S. Navy's Common Broadband Advanced Sonar System (CBASS) version of the Mk 48 Mod 7 heavyweight torpedo deadlier than ever.

Lockheed Martin Sippican experts will recommend design changes; address failure and improvements to weapon hardware, software, and firmware; and support government testing.

The Mark 48 Mod 7 torpedo is standard armament for the Navy's fleet of Los Angeles-, Virginia-, and Seawolf-class fast attack submarines, as well as Ohio-class ballistic-missile and cruise-missile submarines.

The Lockheed Martin Corp. Mission Systems and Training segment in Washington is building the Mark 48 Mod 7 CBASS heavyweight torpedo with advanced common broadband advanced sonar system for expanded operational capabilities for shallow waters along coastlines and inside harbors, as well as in the deep-water open ocean.

The CBASS torpedo also offers multiband operation with active and passive homing; advanced counter-countermeasure capabilities; effectiveness against low-Doppler shallow submarines, fast deep diving submarines, and high-performance surface ships; autonomous fire-and-forget operation or wire-guide capability to enable post-launch monitoring and updates via the submarine combat system; and running Otto Fuel II as the propellant.

The Mark 48 Mod 7 CBASS torpedo can transmit and receive over a wide frequency band and use broadband signal processing techniques to improve the torpedo's search, acquisition, and attack, Lockheed Martin officials explain.

The Mark 48 torpedo is 19 feet long and 21 inches in diameter, and weighs 3,500 pounds. It can be used as deep as 1,200 feet at distances as far as five miles. The torpedo can travel at 28 knots and has a 650-pound high-explosive warhead.

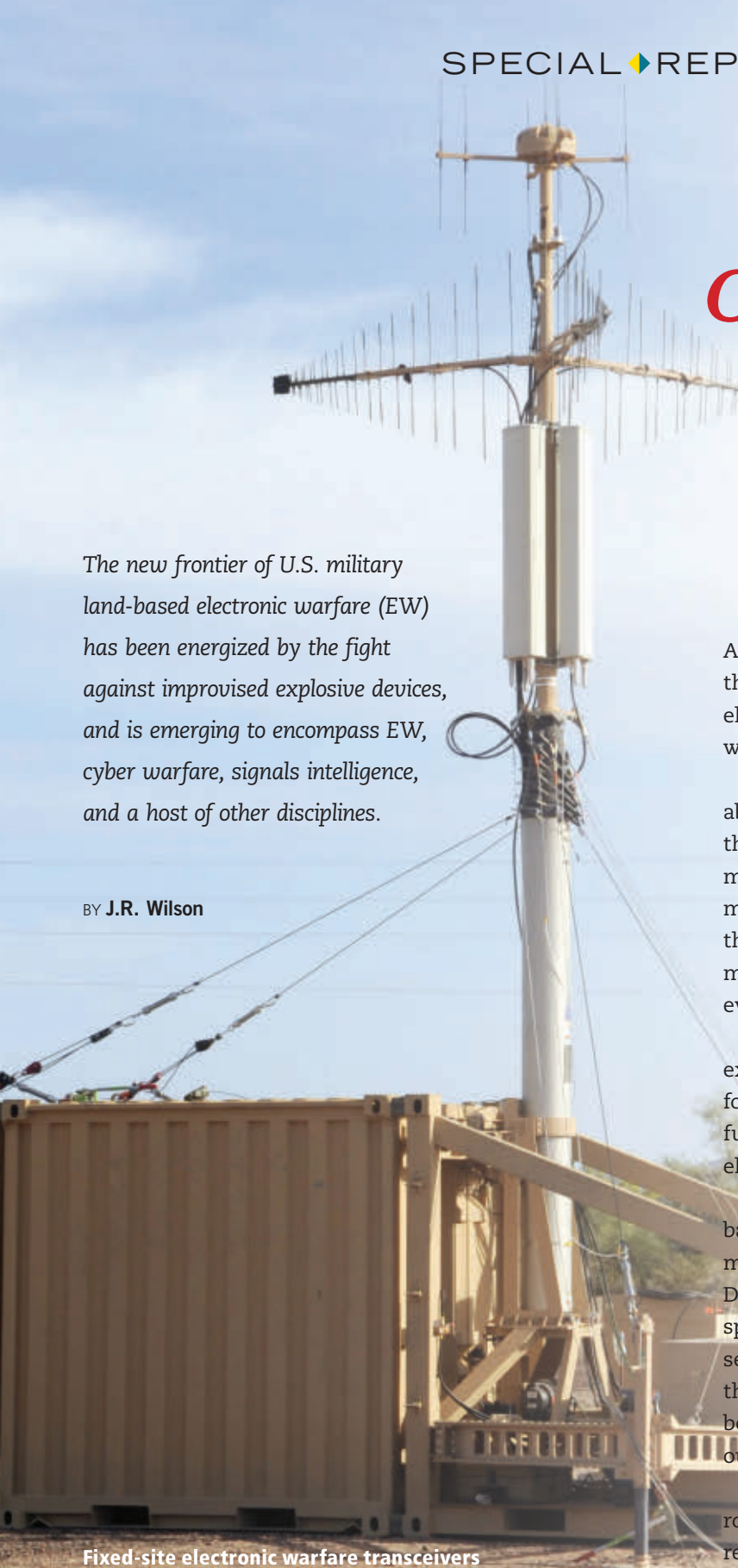
On this contract Lockheed Martin will do the work in Marion, Mass.; Newport, R.I.; Pearl Harbor, Hawaii; Australia; Washington; and Keyport, Wash., and should be finished by June 2020.

FOR MORE INFORMATION visit **Lockheed Martin Sippican** online at *www.sippican.com*, or the **Naval Undersea Warfare Center Division-Newport** at *www.navsea.navy.mil/Home/WarfareCenters/NUWCNewport*.

Not your old timer's electronic warfare

The new frontier of U.S. military land-based electronic warfare (EW) has been energized by the fight against improvised explosive devices, and is emerging to encompass EW, cyber warfare, signals intelligence, and a host of other disciplines.

BY **J.R. Wilson**



Fixed-site electronic warfare transceivers have advantages in power, range, and endurance, yet can be difficult in using to support warfighters on the move.

As part of the "peace dividend" following the end of the Cold War, the U.S. Army disbanded its organic electronic warfare (EW) capability, a decision that was to prove problematic less than a decade later.

The post-9/11 wars in Southwest Asia brought about massive changes for the U.S. military, with the introduction and ever-growing use of unmanned aerial vehicles (UAVs), precision-guided munitions, increased integration and networking of the battlespace, personal armor, advanced forward medical care, and enhanced communications—even down to the individual warfighter.

The enemy's use of radio-controlled improvised explosive devices (RCIEDs), however, set the stage for what may be one of the biggest changes for the future of the U.S. Army—a return to land forces electronic warfare.

"When we got rid of our communications EW battalions in the 1990s, that was a mistake," admits Col. Jeffrey Church, chief of the Army's EW Division. "We cannot ignore the electromagnetic spectrum as a modern Army. I don't think you will see the Army walk away from EW the way we did then. It is now a core competency and we have to be able to maneuver in the EM spectrum through our folks in EW and spectrum management."

The Army's confrontation with radio-controlled roadside bombs in Iraq and Afghanistan—and its resulting grisly casualties—serves as a grim reminder of the need for land-based EW. "Even with a smaller force and a smaller budget, I think we learned our lesson in 2004–05, when the Army saw

the need to reinvest in EW," Church says. "Our science and technology base and industry are very competent to meet EW requirements from the maneuver commanders."

Still, the lingering effects of abandoning land-based EW in the 1990s continue to be felt up and down Army command echelons. "I think we can write very demanding requirements, get those validated and have industry able to fill those," Church says. "If we had not stopped in the 1990s, we would be awesome in EW today. But the good thing is we don't have a lot of old systems to consider and can just acquire the best new technology."

The best new technology

This may be an advantage to the Army and Marine Corps—given sufficient funding—as EW technology and applications are evolving rapidly and often in unpredictable ways. The enemy in Southwest Asia was relatively unsophisticated in a technological sense, but still forced the Army to scramble to defeat RCIEDs and begin the resurrection of land forces EW. Future conflicts, however, could involve non-state adversaries with similar low-tech capabilities, more sophisticated nation-states, or highly sophisticated near-peer or peer states with advanced offensive and defensive EW capabilities.

"It's not just the European theater, but also part of our focus shift to the Pacific," the Army's Church explains. "The Chinese consider EW to be part of their information operations and a fourth dimension to secure victory—a very critical maneuver space. They and the Russians have taken a big liking to EW in the past 10 to 15 years. As the Army develops future EW capabilities, we are looking at the full range of operations from a peer perspective all the way down to RCIEDs."

The competitive landscape in international land EW may end up as a big benefit to Army planners. "We've really opened up what EW means to the Army," Church says. "Because of our adversaries' EW doctrine and capabilities, we're also looking at electronic protect, which is very important. A lot of what the Army does relies on the spectrum,

The truck-based version of Prophet, shown here, is the division and armored cavalry regiment commander's principal signals intelligence and electronic warfare system and preprocessor of organic SIGINT.

so EW is a major consideration we are looking at to incorporate into our future war plans."

Looming EW threats throughout the world are forcing Army planners to get serious about all aspects of EW—and very quickly. "There have been clear instances of a relative peer adversary more than willing to employ EW to enable freedom of action and attack by ground forces," explains Lt. Col. Steve Oatman, capability manager for EW at the Army Training and Doctrine Command (TRADOC) at Fort Eustis, Va.

"In Ukraine, the Russians used EW to support ground maneuver by separatists. Potential adversaries in the Pacific region have demonstrated an intent to develop and invest in EW, so the expectation is, should the time come, they would be more than willing to employ that investment. Identifying and understanding their capabilities and areas of focus reinforces the need for not only the Army but DOD as a whole to respond to the importance of EW," Oatman adds.

"The state-of-the-art for [U.S.] land forces EW really only exists in one realm—the Counter RCIED EW system (CREW), which is one of only two existing programs of record that support Army land EW operations. So SOTA is a relative term for land forces," Oatman says. "However, the Air Force and Navy do have additional very robust capabilities in the EW arena, developed for their specific requirements, that, in the past 12-plus years, we have been able to employ in support of our ground force operations, along with some additional quick reaction capabilities built to support specific theater operations."

Still, reliance on Air Force and Navy EW and Counter-EW assets in future environments is insufficient to maintain the land warfighters' ability to survive and win in a more challenging environment, experts say. This is the reason that the Army's next-generation land-based EW will center on a family of systems called the Integrated EW System (IEWS), providing a three-tier capability.

Integrated EW System

"The first tier is what we call the EW Planning and Management Tool [EWPMT], which will allow an EW officer and a spectrum management operations officer or NCO to effectively integrate EW into the ground force commander's scheme of maneuver by planning, synchronizing and deconflicting EW capabilities in support of ground maneuver operations," Oatman says.

"That tool also will provide capability to support remote control for the second tier—Multi-Functional Electronic Warfare [MFEW], a system-of-systems with a ground variant and an airborne variant. Primarily, it will be focused on electronic attack and support—two of the three EW focuses, along with protect. That will work from the corps down to the brigade level for organic EW ability at the Brigade Combat Team to allow the BCT commander to dominate the electronic spectrum at the time and place of his choosing. The third tier is defensive electronic attack, which will be a more enhanced version of the current CREW system, able to go after other targets than just the RCIED."

Dave Kroetsch, president and CEO of Aeryon Labs Inc. in Waterloo, Ontario, identifies two forms of EW—one involving active interception or jamming, the other a more passive, data-gathering approach.

"Many of those technologies exist today, but will need further miniaturization to more covertly deploy," Kroetsch says. "There also will be some elements to take data from those deployed assets and integrate

them back up the network chain. The overall trend in all technology is miniaturization and increased capability at those smaller scales. You could drop a cell phone-type device that could do network intercept, jamming, acoustic surveillance. So, as a broad trend, things will be more multi-mission, multi-function at a much smaller scale.

"Miniaturization will bring more capabilities, but also counter-EW and counter-counter that will play out over the next couple of decades. Right now, a small swarm of remote-controlled aircraft bought at a hobby store, loaded with explosives and flown toward a target, would be almost impossible to stop. Those kinds of threats will drive counter-EW. In addition, the more you increase reliance on one mechanism or broader, more deployed things, the more likely you are to have a network the enemy can get onto and even use to access greater data stores and intel."

The AN/ULQ-35 Counter Remote Controlled Improvised Explosive Device (RCIED) Electronic Warfare (CREW) Duke system is the most widely deployed counter-IED system protecting warfighters from roadside bombs today.

In a presentation at the Armed Forces Communications & Electronics Association (AFCEA) last January in San Diego, Col. Gregory Breazile, director of the U.S. Marine Corps Command & Control/Cyber & Electronic Warfare Integration Division (C2/CEWID), defined the three pillars of Electronic Warfare:

- Electronic Attack (EA): The use of electromagnetic energy, directed energy, or anti-radiation weapons to attack personnel, facilities, or equipment with the intent of degrading, neutralizing or destroying enemy combat capability; considered a form of fires;
- Electronic Protection (EP): Actions taken to protect personnel, facilities, and equipment from any

effects of friendly or enemy use of the electromagnetic spectrum that degrade, neutralize, or destroy friendly combat capability; and

- Electronic Support (ES): Actions tasked by, or under direct control of, an operational commander to search for, intercept, identify, and locate or localize sources of intentional and unintentional radiated electromagnetic energy for the purpose of immediate threat recognition, targeting, planning, and conduct of future operations.

Land-based electronic warfare approaches make use of mobile EW transceivers, as well as fixed-site equipment.

Compared to three comparable pillars for cyberspace operations:

- DOD Information Network (DODIN) Operations: Actions taken to architect, build, configure, secure, operate, maintain, and sustain DOD networks to create and preserve availability, integrity, authentication, confidentiality, and non-repudiation of information;
- Defensive Cyber Operation (DCO): Actions taken to protect, monitor, analyze, detect, and respond to unauthorized activity within DoDIN, employing information technology, information assurance, intelligence, counter-intelligence, law enforcement, and other military capabilities to defend DoDIN; and
- Offensive Cyber Operations (OCO): Includes the use of computer networks to disrupt, deny, degrade or destroy information resident in computers and computer networks, the computers and networks themselves or to enable future offensive operations; Computer Network Attack (CNA) is a subset of offensive cyberspace operations where the anticipated effect of the operation is equivalent to a military attack.

As the elements of EW, CW, spectrum warfare, information operations, signals intelligence, and further advances in battlespace networking evolve, sometimes combining, sometimes acting independently, they also are becoming a greater challenge, offensively and defensively, to land forces—Army, Marine Corps, and special operations. At the same time, efforts to provide infantry with the capabilities needed to successfully engage in such operations also is reflected in needed changes and adaptations throughout the chain of command.

At a separate conference in Washington last May. Breazile also called for a major shakeup in how the Marine Corps is structured to handle the growing complexities of EW and cyberspace.

"Our headquarters is not functionally aligned to support cyberspace operations," Breazile said. "We are fractured. We've got a CIO over here, we've got intel guys over there. We're not unified in this effort. [And] we realize there are a lot of risks out there if we don't get this right."

As requirements and technologies for EW have grown across all the services and combat domains, so has the debate over terminology and where EW fits into a world also dominated by cyberwar as well as traditional signals competencies and concerns.

Some say that EW enables weapons systems. Others say an EW system is a weapon in itself. Last November then-Secretary of Defense Chuck Hagel announced a new Defense Innovation Initiative (DII) with three basic components for increasing competitiveness:

- attracting talent, including the future of the all-volunteer force, the way the services train the force and their leaders and the way the department trains the future civilian and contractor force;
- technological superiority and operational excellence; and
- accountability and efficiency throughout the Defense Department.

Each of those plays into the evolution of military EW, as well as

cyber and signals intelligence—all part of what the Chinese call Informationalized Warfare: The combination of cyber, information operations, EW, and deception and denial to disrupt enemy command and control.

Hagel's successor, Defense Secretary Ashton Carter, later expanded the DII with what is called the "third offset strategy."

Defensive Electronic Attack (DEA) will help protect vehicles, convoys, foot soldiers, and fixed sites from enemy electronic warfare attacks.

"The whole purpose of the third offset strategy is to identify the technologies, the operational and organizational constructs and the new operational concepts to fight our future adversaries," said Deputy Defense Secretary Bob Work in a keynote address on international security and future defense strategy at the U.S. Army War College last April.

Work described how that will fit into a future battlespace in which warfighters and machines work together in a multidimensional "informationalized" zone while facing a daunting array of challenges involving regular warfare, hybrid warfare, nonlinear warfare, state-sponsored proxy hybrid warfare, and high-end combined-arms warfare. Those may include guided rockets, artillery, mortars, and missiles (G-RAMM) with GPS capability and laser guidance, infrared homing, anti-radiation weapons, fire-and-forget anti-armor weapons, guided .50 caliber rounds, and sensor-fused weapons that home in on the biometric signatures of human beings.

"I like the way Dwight Eisenhower explained it after World War II: 'While some of our allies were compelled to throw up a wall of flesh and blood as their chief defense against the aggressor's onslaught, we were able to use machines and technology to save lives.' But our technological superiority is slipping. We see it every day… The fact is we want to achieve an overmatch over any adversary from the operational theater level all the way down to the fighter plane, Navy ship, or infantry squad. Battlefield advantages in the future are going to be very short-lived because the amount of technology that is out there right now is unbelievable.

"When I went to Afghanistan to visit Marine units, Gen. Joe 'Fighting Joe' Dunford [told me] the record for the disaggregation of a single infantry battalion across the battlefield [was] 77 discreet units spread over a wide area. In an informationalized warfare environment in which the enemy is constantly trying to get into your networks and disrupt your command and control, [that has big implications for leadership and command and control]. If we combine them into well-trained, cohesive combat teams with new advances in robotics and autonomy and unmanned systems, three-play combat at the squad level, we can create super-empowered squads, super-empowered small units with enhanced situational awareness and lethality."

According to the Concepts & Programs project, the Marine Corps is addressing the rapidly changing dynamics of Electromagnetic Operating Environments and

Military planners expect to bring even small unmanned aerial vehicles like the Shadow, shown above, into future land-based electronic warfare efforts.

complex problem of Electromagnetic Spectrum (EMS) control through a new approach called Marine Air Ground Task Force (MAGTF) Electronic Warfare, an integrated system of distributed, platform-agnostic EW capabilities on manned and unmanned assets enabling the MAGTF to "unite air, ground and space-based technologies to ensure collaborative, efficient and effective control of the EMS."

While planning for future growth to include evolving technologies and capabilities from other services and industry, the MAGTF EW portfolio of active and developing elements includes Intrepid Tiger II (IT-II): An EW pod for communications-based targets. The Intripid Tiger II is expandable to radar-based targets, currently deployed to CENTCOM and with MEUs; IT-II Version 1 involves fixed-wing assets, V(2) UAVs, V(3) rotary-wing and Block X radar-based targets.

The portfolio also includes Electronic Warfare Service Architecture (EWSA), an extensible data exchange and hardware protocol to connect EW/SIGINT airborne nodes to ground operators, Cyberspace and Electronic Warfare Coordination Cells (CEWCCs), and other air EW nodes. EWSA will facilitate "on-demand EW fires" in operational conditions under CEWCC control and will unite air and ground EW with SIGINT via an adaptive network with multiple waveforms, as well as basic digital interoperability between air platforms.

Medium-sized unmanned aircraft like the Army Gray Eagle, shown above, are expected to be integral components in electronic warfare architectures of the future.

"Our Corps' operational dependence upon the EMS is increasing in amount, type, density and complexity. Active pursuit of the MAGTF EW strategy provides an opportunity to replace the low-density, platform-centric EA-6B Prowler capability with a scalable, organic, adaptable and cost-effective system-of-systems for EMS control," according to the project office. "This system will be equally applicable across the Range of Military Operations (ROMO). Once MAGTF EW has been fully realized, it will constitute an improvement over current capabilities."

The ongoing Squad X Core Technologies (SXCT) program of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., is another approach to increasing human and machine collaboration at the lowest tactical level to address EW requirements. The goal is to speed the development of new, lightweight, integrated systems to give dismounted infantry capabilities that have involved equipment with size, weight, and power requirements beyond the carrying capacity of individual warfighters or squads.

"SXCT aims to help dismounted infantry squads have deep awareness of what's around them, detect threats from farther away and, when necessary, engage adversaries more quickly and precisely than ever before," says DARPA Program Manager Maj. Christopher Orlowski. "We are working towards advanced capabilities that would make dismounted infantry squads more adaptable, safe and effective."

At the Army Cyber Center of Excellence at Fort Gordon, Ga., cyber electromagnetic activities (CEMA) incorporate three pillars of EW:

The THOR III is a counter-radio-controlled improvised explosive device (IED) jammer for infantry warfighters. The system, built by Sierra Nevada Corp., has been used by the U.S. Army and Marine Corps in Afghanistan. The system uses three transceivers mounted on backpacks to jam radio-controlled IEDs operating at low, medium, and high bandwidths.

electronic attack; electronic support—what frequencies and technologies do friendly forces use to defeat the enemy; and electronic protection—keeping U.S. and friendly forces safe from fratricide and enemy EW.

Now domain experts are starting to focus on how to synchronize EW and cyber to achieve spectrum dominance in the future. This approach is a fundamental part of the future term spectrum warfare.

"DOD [and] its industry partners face an uncertain global security environment driven by adversaries who recognize that the EMS has become vital to the success of their campaigns," says Antonino Amoroso, regional director of the Association of Old Crows (AOC) EW trade association in Alexandria, Va. "Adversaries are aggressively fielding electronic warfare systems and cyber systems/technologies that significantly erode DOD's ability to use and control the EMS while conducting military operations," according to Symposium Chair Antonino Amoroso, AOC's regional director.

The AOC annual Symposium in December will examine how EW and cyber enables military capabilities—sensors, weapons, and networks—to dominate in spectrum maneuver warfare scenarios, says Amoroso, who also serves as the AOC symposium chair.

"We will also examine the underlying EW/Cyber technology base and its implications for future warfighting capabilities... Rapid transition of key EW/Cyber technologies are critical and they must be shared and organized with our joint and coalition partners," Amoroso says.

It is presumed by military strategists that everything the U.S. is doing to enhance its next-generation land forces EW capabilities also is being done by potential adversaries—from China and Russia to Iran and North Korea—as well as by allied nations.

U.S. and NATO Electromagnetic Environment Operational (EEO) concepts reportedly are converging to ensure the ability of friendly forces to employ offensive and defensive EW without hurting blue forces. NATO's Joint Electronic Warfare Core Staff (JEWCS) was created to provide the Alliance and its individual members with a wide range of EW capabilities.

Individual allies also are moving forward with efforts to integrate EW into their militaries, such as India's "Digital Army," the Canadian Forces Land Electronic Warfare Modernization project, the Royal Saudi Land Forces EW Department, and the Australian Defence Science and Technology Organisation's Cyber and Electronic Warfare Division.

Whether it is called electronic warfare, cyber warfare, spectrum warfare, information warfare, electronic maneuver warfare, hybrid warfare, etc., the ability of future land forces to implement those capabilities alongside traditional rifles, tanks, and missiles is becoming increasingly vital.

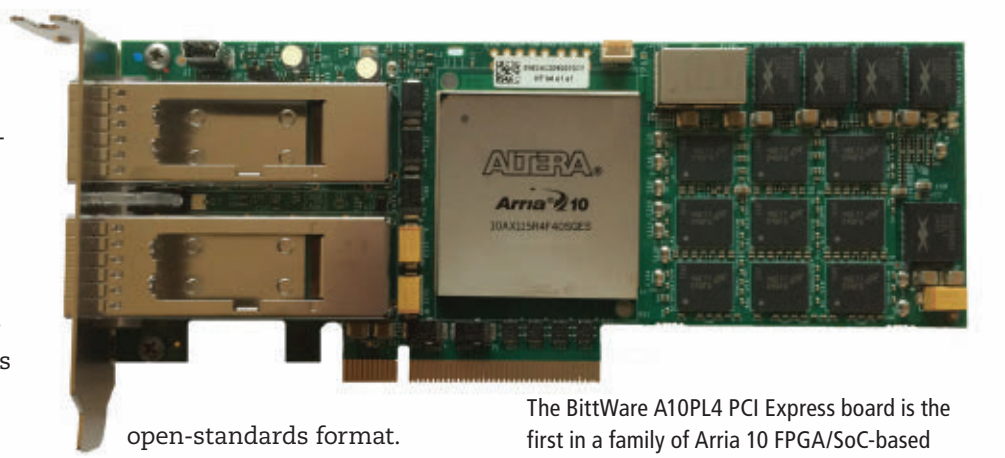
As noted in a TRADOC paper on the subject, "Mission command, intelligence, and protection all rely on effective and secure cyber systems for successful movement and maneuver, fires, sustainment, and engagement. Cyber operations support the conduct of unified land operations and are yet another form of strategic maneuver and expeditionary warfare. The application of Strategic Landpower is now expanded from the human domain to include cyberspace... Innovation and agility are driving tenets as cyber operations strengthen the application of Strategic Landpower at the speed of cyber."

"The Army is not planning on fighting yesterday's battle. We're talking about developing an EW capability that will allow us to fight and win in a peer environment where the EM spectrum is congested and contested. That will allow us to maneuver and dominate at a time and place of our choosing," Col. Church says. "The Army is not just looking at technological solutions to EW. We're also looking at the organizational structure—the facilities, leadership and training required. So technology is not a silver bullet—it needs all those. And we are structuring Army EW to take on the most advanced adversaries in the most contested battlespace. Any lesser adversary would just be that much easier."

HPEC options grow for SWaP-optimized systems

High-performance embedded computing is expanding to a growing number of designs, ranging from Intel-based systems, to FPGAs, hybrid approaches, and full-custom computers.

BY **John Keller**



The BittWare A10PL4 PCI Express board is the first in a family of Arria 10 FPGA/SoC-based products which includes support for 3U VPX and XMC.

High-performance embedded computing (HPEC) for challenging sensor- and signal-processing applications like radar, sonar, electronic warfare (EW), and signals intelligence (SIGINT) used to be a proprietary affair, with complex mixtures of specialized processors, application-specific software, and exotic thermal-management approaches to cool typically hot-running electronics.

Today, however, that's all changed, and HPEC for sensor processing, digital signal processing (DSP), and other challenging embedded computing applications is more accessible than ever before — even for applications where small size, weight, and power consumption (SWaP) is a primary concern.

One of the most significant HPEC developments in the last several years came last spring when Intel Corp. in Santa Clara, Calif., introduced the Xeon D microprocessor, a rugged server-class chip packaged on a ball grid array (BGA) that can bring unprecedented embedded computing power in an open-standards format.

Even though the Intel Xeon D and high-end, mobile-class processors like the Core i7 are helping bring HPEC to a growing number of embedded applications, there still is room for more complex HPEC architectures when system requirements are at their most demanding.

Field-programmable gate arrays (FPGAs), general-purpose graphics processing units (GPGPUs), and even the high-end, power-hungry, and hot-running Intel Xeon server-class processors are playing significant roles in the latest HPEC designs. HPEC also is helping push the bounds of rugged deployable thermal-management techniques to keep processors cool when the battlefield heats up.

What is HPEC?

As relatively easy as HPEC architectures have become to design and deploy, one of the most difficult aspects of HPEC is defining what it is. There is not a clear consensus in industry on what constitutes HPEC, but typically it involves several computing cores working in parallel, and can consist of one or more types of high-end processors.

HPEC architectures generally fall into four different camps: "big-box" designs based on powerful Intel microprocessors; small and tight designs based on FPGAs; hybrid designs that blend general-purpose

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While there are some applications where high speed serial fabrics like VPX are ideal, there are others where VMEbus or CompactPCI still rule the roost.

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and server-class processors, FPGAs, and GPGPUs; and custom designs that make innovative use of proprietary computing architectures and thermal-management techniques.

Much of what defines HPEC these days "depends on who you're talking to and the problem they're trying to solve," says Shaun McQuaid, director of product management at Mercury Systems in Chelmsford, Mass.

Many practitioners of HPEC refer to the Intel model when describing what HPEC is, and what it is not. "At the low end, you have the Atom processor," Mercury's McQuaid says. "In the middle, you have the mobile-class processors like the Core i5 and Core i7. On top, you have the Xeon processors — and even in the Xeon processors you have different segments."

Others say HPEC simply refers to demanding signal-processing applications that require small size, weight, and power (SWaP). "To me, HPEC is much more SWaP stuff, and not the big iron that happens to be conduction cooled," says Jeff Milrod, CEO of BittWare Inc. in Concord, N.H., which specializes in FPGA applications in HPEC.

When it comes to HPEC, Milrod says he sees three market segments: the large rack-based systems based on Intel and other general-purpose processors, as well as hybrid architectures mixing processors, GPGPUs, and FPGAs; smaller-sized custom solutions; and relatively small architectures based largely on commercial off-the-shelf processors.

For BittWare, Milrod defines HPEC as high-performance processing that consumes power in the tens of watts range. "I consider that achievable with today's FPGAs, and I think that will be a game changer," he says.

Ultimately, HPEC involves high-performance processing on a scale that historically has been found in the supercomputer and server worlds that requires specialized ruggedization, packaging, and engineering to render this kind of computing appropriate for embedded applications in harsh environments.

The HPEC embedded board from Mercury Systems features the Intel Xeon D microprocessor.

The role of HPEC

The role of HPEC in aerospace and defense applications has grown as embedded computing architectures have shrunk in size, weight, and power consumption to accommodate the explosion in on-board sensors and data networking on manned and unmanned aircraft, ships, submarines, and land vehicles.

The need for high-end sensor processing in sophisticated applications like imaging radar, hyperspectral imaging and other electro-optical sensors, electronic warfare (EW), signals intelligence (SIGINT), and future applications like passive radar and sonar have made HPEC a necessity rather than a luxury.

One of the problems is the bandwidth of data links. The massive amount of information from a growing number of deployed sensors makes it imperative to process sensor information at the sensor or on the platform, rather than data-linking the information to remote processing stations.

"Radar and EW continue to provide challenges for compute power within SWaP constraints, with latency a big driver for EW in particular," explains Peter Thompson, senior business development manager for high-performance embedded computing at GE Intelligent Platforms in Huntsville, Ala.

"We see strong growth in situational awareness [SA] and autonomy," Thompson continues. "SA requires the ability to ingest multiple video and other sources, process them, and display various views — all with minimal glass-to-glass latency in a compact system that can be added to a platform that often wasn't designed with it in mind. Autonomy takes that and adds in a safety-critical element with all the challenges that brings."

Bittware's Milrod also sees EW, radar, and SIGINT as major technology drivers for HPEC. "We are doing 3U VPX and XMC applications in HPEC," he says. "Our applications would be mid-sized unmanned aerial vehicles (UAVs) where designers are putting in 3U boxes."

Lots of embedded computing in a small space essentially sums up HPEC, says Vincent Chuffart, portfolio manager for aerospace, transportation, and defense at Kontron AG in Plou-lon, France. "Typically HPEC involves problems and applications that cannot be tackled with a typical

mono-socket CPU architecture, where you need a lot of computer power in a small space," Chuffart says.

"Today with cloud computing and big data, there is no problem too big for IT technology," Chuffart continues. "That is where embedded computing comes in. You cannot always get the computing power of the cloud for your problem. The bandwidth needs could be prohibitive, and you need to do these decisions locally.

"Some of the sensor problems like sonar, radar, video surveillance, and situational awareness are examples of this," Chuffart says. "It's really about the amount of data you need to process. No cameras are 4K by 4K pixels on the regular UAV, and you don't send a raw feed of that amount of data to the ground station; you process it locally."

The 6U OpenVPX Starter System from GE Intelligent Platforms is a member of the company's HPEC Application Ready Platforms (HARP) product family and features Intel Core i7 processors.

HPEC architectures

One of the most prevalent architectures for HPEC involves a so-called "hybrid" design that blends general-purpose processors, server-class processors, FPGAs, and GPGPUs. For some systems integrators — especially those designing for the most demanding architectures — the hybrid approach is the only

way to get the processing horsepower they need.

Although there are plenty of potential applications for hybrid HPEC designs, the introduction this past spring of the Intel Xeon D embeddable server-class processor has brought about a fundamental shift in the concept and deployment of HPEC in aerospace and defense applications.

"The Xeon D represents a new branch of HPEC, which particularly is beneficial for the defense industry," says Marc Couture, senior product manager for digital signal processing at the Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va. "For a number of years, we have been marching through the Intel Tick-Tock, starting with mobile processors and the GPU. Now along comes this family called Xeon D. Not only is it a BGA part that can be soldered down, but Intel also will announce an extended-temperature version later this year.

"The Xeon D also consolidates onto one chip the southbridge I/O controller hub," Couture points out. "It's a single device, and for tight form factors — 3U in particular — Xeon D is particularly nice, and has created a lot of stir."

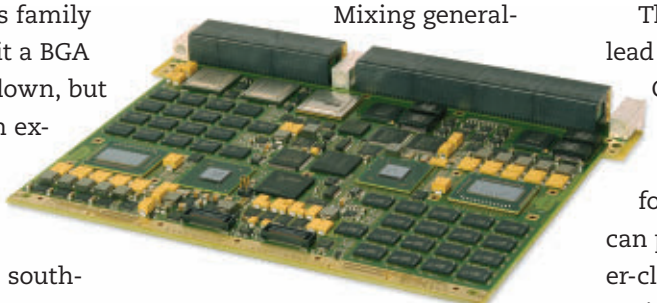
With all the computing power that the Xeon D offers, it still isn't enough for the most demanding HPEC implementations where designers want to go with an open-systems, Intel-based architecture. "For the multi-intelligence programs like synthetic aperture radar imagery imposed on an EO/IR [electro-optics/infrared] image where you need teraflops of performance, that's where you use the Xeon D with a GPGPU," Couture says. "That model is still applicable."

Hybrid architectures

While the Xeon D processor brings a lot of embedded computing power to the table, the new processor will not eliminate the need for a hybrid design, says Mercury's McQuaid. "The Xeon D, as well as the introduction of Xeon-class processors, has driven change in the embedded computing industry, but rather than eliminate the need for a hybrid architecture, the bar has been raised."

"The hybrid architecture still makes sense if you need to squeeze out all the performance you can, and are willing to pay the penalty of the new software complexity it imposes," McQuaid explains.

Mixing general-purpose processors, FPGAs, GPGPUs, and server-class processors in the same system requires a company to have in-house software expertise to support each different kind of processor.



The GE DSP281 dual quad core HPEC platform brings data center performance and scalability to deployed defense and aerospace applications.

Using just one kind of processor, like a Xeon D or Intel Core i7 for example, can simply the software part of the equation. "Anyone who knows C and C++ has ease of programming with high-performance processors like the Xeon D," McQuaid says. "There are a set of applications where it is not worth adding that specialized experience in their architectures."

For some designs, neither the Xeon-only nor the hybrid approach offers the advantages in SWaP that other kinds of architectures can offer. "We always have been focused on the smaller, dense computing applications, and cooling is an issue in that space," says BittWare's Milrod.

HPEC with FPGAs

"We are good at fitting the power density into things that can be cooled with standard traditional approaches, such as optimizing to spread heat out to make it realistically coolable," Milrod says. "Leading-edge cooling is not in our space."

These are among the issues that lead BittWare to rely heavily on FPGAs for HPEC applications. BittWare offers FPGA-based coprocessor and acceleration support for hybrid HPEC designs. "We can pop an FPGA into an Intel server-class board and do offload computing and special functions. It's a lot lower power and performance than you can get with the GPGPUs."

For Milrod and other FPGA specialists, there are other recent breakthrough technologies than the Xeon D to enable HPEC applications. "FPGAs now have pretty high-performance ARM processors in them now. These SOCs [systems on chip] have 1.5 teraflops of hard floating point processing with multi-gigahertz ARMS in one FPGA package."

Others argue that FPGAs confront users with special software

CONTINUED ON PAGE 27 ➔

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Sea-based radar market will reach $13 billion

The global market for sea-based radar for air defense, electronic countermeasures, fire control, navigation, search and track, and surveillance will reach $13 billion and 1,383 units over the next decade, predict analysts at Forecast International in Newtown, Conn. The most valuable segment over the next 10 years will be air defense, valued at $8.2 billion. "The Market for Naval Radar Systems" report reviews 31 radar programs and major trends in sea-based radars, and projects the top three sea-based radar companies over the next decade will be Raytheon, Thales, and Airbus Group.

FOR MORE INFORMATION visit **Forecast International** online at *www.forecastinternational.com*.

Thales I-Master radar integrated on Scorpion jet

Engineers at Textron AirLand in Providence, R.I., have integrated the I-Master radar from Thales Group in Paris on the Scorpion light attack and intelligence, surveillance, and reconnaissance (ISR) jet. Combined with a visible-light and infrared camera, the radar adds long-range, wide-area surveillance, and target tracking to the Scorpion light-attack jet. ←

FOR MORE INFORMATION visit **Textron AirLand** online at *www.scorpionjet.com*.

Thales to build prototype deployable instrument landing systems

HANSCOM AIR FORCE BASE, Mass.—Avionics experts at Thales Defense & Security Inc. in Clarksburg, Md., are taking the next step in developing a deployable aircraft instrument landing system for precision aircraft approach worldwide in difficult conditions.

Officials of the Air Force Life Cycle Management Center at Hanscom Air Force Base, Mass., awarded Thales an $18.4 million contract to build two Deployable Instrument Landing System (D-ILS) prototypes for operational test and evaluation.

The D-ILS will provide a system of equal performance to existing Category I fixed-based systems that provide aircraft guidance on final approach in low-visibility and low-ceiling weather conditions.

The D-ILS prototypes that Thales will build are to conduct an "integrated system test qualification operational test and evaluation," Air Force officials say. When testing is finished, Thales will provide an equivalent of a fixed-based instrument landing system capability at tactical airfields and at airfields where permanent ILS capability has been disrupted.

While a fixed-base ILS is large and requires several aircraft to deliver all the equipment, the D-ILS will fit onto one C-130 aircraft, Air Force officials say.

The Air Force announced plans last year to negotiate with Thales sole-source to develop the D-ILS. Thales is to finish development and provide ready-to-deploy D-ILS capability by mid-2017.

The Thales Deployable Instrument Land System is for unimproved airports, or those with damaged facilities.

The Thales D-ILS will provide precision guidance to fixed-wing aircraft and helicopters in several geographically separated and environmentally diverse regions. Each system will provide guidance based on the aircraft's position in relation to the final approach course glide path from the touchdown point on the runway or landing surface.

The goal is to provide the Air Force with supportable, adaptable, resilient, enduring, and persistent precision approach capability that joint, coalition, and civil ILS-equipped aircraft can use worldwide.

The D-ILS will provide significantly improved reliability, maintainability, and supportability over legacy deployable Precision Approach Radar (PAR) systems.

"Having a mobile ILS system in the Air Force inventory will provide

warfighters in theater with three major capabilities: the ability to convert a bare base into an operating airfield, the ability to augment an existing airfield, and the ability to temporarily restore ILS capabilities at damaged airfields during humanitarian operations," said Col. Jimmie D. Schuman in 2010, who was commander of the 853 Electronic Systems Group at Hanscom.

The Thales D-ILS will offer remote monitoring and maintenance that allows for maintenance configuration from remote locations. It would involve setting up a remote maintenance center in theater for central depot storage of all maintenance items to sustain D-ILS installations at several different airfields.

On this contract, Thales engineers will do the work in Clarksburg, Md.; Italy; and Overland Park, Kan., and should be finished by July 2018.

FOR MORE INFORMATION visit **Thales Defense & Security** online at *www.thalescomminc.com*, and the **Air Force Life Cycle Management Center** at *www.wpafb.af.mil*.

Navy orders shipboard electronic-warfare systems from Lockheed Martin

WASHINGTON — U.S. Navy surface warfare experts are ordering advanced electronic-warfare (EW) systems for surface warships, such as aircraft carriers, amphibious assault ships, cruisers, and destroyers under terms of a $153.9 million contract modification.

Officials of the Naval Sea Systems Command in Washington are asking engineers at the Lockheed Martin Radar Systems segment in Liverpool, N.Y., to build Surface Electronic Warfare Improvement Program (SEWIP) Block 2 systems for fiscal 2015.

SEWIP is an evolutionary acquisition program to upgrade the existing out-of-production AN/SLQ-32(V) EW system and provide improved anti-ship missile defense and situational awareness. SEWIP Block 2 provides improved electronic support receivers and combat system interfaces, and expands the receiver and antenna group to help surface electronic-warfare capabilities keep pace with growing threats.

Lockheed Martin Radar Systems won a Navy award for block 2 in late 2009, leading a team that includes ITT Electronic Systems, Cobham Defence Electronic Systems, Research Associates Syracuse, and Azure Summit Technology of Fairfax, Va. Since the SEWIP program started in 2002, General Dynamics Advanced Information Systems (AIS) in Fairfax, Va., acted as prime contractor for SEWIP blocks 1A, 1B1, 1B2, and 1B3.

The Lockheed Martin Block 2 SEWIP design is based on the integrated common electronics warfare system (ICEWS), which enables rapid reconfiguring of the system with commercial technology.

Mercury Systems in Chelmsford, Mass., for example, is providing advanced radio frequency (RF) microwave tuners and intermediate frequency (IF) products for SEWIP Block 2. Lockheed Martin chose the Mercury Echotek series microwave tuner and digital receiver, which are optimized for fast tuning and high performance, Mercury officials say.

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

The SEWIP shipboard electronic warfare is for Arleigh Burke-class destroyers like the one shown above, as well as for other classes of surface warships.

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

Lockheed Martin will do the work in Syracuse, N.Y; Lansdale, Pa.; and Chelmsford, Mass., and should be finished by April 2018.

FOR MORE INFORMATION visit **Lockheed Martin Radar Systems** online at *www.lockheedmartin.com*, and **Naval Sea Systems Command** at *www.navsea.navy.mil*.

Textron continues Navy's unmanned minesweeping surface vessel program

Textron Systems Corp. is continuing its support for a fast unmanned boat designed to provide the U.S. Navy's Littoral Combat Ship (LCS) with unmanned minesweeping capability to detect, pinpoint, and destroy ocean mines. Officials of the Naval Sea Systems Command awarded an $11 million contract modification to the Textron Unmanned Systems segment in Hunt Valley, Md., to continue providing engineering services for the Unmanned Influence Sweep System (UISS) program. The UISS is an unmanned surface vessel (USV) with integrated magnetic and acoustic minesweeping capability that will be part of the LCS mine warfare module. It will provide magnetic and acoustic influence minesweeping capability when deployed from the LCS. The UISS, which uses the Textron Common Unmanned Surface Vessel (CUSV), will target acoustic, magnetic, and magnetic and acoustic combination mine types, and provide the LCS with a rapid, wide-area coverage mine-clearance capability to neutralize magnetic and acoustic influence mines. UISS seeks to provide a high area coverage rate in a small, lightweight package with minimal impact on the LCS, Navy officials say.

Air Force ready to approach industry for enabling technologies in affordable attack drones

WRIGHT-PATTERSON AFB, Ohio—U.S. Air Force researchers are notifying industry of an upcoming project to develop many inexpensive, disposable unmanned drones for long-range, high-speed attack missions in remote regions.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, are notifying industry of the upcoming Low-Cost Attritable Aircraft Technology project. A formal broad-agency announcement for this program, BAA-AFRL-RQKP-2015-0004, will be issued in the near future. No further information about when the solicitation will be issued is available.

The goal is to develop unmanned aerial vehicle (UAV) technology that can lend itself to large-scale aerial attacks in remote regions where forward basing is difficult or impossible, researchers say. For this kind of engagement, Air Force researchers want enabling technologies for affordable UAVs able to carry out long-range and high-speed attacks that are of sufficiently low cost that loss of these aircraft in battle could be tolerated, researchers say.

Tight defense budgets and many kinds of military threats throughout the world make it imperative for the Air Force to make dramatic reductions in the costs of attack UAVs to bring mass to the engagement, and increase defensive costs to potential adversaries.

Air Force researchers are interested in small, affordable attack drones, unlike the relatively large Predator shown above.

Researchers want to trade the relatively high costs of UAV performance, design life, reliability, and maintainability for low-cost attritable aircraft intended for reuse with limited life and number of sorties.

The goal of this program is to establish a benchmark, concluding in a flight demonstration that will test the bounds of what can be accomplished in a short time to establish a baseline system cost against a notional set of strike vehicle requirements. Air Force officials expect to award one 30-month contract worth about $7.5 million.

E-mail technical questions or concerns to the Air Force's Peter Flick at peter.flick@us.af.mil, Bill Baron at william.baron.1@us.af.mil, or Craig Nelson at craig.neslen@us.af.mil. E-mail contracting questions to James Patterson, Jr. at james.patterson.41@us.af.mil or Eric Carlin at eric.carlin@us.af.mil.

MORE INFORMATION IS online at *http://1.usa.gov/1IcAIkO.*

DEKA developing touch-sensitive robotic artificial limbs for injured warfighters

BY **John Keller**

ARLINGTON, Va.—U.S. military officials are choosing a N.H. research firm to develop enabling technologies that could help provide injured warfighters with robotic artificial limbs that feel and function like natural limbs.

Officials of the Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a $7 million contract to DEKA Research and Development Corp. in Manchester, N.H., for the Hand Proprioception & Touch Interfaces (HAPTIX) program. HAPTIX seeks to develop touch-sensitive prosthetic arms and legs for warfighters who lose limbs in battle. The project seeks to link artificial limbs with implantable devices for touch and muscle memory.

DARPA is asking DEKA engineers to design and build sensorized prosthetic arms for the HAPTIX program, as well as for the DARPA Revolutionizing Prosthetics Follow-on Studies (RPFS) project. DEKA will train performers on the setup and operation of arm systems, provide technical support, and maintenance and repair of the arm systems.

System performance and the ultimate benefit to prosthetic users will be determined in a yearlong, take-home trial, providing the government with the required data to seek market approval and deliver the system into the wider patient population.

The DARPA RPFS effort will provide the U.S. Food and Drug Administration an approved variant of the DEKA arm system to inform product and reimbursement code submissions to the Center for Medicaid and Medicare Services. These studies also will validate prescription criteria and explore other control techniques with the aim of ensuring the DEKA arm system can accommodate the broadest user community possible.

The HAPTIX program will focus on implantable peripheral interfaces for volitional motor recording and sensory feedback signals; implantable electronic systems to transfer information between these interfaces and the prosthesis; and sophisticated encoding and decoding algorithms to transform recorded volitional motor control signals into limb movements and patterned stimulation into naturalistic touch and proprioceptive sensations.

The program seeks to adapt a prosthetic limb system developed under DARPA's Revolutionizing Prosthetics program to incorporate interfaces that provide intuitive control and sensory feedback to users. The interfaces build on neural-interface technologies developed through DARPA's Reliable Neural-Interface Technology (RE-NET) program.

The HAPTIX program has four thrusts: electrodes and algorithms, electronics and packaging, human use testing, and cutting-edge science and technology to support next-generation HAPTIX systems.

Electrodes and algorithms involve implantable, multichannel interfaces for monitoring or modulating activity in muscles and nerves, as well as algorithms for decoding volitional control signals and encoding naturalistic touch and proprioceptive signals.

The DEKA Arm from DEKA Research and Development will be the foundation for the DARPA Hand Proprioception & Touch Interfaces (HAPTIX) program.

Electronics and packaging deals with implanted components packaged hermetically for bioelectric signal acquisition, neural stimulation, power transfer, and bidirectional telemetry between implanted nerve and muscle interfaces and external electronics for communicating with the prosthesis. Human use and testing involves trials of the system in humans for motor/sensory function, psychology, pain, and quality of life.

Also working on the HAPTIX program are Case Western Reserve University in Cleveland; the Cleveland Clinic; Charles Stark Draper Laboratory in Cambridge, Mass.; Nerves Inc. in Dallas; Ripple in Salt Lake City; University of Pittsburgh; University of Utah in Salt Lake City; and University of Florida in Gainesville, Fla. DEKA will do the work in Manchester, N.H., and finish by April 2020.

FOR MORE INFORMATION visit DEKA online at *www.dekaresearch.com*.

DHS eyes bomb detector by identifying thumbprint-size explosives residue

U.S. government explosives-detection experts are conferring with industry for the best ways to protect government facilities from car bombs with bomb detector technology that finds explosives concealed in or on vehicles from safe standoff ranges. Officials of the U.S. Department of Homeland Security released a solicitation for the Standoff Explosives Detection on Vehicles component of the Standoff Explosives Trace Detection program. Officials want technology to detect explosives residue on vehicles with non-contact, near real-time detection technologies that are designed to screen potential vehicle- and person-borne threats at fixed and portable checkpoints using emerging optical techniques like Raman and infrared reflectance spectroscopy.

Intevac to provide cameras on attack helicopters

U.S. Army electro-optics experts needed rugged, high-performance cameras and related electro-optical sensor equipment for the Boeing AH-64D Apache Longbow and AH-64E Apache Guardian attack helicopters. They found their solution at Intevac in Santa Clara, Calif. Officials of the Army Contracting Command at Redstone Arsenal, Ala., awarded a $12.6 million contract to Intevac Photonics for electronic image intensifier ship-sets for Lot 4 of the Apache AH-64D/E program. The electronic image intensifier comprises the camera and lens assembly.

Raytheon upgrading Army sensors for networking, anti-sniper capability

FORT BELVOIR, Va.—U.S. Army electro-optics experts are asking Raytheon Co. to upgrade long-range electro-optical sensors with networking capability so soldiers can share battlefield imaging data and improve their effectiveness against enemy snipers.

Officials of the Army Contracting Command at Fort Belvoir, Va., announced a $27 million contract to the Raytheon Integrated Defense Systems segment in McKinney, Texas, to upgrade as many as 100 Block 0 Long Range Advanced Scout Surveillance System (LRAS3) units.

Raytheon engineers will upgrade Block 0 LRAS3 second-generation, forward-looking infrared (FLIR) systems to the Block 1 Netted LRAS3 sight sensor configuration to improve networking and situational awareness.

The LRAS3 system consists of second-generation FLIR sensors, TV camera, GPS interferometer, and an eye-safe laser range finder. It provides long-range target acquisition for armor and infantry scouts. The system can operate in stationary vehicle-mounted configurations and in an autonomous dismounted configuration. LRAS3 provides real-time capability to detect, recognize, identify, and pinpoint far target locations during the day, at night, and in bad weather. It can be mounted either on armored ground vehicles or used on a tripod.

Raytheon is networking the Long Range Advanced Scout Surveillance System, shown above, to enhance its anti-sniper capability.

The contract calls for Raytheon to provide networking for LRAS3 systems to enable operators to share information across each networked LRAS3. Upgrades also will network LRAS3 sensors with the Gunshot Detection System (GDS) for counter-sniper capability. The GDS will provide bearing and elevation cues to the networked LRAS3 to enable the operator to identify and locate sniper locations and send target location and images to fighting forces so they can destroy the snipers.

The LRAS3 can establish target location coordinates at about six miles with an estimated circular error probability (CEP) of about 200 feet. The system's laser rangefinder can measure range with 16-foot accuracy.

On this contract Raytheon will do the work in a variety of locations, and should be finished by May 2017.

FOR MORE INFORMATION contact **Raytheon Integrated Defense Systems** online at *www.raytheon.com*.

Navy selects L-3 Wescam electro-optical sensors for P-8A jet

The MX-20HD high-definition, electro-optical/infrared system from L-3 Wescam is going aboard the Navy's P-8A Poseidon maritime patrol jet.

LAKEHURST, N.J.—U.S. Navy maritime surveillance experts needed high-altitude surveillance electro-optical sensors for the Navy Boeing P-8A Poseidon maritime patrol aircraft. They found their solution from L-3 Wescam in Burlington, Ontario.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., have announced plans to purchase the company's MX-20HD digital, high-definition, electro optical/infrared (EO/IR) systems, technical data, and repair services for integrating the sensors aboard the P-8A.

The L-3 Wescam MX-20HD electro-optical sensor system is for intelligence, surveillance, and reconnaissance (ISR) capability aboard high-altitude long-range maritime patrol aircraft and persistent surveillance missions.

The pod-mounted sensor suite is suitable for fixed-wing aircraft, helicopters, unmanned aerial vehicles (UAVs), and aerostats, company officials say.

L-3 Wescam is the sole designer, developer, and manufacturer of the MX-20HD EO/IR system for use in the P-8A, and is the only source that is able to supply a system capable of meeting the P-8A requirements, Navy officials say. The government does not own the system's technical data and drawings.

The MX-20HD EO/IR system has multi-sensor imaging and lasing payload options, and can support as many as seven sensors simultaneously for HD imaging from visible-light and infrared cameras. It also has three laser illuminator options.

The system offers real-time image enhance for daytime, nighttime, and infrared operations, and its inertial sensors work together to create accurate target location, automatic alignment to the aircraft, and automatic image focus.

The sensor pod offers five-axis gimbal stabilization with an internal inertial measurement unit.

FOR ADDITIONAL INFORMATION
visit **L-3 Wescam** online at *www.wescam.com*, or the **Naval Air Warfare Center Aircraft Division-Lakehurst** at *www.navair.navy.mil*.

TECHNOLOGY FOCUS

HPEC CONTINUED FROM PAGE 20

challenges, but Milrod says the Open Computing Language (OpenCL) language — of particular interest to GPGPU users — also has application to simplify FPGA software support.

"The FPGA vendors are doing tremendous work in standardizing with Apple and Nvidia with OpenCL initiatives for streaming and pipes to allow streaming inputs and multi kernel implementation with much easier development environments," Milrod says.

The custom approach

For some HPEC designers, the custom approach is the way to go, and it seems to be paying off.

General Micro Systems (GMS) in Rancho Cucamonga, Calif., has an HPEC design called Rugged Cool that packages high-end Xeon server-class processors in a rugged design that offers eight to ten server-class processor cores, and can cool processors running as hot as 300 watts in a conduction-cooled box.

"VPX cannot cool this kind of stuff," says Ben Sharfi, CEO of GMS. "We are deploying dual Xeon processors — each one running 85 watts. We have a box called Tarantula with single or dual processors, with 28 cores of Xeon processors in one box."

Some might criticize GMS for not using a standard approach but Sharfi claims design wins aboard the U.S. Army Apache and Chinook helicopters, as well as on a night-vision system on the MRAP armored combat vehicle.

"At the end of the day, it all comes down to cooling," Sharfi says. "There is a need to conduct the entire surface of the processor board to the frame of the platform, and that's what our technology does."

PRODUCT applications

AIRBORNE RADAR

Thales to provide radar and computers for Royal Navy Merlin helicopters

Military helicopter systems integrators at Lockheed Martin U.K. Holdings Ltd. in London needed helicopter radar and mission systems for the United Kingdom Royal Navy Merlin helicopters. They found their solution from Thales Holding UK PLC in Weybridge, England.

Lockheed Martin has chosen a new generation of the Thales Searchwater radar and Cerberus mission system for specially adapted Merlin helicopters to provide the Royal Navy with an airborne surveillance and control capability (ASaC), Thales officials explain.

The fleet of Merlin helicopters will replace the Royal Navy's outgoing Sea King Mark 7 ASaC force, which has an earlier version of the Searchwater and Cerberus systems. The new capability will enter operational service in 2018 when the last of the Sea King ASaC helicopters are retired, Thales officials say.

The Thales Searchwater-Cerberus combination is designed for maritime force protection, air surveillance, and land operations. The CROWSNEST capability of the Thales helicopter avionics has new radar modes and improved performance against low-radar-cross-section targets.

The Thales radar and mission systems will make the most of equipment, training, and expertise reuse by upgrading, updating, and adapting existing capabilities, Thales officials describe.

Improvements to the Royal Navy's new system include enhanced performance and data processing, as well as the addition of new modes to the multimission radar. It has an improved human machine interface, reduced weight, and built-in training.

Originally designed for maritime airborne force protection, the advanced multimode radar and sensor systems can detect and track several targets over land, air, and sea for anti-piracy operations and many other missions.

FOR MORE INFORMATION visit **Thales** online at *www.thalesgroup.com/en/united-kingdom*.

NAVIGATION AND GUIDANCE

Navy chooses laser navigation for unmanned aircraft from ADSYS

U.S. Navy shipboard unmanned aviation experts needed navigation and landing capabilities for unmanned aerial vehicles (UAVs) in areas where RF and GPS signals are jammed or disrupted. They found their solution from ADSYS Controls Inc. in Irvine, Calif.

ADSYS is working with the Naval Air Systems Command at Patuxent River Naval Air Station, Md., to develop the Laser-Aided Recovery System (LARS) for precision 3D navigation and landing capabilities for ships and land sites where RF jamming is in effect.

ADSYS is working under terms of a Small Business Innovative Research (SBIR) phase-two agreement with Naval Air Systems Command on current LARS development, says James Garrett, director of business development for ADSYS.

The LARS airborne receiver offers low size, weight, and power consumption (SWaP), which makes it suitable for placement on manned and unmanned fixed-wing aircraft and helicopters. It uses eye-safe lasers to broadcast navigation signals to several aircraft at the same time. The system's eye-safe laser helps it resist electronic jamming, and helps the system operate stealthily with low probability of

intercept in hostile conditions.

The LARS laser communications uplink allows for system reconfiguration, vehicle deconfliction, and flexible user-vehicle command for system updates or to adapt to changing conditions.

FOR MORE INFORMATION visit **ADSYS Controls** online at *www.adsyscontrols.com*.

EMBEDDED COMPUTING

Navy orders Core i7-based VME boards from Concurrent Technologies

U.S. Navy aircraft researchers needed VME single-board computers based on the third-generation Intel Core i7 microprocessor for a variety of research tasks. They found their solution from Concurrent Technologies Inc. in Woburn, Mass.

Officials of the Naval Air Warfare Center Aircraft Division at Patuxent River Naval Air Station, Md., issued a request for quote to Concurrent Technologies for the company's VP 927/411-41 embedded computing boards. The VP 927/411-41 is a PC-compatible 6U VME processor board supporting 3rd generation Intel Core processors and the Mobile Intel QM77 Express Chipset with up to 16 gigabytes of DDR3-1600 ECC DRAM.

The board is suitable for a range of military, aerospace, industrial control, telemetry, and scientific applications, and has options for extended-temperature versions.

Navy officials are ordering the VP 927/411-41 VME single-board computer version with a two-core 1.7 GHz Core i7 microprocessor and 8 gigabytes of dynamic random access memory, with front-panel I/O. The single-slot VME64 board features 1 or 2 PMC/XMC sites and a variety of interfaces including an option for an on-board mass storage drive and a CompactFlash site.

The Naval Air Warfare Center Aircraft Division (NAWCAD) at Patuxent River NAS supports Navy and Marine Corps aircraft systems and trainers. The NAWCAD handles the Navy's ranges, test facilities, laboratories, and aircraft for acquisition and testing needs.

Naval Air Warfare Center officials are ordering eight of the VP 927/411-41 VME single-board computers from Concurrent Technologies.

FOR MORE INFORMATION visit **Concurrent Technologies** online at *www.gocct.com*.

ELECTRONIC WARFARE

Navy looks to Mercury for spare parts to shipboard EW systems

U.S. Navy shipboard electronics experts needed various electronic spare parts for the Navy's AN/SLQ-32(V)6 ship-mounted electronic warfare (EW) system. They found their solution from Mercury Systems Inc. in Chelmsford, Mass.

Officials of the Naval Surface Warfare Center in Crane, Ind., announced a potential $7.3 million contract to Mercury to provide digital and RF and microwave components as spares for the AN/SLQ-32(V)6 shipboard EW system, part of the Navy's Surface Electronic Warfare Improvement Program (SEWIP) Block 2 upgrade program.

The contract calls for Mercury to provide ARC bus controllers,

PDF synthesizers, PDF tuners, 8-channel digital receivers, 4-channel digital receivers, and clock generator VME cards for the AN/SLQ-32(V)6 EW and shipboard missile-defense system.

The five-year contract has a minimum value of $54,000 and a maximum value of slightly more than $7.3 million, Navy officials say. The prime systems integrator for the AN/SLQ-32(V)6 is the Lockheed Martin Corp. Mission Systems and Training segment in Liverpool, N.Y.

Navy officials are awarding the contract to Mercury sole-source because Mercury is the only qualified supplier of the spare electronic parts, and an award to any source other than Mercury would result in an unacceptable delay of more than 38 months with additional costs, officials say.

Lockheed Martin awarded a contract to Mercury in 2011 to provide advanced RF microwave tuners and intermediate frequency (IF) products as part of the SEWIP Block 2 upgrade program. For that contract Mercury provided the company's Echotek series microwave tuner and digital receiver, which are optimized for fast tuning and high performance. The SEWIP block 2 upgrade includes receiver, antenna, and combat system interface.

FOR MORE INFORMATION visit **Mercury Systems** online at *www.mrcy.com*

new PRODUCTS

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

RF AND MICROWAVE

6U VXS module based on OpenRFM guidelines offered by Mercury

Mercury Systems in Chelmsford, Mass., is introducing the open-systems Ensemble RFM-1RS18 RF and microwave tuner for electronic

warfare (EW) applications that use board-based RF and microwave components and embedded computing for on-board digital signal processing. Mercury engineers developed the RFM-1RS18 tuner using building blocks that adhere to OpenRFM guidelines and a modular, open-architecture approach, standardizing the electromechanical, software, control plane, and thermal interfaces to streamline the design, integration, and testing of RF and digital capabilities within sensor processing systems. Mercury developed OpenRFM for open-systems digital and RF and microwave convergence, spectrum-fusion and maneuverability, complementary system interoperability, and affordability.

FOR MORE INFORMATION visit **Mercury Systems** online at *www.mrcy.com*.

POWER ELECTRONICS

DC-DC converter for autonomous ground vehicles introduced by TDK-Lambda

TDK-Lambda Americas in San Diego

is introducing the TDK-Lambda 2500W EZA2500-32048 bidirectional DC-DC converter for power electronics needs in autonomous ground vehicles, robots, cranes, and elevators. This power supply can change conversion direction automatically and continuously from grid side 320 volts DC nominal to battery side 48 volts DC nominal. The EZA2500 also is for solar- or wind-powered energy storage systems, energy recovery, and recycling previously wasted power from battery testers. When a 300 to 380 high-voltage DC source is available, the converter can be programmed to charge 48 volts DC rechargeable lithium-ion battery banks. At night, the stored energy then can convert back to high-voltage DC to power either DC-AC inverters or DC-input electrical and electronic devices.

FOR MORE INFORMATION visit **TDK-Lambda** online at *www.tdk-lambda.com*.

SENSOR PROCESSING

3U CompactPCI and 6U VME sensor interfaces introduced by NAI

North Atlantic Industries (NAI) in Bohemia, N.Y., is introducing a family of sensor interface units (SIU) in 3U CompactPCI or 6U VME board form factors for military and aerospace applications. The boards come in configurations ranging from one to five slots, and are for embedded computing applications that require high-density I/O, communications, Ethernet switching, and processing. The boards are built on NAI's Custom-On-Standard Architecture (COSA), which offers configurable communications systems via a flexible mix-and-match design.

The rugged systems deliver off-the-shelf solutions that accelerate deployment of SWaP-optimized systems in demanding air, land, and sea applications, company officials say. By employing NAI's scalable COSA architecture, customers can choose from more than 40 intelligent I/O, communication, and Ethernet switch functions, as well as single-board computer options.

FOR MORE INFORMATION visit **North Atlantic Industries** online at *www.naii.com*.

AVIONICS

Line driver to convert TL/CMOS data to ARINC amplitudes introduced by DDC

Data Device Corp. (DDC) in Bohemia, N.Y., is introducing the DD-4107X ARINC 429 line driver to

convert TL/CMOS serial input data to ARINC-specified amplitudes in avionics applications. The 8-pin small outline integrated circuit (SOIC) package with exposed pad for thermal enhancement is a drop-in replacement for Holt and DEI line drivers. Benefits include low power consumption. "The ARINC 429 line driver continues DDC's commitment to providing a range of connectivity support for aerospace applications, from components to boards to system-level solutions," says Mike Hegarty, DDC's data bus component product line manager.

FOR MORE INFORMATION visit **DDC** online at *www.ddc-web.com*.

DATA RECORDERS

Rugged portable data recorder for SIGINT and test introduced by Pentek

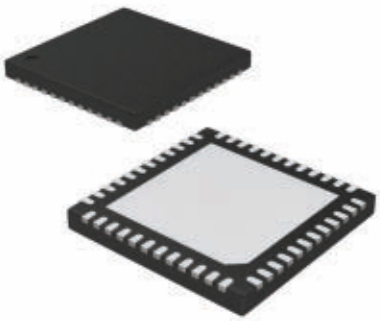
Pentek Inc. in Upper Saddle River, N.J., is introducing the model RTR 2726A rugged portable data recorder for wideband signal recording and playback in signals intelligence (SIGINT) and RF testing applications. The RTR 2726A has as many as eight recording and playback channels configurable for a specific mission or application. An optional DC power supply enables use in ground or airborne vehicles without inverters. At the heart of the RTR 2726A are Pentek Cobalt series Virtex-6 software radio boards with A/D and D/A converters, digital downconverters, digital upconverters, and field-programmable gate array (FPGA) IP. The RTR 2726A has a portable, lightweight housing measuring 16 by 6.9 by 13 inches and weighing less than 30 pounds. The workstation is reinforced with shock-absorbing rubber corners and influence-resistant protective glass for its high-resolution, 17-inch LCD monitor.

FOR MORE INFORMATION visit **Pentek** online at *www.pentek.com*.

RAD-HARD FPGAS

Radiation tolerant FPGAs for space introduced by Microsemi

Microelectronics experts at the U.S. Defense Logistics Agency (DLA) at Fort Belvoir, Va., have placed the ProASIC3 field programmable gate array (FPGA) from Microsemi Corp. in Aliso Viejo, Calif., on the Qualified Manufacturers List (QML) for Class Q radiation-tolerant devices for use in space applications. The listing qualifies the Microsemi radiation-tolerant (RT) ProASIC3 FPGAs to MIL-PRF-38535 QML Class Q military standards, and assures buyers of the ProASIC3 devices that the FPGAs can operate reliably in space and in similar radiation environments. The devices are the first flash-based FPGAs to receive a QML qualification, Microsemi officials say. A QML designation qualifies a manufacturing process through statistical process control, rather than qualifying each electronic part individually.



FOR MORE INFORMATION visit **Microsemi Corp.** online at *www.microsemi.com/products/fpga-soc/fpga-and-soc*.

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