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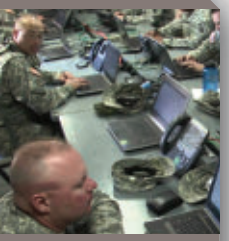

COVER STORY

BY **JOHN KELLER**, EDITOR IN CHIEF

Why is the Navy developing weapons so quickly? Just look to the South China Sea

U.S. Navy technology and weapons development has been among the top defense priorities of the Trump Administration; a quick glance across the Pacific, and it's easy to see why. The South China Sea is one of the most important international waterways, and it's quickly falling under exclusive control of the People's Republic of China.

The armed forces of China are building military bases on contested islands in international waters of the South China Sea, and have deployed anti-ship cruise missiles on at least one of these islands. It's clear from the military buildup in the region that China has the ability to dominate the South China Sea, and the U.S. Navy is about the only thing that could stand in its way.

So why should we care about the South China Sea, and why should China's emerging military superiority in the region be a concern?

The South China Sea borders on China, Taiwan, the Philippines, Malaysia, Indonesia, and Vietnam. China has the longest coastline on this waterway — about 9,000 miles — so it's understandable that China has legitimate territorial concerns.

At the same time, however, the South China Sea has tremendous international strategic and commercial significance aside from China. At least one-third of the world's shipping passes through it each year, carrying more than $3 trillion in trade. The South China Sea also has important fisheries, and may hold large oil and gas reserves.

Much of the world depends on free access to the South China Sea for maritime commerce. While China has not indicated a desire to limit access to and through the waterway, such a move cannot be ruled out — given today's volatile climate in international relations.

China's military has test-fired a YJ-62 anti-ship missile from Woody Island in the Paracel Islands in the northern part of the South China Sea. The island is northwest of the disputed Spratly Islands, east of Vietnam, and southeast of China's Hainan Island.

The YJ-62 is a subsonic cruise missile with a 463-pound explosive warhead. The missile can attack ships from as low as 23 feet above the water and can cover distances from its launch site as far out as 250 miles.

In itself, one YJ-62 missile battery in the Paracel Islands is not a dire threat to international shipping, yet add a YJ-62 battery in the disputed Spratly Islands, and China would be in a position to seal-off the South China Sea from Vietnam to the Philippines.

Would the world's tanker and cargo ships attempt to transit through the South China Sea if under threat from China's land-, sea-, and air-based anti-ship cruise missiles? I wouldn't think so. Is this a likelihood today? Not really. But is it a possibility? Certainly yes.

So what if the worst happens and China effectively decides to close the South China Sea to international military and commercial shipping? Certainly much of that ship traffic could be rerouted south of Indonesia and north of Australia, but such a move causes its own problems.

Now consider the energy potential of the South China Sea with its oil and gas deposits. What chance does a Brunei, Malaysia, Philippines, Vietnam, or Taiwan have in an equitable sharing of regional energy resources with a China that dominates the region militarily?

Realistically, the only force that could level the playing field is the U.S. Navy. Is it any wonder, then, that Navy leaders urgently are developing new technologies in laser weapons, hypersonic missiles, fast attack submarines, emergency communications, radar-evading stealth, and advanced combat aircraft, just to name a few?

I have to admit that the South China Sea is one of the things that keeps me awake at night. The military forces of China and the U.S. are building up there quickly, and things easily could get out of hand.

Put simply, if there's a World War III, it's likely to start in the South China Sea. ←

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news

Raytheon to provide high-speed SATCOM antennas for nuclear submarines

Satellite communications (SATCOM) experts at the Raytheon Co. will provide the U.S., United Kingdom, and Australian navies with high-speed SATCOM antennas for submarines under terms of a $25.8 million order. Officials of the Space and Naval Warfare Systems Command (SPAWAR) in San Diego are asking the Raytheon Integrated Defense Systems segment in Marlborough, Mass., to provide six Submarine High Data Rate (Sub HDR) antenna systems. The Sub HDR antennas provide submarines with high-capacity communications in the extremely high frequency (EHF) and super high frequency (SHF) SATCOM bands and enable reception of Global Broadcast Service messages. The Sub HDR connects submariners to the above-sea world by giving them high-data-rate, multi-band SATCOM capability. Submariners deploy Sub HDR by raising a mast-mounted antenna above the ocean's surface, while the submarine remains submerged at periscope depth where the boat is difficult to detect. The system can send and receive mission-critical information, such as secure wideband multimedia, voice and data traffic, imagery, and video teleconferencing. Sub HDR enables underwater forces to participate in coordinated fleet battle group operations.

L-3 eyes advanced submarine towed array sonar with ability to resist obsolescence

Submarine sonar experts at L-3 Chesapeake Sciences Corp. in Millersville, Md., will build additional TB-34X towed array sonar systems for U.S. Navy submarines under terms of a $9.6 million order. Officials of the Naval Sea Systems Command [PAGE 8]

Pentagon eyes 12.3 percent spending boost in electronics, communications, and intelligence

BY **John Keller**

WASHINGTON — U.S. military spending in substantial electronics accounts is set for notable increases next year as spending increases are expected for procurement and research in military communications, electronics, telecommunications, and intelligence (CET&I) technologies.

The U.S. Department of Defense (DOD) is asking Congress for $12.93 billion for CET&I procurement and research in the fiscal 2019 proposed DOD budget, which is up by $1.42 billion, or 12.3 percent, over the 2018 DOD request. These accounts contained $15.1 billion as recently as fiscal 2012.

The DOD request for CET&I procurement and research does not include military activities with substantial electronics content, such as aircraft avionics, vetronics, and missile guidance.

When these additional DOD electronics-heavy accounts are added, Pentagon spending levels for military electronics and defense electro-optics next year could approach $137 billion, industry analysts believe.

The DOD's CET&I budget request for fiscal 2019, which begins next October, includes $9.83 billion for procurement, which is up by 18.36 percent from the Pentagon's 2018 request of $8.3 billion.

Military electronics spending is headed for a 12.3 percent spending increase in fiscal 2019.

The proposed budget also requests $3.1 billion for CET&I research, development, test, and evaluation (RDT&E), which is down from the 2018 requested level of $3.21 billion.

Highlights of the Army's proposed CET&I 2019 procurement budget request include $469.1 million for tactical network technology modernization; $351.6 million for handheld manpack small form fit (HMS) radios; $213.8

million for commercial off-the-shelf (COTS) communications equipment; $88.3 million for communications security; $104.3 million for information systems; $276.8 million for installation information infrastructure modernization; $299.7 million for the Army Distributed Common Ground System; $153.6 million for night-vision devices; $297.8 million for the indirect fire protection family of systems; $431.4 million for Joint Battle Command-Platform (JBC-P); $327.3 million for counterfire radars; and $230.4 million for automated data processing equipment.

Highlights of the Navy's CET&I request include $318.2 million for fast attack submarine acoustic equipment; $294.7 million for the Fixed Surveillance System deep-sea sonar; $420.3 million for the AN/SLQ-32 shipboard electronic warfare system; $220.9 million for shipboard information warfare exploit; $423 million for the Consolidated Afloat Networks and Enterprise Services (CANES) program; and $113.9 million for the Navy multiband terminal.

Highlights of the Marine Corps CET&I request include $225 million for the Ground/Air Task Oriented Radar (G/ATOR); $124.8 million for command post systems; $73.8 million for intelligence support equipment; $87.1 million for Next-Generation Enterprise Network (NGE N); $124.8 million for command post systems; and $279.7 million for radio systems.

The Air Force CET&I request includes $114.4 million for communications security equipment; $114.8 million for air traffic control and landing systems; $205.4 million for the Air Force Physical Security System; $132.7 million for combat training ranges; $140.9 million for minimum essential emergency communications; $102.8 million for the Air Force Network (AFNet); $189.1 million for tactical communications and electronics equipment; and $169.4 million for base communications infrastructure. ←

Draper Lab to upgrade inertial guidance on Trident submarine nuclear missiles

BY **John Keller**

WASHINGTON — U.S. Navy strategic weapons experts are improving the accuracy of the nation's fleet of submarine-launched ballistic missiles with the latest upgrades to the Trident (D5) nuclear missile guidance systems.

Officials of the Navy Strategic Systems Program office in Washington announced a potential $132.9 million order to the Charles Stark Draper Laboratory Inc. in Cambridge, Mass., for Trident (D5) MK 6 guidance system production.

The order — a modification to a $53.5 million contract awarded to Draper in January 2017 — includes failure verification, test, repair, and recertification of Trident MK 6 guidance system inertial measurement units (IMUs), electronic assemblies, and electronic modules.

The Trident II submarine-launched ballistic missiles will be more accurate than ever with upgraded guidance systems.

The Navy's Trident II D5 nuclear missiles are designed for launch from Ohio-class ballistic missile submarines, as well as from the Navy's future Columbia-class submarine. The Columbia-class submarine program, which will replace the Ohio-class ballistic missile submarines, will begin construction in 2021 and enter service in 2031. From there, the submarine class will serve through 2085.

The Trident II nuclear-tipped ballistic missile has a range of more than 7,000 miles and carries four independently targeted 475-kiloton nuclear warheads.

The Trident missile's MK 6 guidance system consists of an electronics assembly with the system's flight computers, and an IMU with the system's inertial sensors. The

electronics assembly interfaces with the submarine's fire-control system and the missile's flight-control electronics assembly. The IMU, meanwhile, senses the motion of the missile and provides navigation information to the mission computer.

Trident missiles are aboard 14 Navy Ohio-class submarines and four British Royal Navy Vanguard-class submarines. Each Ohio-class submarine can carry as many as 24 Trident atomic missiles. These vessels together carry about half of all U.S. strategic thermonuclear warheads.

The Draper Lab contract is part of a Navy effort begun in 2002 to extend the life of the D5 missiles to the year 2040 by replacing obsolete components with commercial off-the-shelf (COTS) hardware. Upgrades involved the missile reentry systems and guidance systems.

The first flight test of a D5 extended-life subsystem, the MK 6 Mod 1 guidance system, was in early 2012 aboard the ballistic missile submarine USS Tennessee (SSBN 734).

The Trident nuclear missile has a maximum speed of 13,000 miles per hour, and has precision guidance from inertial sensors with star sighting. No GPS-guided Trident D5 missiles have been deployed.

The Trident II missile warhead discharges the energy of 475,000 tons of TNT, and is roughly 30 times the size of the U.S. nuclear bomb dropped on Hiroshima, Japan, in 1945.

On this order, Draper Lab will do the work in Minneapolis; Pittsfield and Cambridge, Mass.; and Clearwater, Fla., and should be finished by January 2021. ←

For more information, visit ***Draper Lab*** *online at* www.draper.com, *or the* ***Navy Strategic Systems Programs Office*** *at* www.ssp.navy.mil.

Trophy active-protection system: The best defense is shooting back

The Trophy anti-missile system now going on U.S. tanks won't accidentally shred friendly troops when it goes off; it will calculate where the enemy fired at you from so you can shred them. Breaking Defense reports. To intercept a threat, the Trophy tank-defense system needs detailed data on the incoming munition's trajectory, which means it can figure out the point of origin. Since 1916, the biggest

threat to tanks has been, not other tanks, but ambush by hidden anti-tank weapons, from repurposed field guns in World War I to specialized panzerjäger vehicles in World War II to shoulder-fired rocket propelled grenades and anti-tank guided missiles today. Tank designers have improved armor materials to diffuse the impact of explosions and installed "reactive armor" that blows itself up to prematurely detonate incoming warheads. But without some sort of breakthrough, more advanced threats require heavier armor, driving modern Western main battle tanks like the American M1 Abrams and Israeli Merkava north of 70 tons. ←

[FROM PAGE 4]

in Washington are asking L-3 to provide TB-34X towed array assemblies and cable assemblies. The TB-34X is a submarine fat line towed array passive sonar receiver in the same form factor as the TB-34 array, yet it provides increased capability, reliability, and ability to resist the effects of obsolescence. The Navy's TB-34 towed array is replacing the TB-16 legacy array, and provides enhancements to towing and self-noise characteristics compared to the TB-16. It provides more hydrophones than the TB-16 for future capability in passive sonar processing. The TB-34 towed array is one of several acoustic sensors that provide data to the Acoustics-Rapid Commercial Off-the-Shelf Insertion (A-RCI) sonar system installed on U.S. fast-attack, ballistic missile, and cruise missile submarines. The array is to provide improved capability for anti-submarine warfare (ASW), and will help submarine crews avoid threats in cluttered undersea areas near coastal waters and harbors.

Naval warfare will change forever if submarines turn into underwater aircraft carriers

Imagine a future in which nuclear attack submarines (SSNs) can deploy unmanned undersea vehicles (UUVs) to hunt, and possibly kill, enemy subs. The U.S. Navy, at least, is taking steps to make this a reality. What impact could aircraft-carrying unmanned underwater vehicles have? On the one hand, UUVs could shake modern antisubmarine warfare (ASW) to its core, making existing platforms vulnerable or obsolete. On the other hand, the development of UUVs could reinforce existing hierarchies; in contrast to popular understanding, established organizations are often the best at adapting to disruptive military innovations. The future of the U.S. Navy depends to great extent of which of these becomes a reality. ←

Army makes big order for Excalibur satellite-guided smart munitions

Smart munitions experts at the Raytheon Co. potentially will build hundreds of additional M982 Excalibur satellite-guided heavy artillery shells for the U.S. Army under terms of a $70.7 million order. Officials of the Army Contracting Command at Picatinny Arsenal, N.J., are asking the Raytheon Missile Systems segment in Tucson, Ariz., to produce Option 6 Excalibur 155-millimeter Increment Ib projectiles. Excalibur has a ruggedized global positioning system (GPS) satellite navigation receiver and uses satellite signals to help guide itself to its intended targets. The 155-millimeter artillery shell can hit targets as far away as 25 miles, or detect and attack moving targets in cities and other complex terrain after being fired at high angles and high altitudes. Excalibur is a fire-and-forget smart munition with better accuracy than existing 155-millimeter artillery rounds. These shells are fin-stabilized, and are designed to glide to targets with base bleed technology, as well as with canards located at the front of the munition that create aerodynamic lift. ←

MILITARY WEARABLE COMPUTING

HITS THE MAINSTREAM

Warfighters capitalize on Internet of Things (IoT) technology, secure networking, and batteries to create tactical smartphone-like computing for the infantry, as well as new generations of smart clothing with electronics built-in.

BY **J.R. Wilson**

Fifty years ago, computers were housed in their own specially designed buildings, incorporating strict temperature controls, anti-dust air circulation, and even vibration dampeners.

In 1983, Motorola introduced the first commercial handheld cell phone, the DynaTAC 8000x, which weighed 1.75 pounds, was 13 inches long, took 10 hours to recharge, offered 30 minutes of talk time, cost $4,000, and could only make and receive voice calls.

The first commercial smartphone — which combined voice and text messaging with limited computing applications — was introduced in 1999, but it took more than a decade for them to become the cell phone market leader. By that time, they were beginning to incorporate clocks, cameras, GPS navigation, address books, word processors, barcode scanners, calculators, and much more.

The evolution of the cell phone and smartphone eventually came to be the primary driver of small, fast, capable, and reliable computer chips and related electronics. As a result, the average smartphone of 2018 has greater computing speed and capability than all the NASA computers used for the Apollo 11 moon landing.

All of this has led to the greatest revolution in individual warfighter equipment and capability in history. With a variety of wearable computing devices already in or on combat uniforms and backpacks, the modern warfighter has less in common with his Vietnam-era counterpart than the Vietnam soldier had with a Roman legionary.

But the current state-of-the-art in military wearable computing soon will seem as primitive as comparing an Operation Desert Storm Pioneer unmanned aerial vehicle (UAV) with a 2018 U.S. Air Force MQ-9 Reaper hunter/killer UAV.

The role of batteries

Batteries represent the major limitation on the expanded implementation of wearable computing devices — from communications to health monitoring to chemical/biological/radiological (CBR)

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sensors to helmet-mounted displays of real-time maps and data from other warfighters, other units, field headquarters, UAVs, satellites, and manned airborne platforms. Lightweight, long-lasting, fast, and field-rechargeable batteries are in heavy demand.

Battlefield deployments away from supply depots typically last for 72 hours or longer. Under these circumstances, short-lived batteries could prove fatal to warfighters relying on in-uniform communications and other devices.

Lithium thiol chloride batteries, while not rechargeable, meet many of those requirements. They are compact and lightweight, have extended runtime, and are able to operate in temperatures from -30 to 140 degrees Fahrenheit. Nevertheless, greater advances are required for in- or on-uniform power to handle everything currently in development for wearable computing.

Other areas where today's wearable computing technology is lacking include secure communications with anti-spoofing, anti-jamming, and non-interception; non-interference among worn devices; onboard data processing; response to abnormal readings; and even smaller sizes.

A warfighter's combat uniform, loaded with a vast array of wearable computing devices, is, essentially, an Internet of Things (IoT) application in a personal area network (PAN).

The U.S. Department of Defense (DOD) was an early leader in IoT technologies, in such programs as Nett Warrior, an integrated dismounted situational awareness and mission command system, and the Force XXI Battle Command Brigade and Below (FBCB2) for battle command and control, communications, and real-time situational awareness. In the past decade, however, commercial IoT developments, with fewer security and ruggedization requirements, have significantly outstripped the military.

Marine Corps Lance Cpl. Skyler Stevens uses new night optics technology during Advanced Naval Technology Exercise 2018 at Camp Pendleton, Calif. The Marines were testing new technologies to improve survivability, lethality, and connectivity in complex urban environments.

Smart clothing

One area in which commercial development is moving more rapidly than might be imagined — and in which the military has a vested interest but little direct involvement — is "smart" clothing.

The first and some early second generations of smart clothing already are available, primarily designed to monitor physical fitness and body reactions to exercise. The third generation, now in development, is being called a wearable computer, featuring flexible, stretching material onto which a 3D printer can print a variety of sensors reading several types of data simultaneously. Such clothing can be washed without removing the sensors, which also would be invisible to the naked eye.

Other features include wireless connections, a large surface for reading out data, freedom of movement and, of special interest to the military, potentially low-cost production.

With its built-in microcomputer, based on miniaturization and flexible components, proponents claim third-gen smart clothing not only can collect a variety of data, but also can use it to predict outcomes and adapt itself to a changing environment without the need for preconfiguration.

Another potential plus of smart clothing is "passive haptic learning" (PHL), in which the results of a motion capture system — tracking a martial arts expert, for example — are programmed into the clothing. Whenever the wearer makes an incorrect move, the applicable part of the body receives a tactile (haptic) response. In theory, this would stimulate muscle memory and greatly reduce the time required to learn a new skill, even to an advanced level.

Smart clothing also could help bring a long-sought military goal to fruition — augmented reality — which the military and its research labs have been seeking since the Soldier Integrated Protective Ensemble effort in 1989. In 2017, the Army Communications-Electronics Research, Development and Engineering Center (CERDEC) and Army Research Lab (ARL) unveiled their wearable Tactical Augmented Reality (TAR) program to help soldiers access sensor and other data, both those monitoring their own health and those providing enhanced situational awareness.

Graphical situational awareness

CERDEC experts also are working on Soldier Visual Interface Technology (SVIT), which improves situational awareness with icons and graphics that are visible within the user's field of view (FOV). The Nett Warrior (NW) end user device (EUD) enables the warfighter to see-through a helmet-mounted display in limited visibility. SVIT improves lethality with the Rapid Target Acquisition function providing bore-sighted weapon sight imagery within the user's FOV. The device is controlled with four integrated buttons or voice activation using a boom microphone. SVIT reduces the need for the user to look down at a display and improves lethality and survivability with remote weapon sight imagery.

The Defense Department urges service members and DOD civilians with wearable electronic devices to use the strictest privacy setting. Officials suggested after publication of a "heat map" showing concentration of U.S military personnel overseas.

The Army's Program Executive Office (PEO) Soldier at Fort Belvoir, Va., is working on CombatConnect — a rugged, lightweight, power-efficient, soldier-worn electronics system that distributes data and power to and from devices via a smart hub integrated into the vest or plate carrier. It has a common connector to translate data between devices.

The Army's Nett Warrior Future Initiatives (NWFI) project provides situational awareness and mission command capability to the infantry leader by disseminating information quickly to help commanders make rapid decisions. NWFI expands on the Nett Warrior system by integrating new capabilities like full-motion video, robotic control, broadband networks, sensors, and physiological monitors.

The Army Intelligence Center Of Excellence at Fort Huachuca, Ariz., is working on the Machine Foreign Language Translation (MFLTS) to provide warfighters with basic automated foreign speech and text translation capability. Soldiers can translate foreign language documents using the MFLTS Text-to-Text Translation Application to support situational understanding.

FLIR Systems in Wilsonville, Ore., is manufacturing the Black Hornet 3 pocket-sized unmanned helicopter with integrated camera for mounting on a squad member's combat vest as an elevated binocular for pre-strike and urban-maneuver in all-weather and day-night environments.

Gwacs Defense Inc. in Jenks, Okla., produces the Ground Warfare Acoustical Combat System (GWACS), a man-wearable tactical system that identifies and locates hostile fire in less than one second. It also can detect and track Small UAVs and display friendly forces, and provides extensive post-incident forensic capabilities.

The potential of IoT

In December 2016, a paper titled "DOD Policy Recommendations for the Internet of Things" described IoT's potential benefits to battlefield situational awareness. Early deployment of wearable computing devices like fitness trackers, however, have emphasized the need for security at levels far beyond commercial requirements.

In November 2017, DOD discovered a global "heat map" posted by an online "social network for athletes," showing where its users running routes were located. This enabled terrorists or enemy nations to locate known and suspected U.S. military bases in combat zones in Afghanistan and Syria, as well as on the African continent — all outlined on the heat map from fitness data transmitted to the Internet as warfighters performed their morning workouts. The heat map also made it possible to identify supply routes and other links between bases and local population centers.

The battle dress uniform may become a wearable electronic network that transports data to and from a troop's wearable computer. A modular load-bearing vest with a built-in radio antenna will be evaluated this year.

Earlier this year, Bitdefender, a Romanian cybersecurity and anti-virus software company, reported discovery of a new, fast-spreading and constantly changing IoT malware botnet dubbed Hide and Seek (HNS) that can hack IoT devices and create its own self-protecting firewall rules, enabling it only to accept commands from its creator while mining its target for information.

"The discoveries made during the investigation of the Hide and Seek bot reveal greater levels of complexity and novel capabilities, such as information theft — potentially suitable for espionage or extortion," according to Bitdefender senior e-threat analyst Bogdan Botezatu. "It is also worth noting that the botnet is undergoing constant redesign and rapid expansion."

Ensuring the security of wearable computing devices is further complicated by a shortage of data scientists and IoT expertise, from the highest levels of the Pentagon down to troops in the

field. While DOD is working to resolve that issue, it is complicated by an overall shortage of such experts to meet high demands from the commercial sector.

The U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., has been working on these issues for a long time and program managers now believe they are closer than ever to developing new technologies to benefit not only those in combat, but also those in training. The Marines, for example, have suffered 1,250 combat deaths since the turn of the century in Iraq, Afghanistan, and Syria. During that same period, however, 1,500 Marines have died in training, some in accidents, others from medical problems.

Tracking soldiers with smartphones

Warfighter Analytics using smartphones for Health (WASH) is a new DARPA program looking at how the military might use health sensors to monitor individual warfighters, then transmit that data to medics, corpsmen, field hospitals, and higher command.

"The immediate intent is to use sensors embedded in cell phones carried by warfighters, but that is sort of a rehearsal on figuring out what we could or should be able to do with sensors attached to the body or on clothing," says WASH Program Manager Angelos Keromytis. "We're interested in raw data, but also data processed by the phone's hardware and software. We expect to do some level of preprocessing, on the phone itself, if only for data reduction. During the research process, we will be taking a lot of data out of the phone, but any production effort would minimize data leaving the device."

The whole idea is to link the transmitted data to the individual warfighter's profile, based on the device from which it is transmitted.

"In a field deployment, very little data might be streamed out ahead of time, instead remaining on the device until the user authorizes it or the data indicate a problem," Keromytis says. "If we can detect the wearer is immobile or unconscious, the system could well be designed to notify the nearest medical personnel. But the program only kicked off about a month ago, so the end use is a little early to determine. The hard question is whether we can make sense of collected data, detect health issues or injuries using this direct way of sensing the user and environment."

This technology has potential application to detecting warfighter exposure to a chemical or biological agent remains. For now the program is investigating traumatic brain injury (TBI) and infectious disease. "If we are successful there, chances are it will spur research into expanding the scope of what can be sensed," Keromytis says.

Networking wearable sensors

Linking wearable sensors to in-uniform medical response systems like automatic tourniquets, injections of common medications, and application of blood-clotting agents, is a future possibility.

"Most of the work done in this space focuses on specific sensors — miniaturizing them and improving batteries — and those sensors tend to be focused on specific capabilities, such as EKG," Keromytis says. "We're looking more holistically at a universal collection platform, which is less customized, but gives us the potential capability to have a lot more and more diverse data than would otherwise be possible to deploy on the wide population."

While WASH is basically a communications hardware development, another program in DARPA's Biological Technologies Office has potential sensor linkage to WASH down the line. In Vivo Nanoplatforms (IVN) is a tissue-integrating hydrogel biosensor developed for DARPA by Profusa Inc. in San Francisco. A variation on wearables, it measures body chemistry from inside the body and can be interrogated by a patch worn on the skin that sends data to a smartphone or similar device.

The IVN system comprises a sensor that is smaller than a grain of rice, that goes under the skin, with a reader on the skin. The sensor is composed of hydrogel, which is similar to the composition of the underlying subcutaneous tissue. That is important because the body does not see it as foreign and so does not surround it with scar tissue or a foreign body response. As a result, the sensor can stay in place for as long as four years, sensing and transmitting data to the reader without the warfighter worrying about removing or replacing it.

"IVN will monitor tissue-level oxygen and lactate, indicators of muscle utilization and activity, but also show problems with respiration," says IVN Program Manager Col. Matt Hepburn. "If the warfighter is losing a lot of blood and so not getting enough oxygen to the tissues, lactate levels go up and oxygen levels decrease. We're also doing research to look at other things we measure."

Smaller than a grain of rice, Profusa's implantable biosensors can measure body chemistries such as oxygen and glucose continuously to overcome the "foreign body response" that results in local inflammation or rejection.

Medical sensors

"The commercial world is funding glucose sensors, so commercial investment is pushing the platform forward, even though for different analytes," Hepburn points out. "For the DOD, we also would like to measure electrolytes and carbon dioxide, which can be an early marker to respiratory failure. The playbook for DARPA is to invest in the proof-of-concept of a new and developing technology, then let our partners in DOD and elsewhere develop the future apps."

Such sensors also could help control any future in-uniform medical interventions. This could help determine optimal use cases and duration of those interventions. For example, in applying a tourniquet, depending on how much blood flow is stopped and the duration, the sensor could monitor oxygen levels to ensure the amount of bloodflow to the arm was optimized.

"We really want to assess someone's health on a continuous basis, which fundamentally transforms the practice of medicine and enables us to tell if our soldiers are 100 percent effective to accomplish the mission, even before they begin to really feel bad," Hepburn explains. "Once you go into septic shock, for example, it's hard to bring someone back. All these sensing programs will enable an early intervention to prevent a bad outcome."

Wearable technologies have their limitations — especially those placed on or under the skin for medical applications. "The first can sense heart rate, but that doesn't give enough of a picture to figure out on an early basis if the individual is outside the normal range of health," Hepburn says. "If you can sense what is happening beneath the skin at the tissue level that will be more sensitive to tell us something bad may be happening."

Hepburn says he expects to begin field tests and evaluation of IVN in the next year or two as they work to deploy these technologies as fast as possible.

"This could be an amazing training aid to optimize personal performance, such as really elite military personnel who train at the level of high-performance athletes," Hepburn says. "But in the Army, we have a constant impetus on readiness, ensuring each soldier is

ready to deploy. There are a lot of reasons why people are not in optimal physical condition, so if we can boost performance on the Army physical fitness test by 20 percent by optimizing the soldiers' training performance, it would be a great advantage."

Saving lives

Marine Corps officials acknowledge using such devices essentially to tailor training to individual needs and capabilities will require a major change in Marine culture. Even so, they add, being able to monitor warfighters for readiness — and to keep them from over-exerting themselves during training — will save lives and add to the warfighters' deployable effectiveness.

Once deployed, the information the wearable medical devices gather for field medics, field hospitals, and commanders will be mission-dependent. Transmitting health information to preventive medicine units or a garrison could help control disease outbreaks. If transmitted from a point of injury, vital signs, oxygen, and lactate levels would help field medical personnel prepare to treat the patient.

"In other situations, we may not want to transmit information if it is a possible security risk," Hepburn notes. "If transmitting information is a security risk to the mission, then it can be localized and not transmitted at all. If the mission requires tracking the health of the population, then it would be secured as we secure any critical information now."

Keromytis says security is an important component of WASH, preventing an enemy intercepting WASH data to gain some advantage in knowing the physical condition of U.S. forces. "If that were to happen, they would get the same insight as our commanders. So the program is looking not just at collection and analysis of the data, but also its safety. It will be kept encrypted from the collection point, through the network and even at the back-end database, to comply with privacy regulations and because it is potentially useful data to an adversary," he explains, adding that an enemy "spoofing" data to give U.S. commanders false information is a somewhat different case.

"That would require that the device itself is captured or compromised or the cryptographic keys are broken or stolen. Of course, anything is possible, but we are taking measures within the context of the program to minimize the risk. There are other efforts, within DARPA and across DOD, to protect all types of platforms and IT systems. So, it is a moving target in terms to ensuring protection right now."

WHO'S WHO IN WEARABLE DEVICES

Army Communications-Electronics Research, Development and Engineering Center (CERDEC)
Fort Belvoir, Va.
https://www.cerdec.army.mil

Army Program Executive Office (PEO) Soldier
Fort Belvoir, Va.
http://www.peosoldier.army.mil

Army Research Laboratory (ARL)
Adelphi, Md.
https://www.arl.army.mil/www/default.cfm

FLIR Systems
Wilsonville, Ore.
https://www.flir.com

Gwacs Defense Inc.
Jenks, Okla
http://www.gwacsdefense.com

Bitdefender
Bucharest, Romania
https://www.bitdefender.com

U.S. Defense Advanced Research Projects Agency (DARPA)
Arlington, Va.
https://www.darpa.mil

Aerospace and defense applications drive connector and cabling innovation

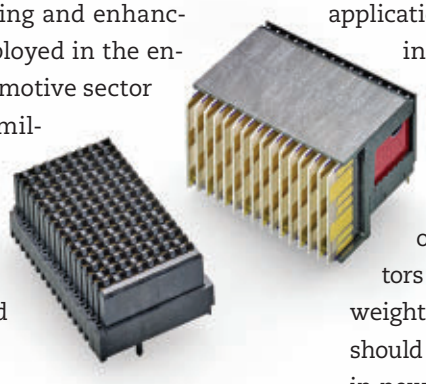
Growing demands for high-throughput, ruggedness, and small size and weight are making their mark on modern interconnect and cabling designs.

Connector and cable firms are innovating to meet the demands of deployed warfighters.

BY **Courtney E. Howard**

Modern applications across aerospace and defense require advanced interconnect and cabling technologies capable of meeting the demands of power-hungry devices and data-heavy workloads in harsh environments.

Connector and cabling product engineers are transferring and enhancing technologies employed in the enterprise and the automotive sector to meet the needs of military and aerospace systems, which are trending toward ever more compact, high-throughput, and rugged designs.



TE Connectivity MULTIGIG RT3

Compact and capable

"Commercial aerospace and defense applications continually drive technical advancements and are pushing new product options and performance requirements," says Matt McAlonis, global engineering leader of the TE Connectivity aerospace, defense, and marine business unit in Lancaster, Pa.

Vehicle and system designs are shrinking in size and weight across virtually all aerospace and defense applications, prompting the increased density of modern connectors and cables.

"Functional density should be optimized in connectors and cables, and size, weight, and power (SWaP) should always be optimized in new designs," McAlonis says, describing the current "rule of thumb" for new mil/aero products. "These connectivity products are expected to provide increased performance and enable connectivity in new applications."

Requests are growing for cables to data standards such as Gigabit Ethernet using smaller conductors than described in the American National Standards Institute/Telecommunications Industry Association (ANSI/TIA) 568 C.2 standard, says Robert Moore, senior principal engineer at TE Connectivity.

In applications with cable run lengths as short as 10 meters, for example, systems designers ask for 28 (AWG) to accommodate size and weight limitations, as compared to standard 24 or 26 AWG constructions. In commercial aerospace, break strength and longevity in vibration environments place limitations on what designers specify. "They will not use smaller than 26 AWG conductors," Moore says.

Low weight and high EMI

"In weight-critical designs and those that require long-distance, high-speed data transfer, fiber-optics technology

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can provide significant reductions in space and weight compared to copper-based connectivity solutions," says TE Connectivity's McAlonis.

Fiber optics is becoming more and more desirable in mil/aero applications, says Mark Hearn, product manager at MilesTek Corp. in Lewisville, Texas. Fiber-optic technologies are a popular choice for reasons that include protection from electromagnetic interference (EMI).

"Mission-critical signals are increasingly in need of greater EMI protection," says Mike Savage, director of product management at ITT Cannon in Irvine, Calif. "As the rate and frequency of signals continue to increase, the likelihood of interference or crosstalk also increases, creating the potential for data breaches, inaccurate mission intelligence, and even possible loss of life.

Immunity to electromagnetic interference and radio-frequency interference (EMI/RFI) and electromagnetic pulse (EMP) is a major consideration in theaters of war as well as fiber's high-bandwidth handling capabilities, which far exceed any copper-based solution. "Its flexibility, small size, and light weight make it a perfect choice when designing new aerospace and military communications systems," says MilesTek's Hearn. "Also, fiber is a true future-proof technology since it can handle terabits of throughput even over a single core."

Concerns over cost and strength kept some engineers from opting for fiber optics in the past. Yet, Hearn stresses the durability of modern fiber-optic designs, noting that MilesTek "offers crush-proof tactical fiber cables that you could drive a vehicle over without causing damage to the cable. And, although previously a big cost concern, the optical transceivers used in fiber-based systems continue to decline in price, making fiber optics an even more attractive choice for newer designs."

MiniMRP, where MRP stands for modular rack principle, is a new ARINC standard, ARINC 836A, that includes fiber optics, small electronic packaging, and new connectivity options. MiniMRP can help modular avionics designers reduce weight and package size, and increases design flexibility over existing architectures.

"MiniMRP avionics is the next generation of integrated circuits (ICs), putting ever-increasing computing power into 40 percent smaller packages at lower costs," says TE Connectivity officials. "The ability to interconnect small-form-factor (SFF) electronic devices, either directly or over a network, enables distributed systems that replace traditional centralized systems. With MiniMRP avionics, the big box in the avionics bay can be replaced with many small boxes distributed throughout the aircraft, helping meet SWaP-reduction requirements."

Systems designers are building systems with distributed architectures in mind and now have electronic packing options in addition to the ARINC 600 legacy systems, says TE Connectivity's McAlonis. "Fiber-optic technologies are one of the hottest areas as industry demands are requiring and adopting this technology."

Automotive influence

The hottest innovation is Ethernet over single pair, TE Connectivity's Moore says. "New developments for 100BaseT1 and 1000BaseT1 that have been worked on for the automotive market are finding interest in the aerospace community. These new standards can reduce the size and weight of the cable; because of the use of a single pair, 100BaseT quadraxial cables or traditional four-pair cables are no longer required. We are working with standards committees to translate the requirements the automotive concerns have established into constructions that meet the environmental and safety demands of the aerospace community."

ITT Cannon's MKJ Clip Lock taps technology originally designed for the automotive industry to fulfill a need for reliable, cost-efficient, mini-circular connectors capable of delivering high

TE Connectivity MiniMRP offerings

performance in aerospace and defense applications.

"Today's aerospace and defense contractors are increasingly challenged to meet the ongoing demand for lighter, high-reliability interconnects for a wide range of applications, from commercial aircraft avionics and cabin systems to missiles and ordnance used by a modern military," ITT Cannon officials say. The quick-connect clip lock feature was intended for automotive installations but is well suited to soldier-worn systems given that it is easy to use and install, is field repairable, and offers multiple keying options to prevent miss-mating.

Industry continues to focus on soldier-worn system innovation to meet increased data demands in the field, while also reducing the physical burden of heavy, cumbersome equipment on warfighters in the field.

Soldier systems

"The trend toward smaller-sized connectors continues to influence soldier-worn defense technology," ITT Cannon's Savage says. "Today's warfighters need lighter, smaller interconnects that push data transfer rates, reduce overall weight, and enable quicker decision making.

"Soldier-worn equipment and devices will continue evolving, driving the need for further changes in electronic connectivity," Savage says. "Some examples of what the future may hold include: augmented and virtual reality (AR/VR) devices, smaller and more advanced military-grade radios and tablets, and helmets embedded with smart goggles, eye movement monitors, and advanced imaging technology.

Today, we're focused on enabling emerging high-speed protocols and designing interconnect solutions that are lighter and faster with increased bandwidth, keeping soldiers connected and allowing them to make quicker decisions."

Three expected requirements for connectivity in soldier systems are coming together in a way that experts say will continue influencing the connector market in the foreseeable future, explains Wayde King, product manager at ITT Cannon. "The first is the increasing demand for high-speed data, signal, and power to help soldiers remain connected, no matter the environment. The second is demand for

Modern cables and connectors must meet a variety of environmental demands.

connectors that can withstand water ingress or water submersion. This requirement has become increasingly important when designing interconnects for soldiers who are often exposed to uncertain terrain and harsh environments. And third is increasing demand for soldier-worn connector solutions with EMI shielding."

Designing connectors and cabling for harsh military environments is nothing new for many of today's suppliers. "Our design and engineering processes continue to keep pace with the needs of today's military," says ITT Cannon's Savage. "We advanced our existing Nemesis product technology knowing that soldiers needed something ultra-lightweight, incredibly durable, and highly reliable for extreme conditions and harsh environments." The new Nemesis II CBA is one of the first in the industry to be tested for water submersion to 20-plus meters, or roughly 65 feet of water, King adds.

ITT Cannon engineers designed the company's Nemesis II CBA miniature circular connector, with high-speed, quick termination to transmit power, signal, and data in a small, robust package. "It includes three innovative features: propriety sealing for water submersion to 20-plus meters (65.6 feet); Cannon Breakaway functionality to enable soldiers to disconnect and reconnect quickly when their cables and equipment become snagged, significantly reducing risk of injury and minimizing equipment damage; and spring-loaded Pogo contacts that enable 10,000-plus mating cycles (connection/disconnection) and superior durability."

The company's Rock-in-Lock (RIL) lightweight receptacle connector, roughly the size of a flash drive, is worn on a soldier's helmet or attached to field-use tablets to provide improved signal integrity and faster data transfer times on everything from augmented-reality headsets to tactical combat radios, King says. RIL features key to soldier-worn applications include: a positive lock or latching mechanism to maintain signal integrity and secure connectivity in the harshest environments, and single-handed "quick connect" allowing soldiers to attach the interface without a thumbscrew or coupling tool – saving critical seconds and minutes when it matters most, he adds.

The Nemesis II CBA and RIL both are used by ITT Cannon's aerospace and defense customers, and are garnering interest from the first responder community. "Our goal is to continue to design interconnect solutions that improve mobility, lighten physical load, and equip our customers with state-of-the-art technologies that evolve their combat systems and help them get home more safely," Savage says.

Connecting Nett Warriors

TE Connectivity product engineers designed the company's O.C.H. micro circular connectors in accordance with standards specified by the U.S. Army's Nett Warrior program, which was developed to connect ground soldiers directly to the Army's tactical network. The program requires that communications equipment be smaller and lighter than currently fielded systems to help take extra weight off the backs of soldiers. It adheres to certain mechanical and performance standards, including MIL-STD-810G related to harsh environmental conditions.

"In today's world, dismounted soldiers in the field rely on instant communications to assure informational superiority on the battlefield, and our O.C.H. Micro Circular connectors are built to withstand the harsh conditions soldiers endure and provide that connection they can count on," says Steven McIntire, senior manager of TE Connectivity's aerospace, defense, and marine products.

TE's O.C.H. micro-circular connectors are now the second authorized

source of Nett Warrior connectors, officials say. The new connectors are designed to meet the program's rigorous performance requirements, and feature breakaway coupling to enable the quick connection and single-action disconnection that battlefield conditions require, and a small, rugged package well suited to soldier-worn applications with a lightweight aluminum shell and thermoplastic inserts.

MilesTek Cat6 RJ45 Jam Nut

Data demands

"Sensors in new places are collecting data that can be used to provide greater intelligence to the users," TE's McAlonis says. Trends in the Internet of Things (IoT) and related capabilities have driven the innovation of many "smart" devices commonly used to share mission-critical information in aerospace and defense applications, including mobile platforms from warfighters to myriad vehicles in air, on land, and at sea. In some cases, he adds, high-speed signal protocols that specify connector signal impedance will limit the ability for further size reduction in high-speed copper cables and connectors."

The growing use of imaging and video for front-line warfighters also is pushing the bounds of cabling and connectors. "Many military and aerospace applications today require extensive use of imaging as well as high-speed data transfer that legacy connectors and cables cannot provide," MilesTek's Hearn says. "In many cases, customers have been requesting at least gigabit- and sometimes multigigabit-capable connectors and assemblies.

"We are seeing a trend toward the use of fiber-optic, ingress protection (IP)-rated copper Ethernet and high-frequency coaxial connectors," Hearn continues, which are "not necessarily multi-pin, high-density style connectors but higher-throughput and higher-frequency designs than previously used by the mil/aero industry. The driver for this is the industry's requirements for high-performance connectors that are faster, lighter, and capable of higher throughput compared to their predecessors."

Regardless of the application itself, "my advice to engineers designing systems today is to pay special attention to the connector selected with the cable," TE's Moore explains. "In the past, data rates and the data standards that

Selection criteria

BY MARK HEARN

The first consideration or question to ask is: In what environment and specific application will the connector/assembly be used? Determining environmental factors – such as shock, vibration, presence of chemical and liquid exposure – will lead you toward a connector/cable design that meets those specific requirements.

Another consideration is bandwidth and throughput requirements, both now and for the expected life of the platform the connectors/cables are being used in, considering potential future technology upgrades, etc. Some military communications platforms have a service life of 20 years or more.

One more thing to consider is the use of interconnects that are based on standards, with wide availability and limited servicing requirements.

Mark Hearn is a product manager at MilesTek Corp. in Lewisville, Texas

were transmitted could withstand the unmatched cable/connector impedance changes. As data rates have increased significantly, using a matched impedance connector is critical to signal integrity."

TE Connectivity NanoRF

Connected aircraft

Defense applications leverage advances in electronics technology and must offer secure and reliable data management. In commercial aerospace applications, safety and reliability is a given, says TE Connectivity's McAlonis, which provides aerospace-qualified sensor solutions and rugged connectivity products from the engines to the cockpit avionics and other electronics within the aircraft. Commercial aerospace and defense applications require reliable and rugged connectivity options that are optimized for high performance and SWaP, he says.

"Passengers desire an enhanced experience with the expectations of Internet, entertainment and social media connectivity, and TE's products are part of the systems which provide these features in a connected aircraft," McAlonis continues. "The expectation is that all this must be accomplished without compromise in connection speed or reliability."

The European Aviation Network (EAN) multinational initiative formed by Inmarsat and Deutsche Telekom in Pleinfeld, Germany, combines high-capacity satellite coverage from Inmarsat and a 4G LTE ground network from Deutsche Telekom to provide airline passengers traveling across Europe an in-flight broadband experience. The next-generation mobile satellite and ground network platform pairs a cellular network of 300 LTE towers with Ka-Band, Ku-Band, and S-Band satellites to supply Internet connectivity to aircraft at high data rates.

"European airspace is one of the busiest in the world and passenger volumes are expected to double in the next 15 years, with an increasing number of people wanting to stream videos or send e-mails at the same time while in the air," says Rolf Nafziger, senior vice president for international wholesale business at Deutsche Telekom. "A combined system that seamlessly integrates satellite connectivity with a complementary LTE-based network on the ground will create the much-needed additional capacity to meet demand now and in the future."

Engineers selected the GORE Microwave/RF Assemblies 7 Series from W. L. Gore & Associates Inc. in Newark, Del., to deliver continuous, high-quality signals for improved Wi-Fi Internet access on European short-haul flights. Chosen for installation in commercial aircraft, Gore's durable, vapor-sealed assemblies are engineered to prevent the ingress of water vapor, jet fuel, and harsh contaminants that naturally flow to the lowest point in the fuselage where the antenna is located. Shielding protects against EMI that can compromise signal integrity and reduce the quality of signal transmission.

"Passengers will benefit from this integrated approach by getting the speed that a ground network can deliver and the continual coverage that only a satellite can provide," officials say. "Data transmission between satellites, ground towers, and commercial aircraft must work seamlessly for this approach to be successful. Gore's vapor-sealed assemblies reliably connect the antenna located on the underside of the aircraft to the electronics within the aircraft, which in turn are communicating with the transceivers located on the ground."

Environmental concerns

Industry continues to bring commercial innovations and enterprise-level capabilities to aerospace and defense environments through rugged designs engineered to perform under extreme shock, vibration, exposure, and other harsh conditions. Commercial connector product technology will typically lead the aerospace industry, McAlonis says, so TE Connectivity will enable ruggedized versions of commercial products for aerospace and defense applications.

"With today's systems and vehicles being exposed to high levels of heat, shock, vibration, and other factors, the need for rugged, sometimes IP-rated, connectors is a requirement for many," MilesTek's Hearn says. The company's series of Fiber ST connectors/assemblies feature "a twist-lock connection along with a reinforced, beefier, spring compared to standard ST fiber cables that will withstand major shocks and vibration that are often found in combat and field operations."

Programs like the U.S. Army's Nett Warrior are driving the need for more durable, and yet lightweight connectors and cables.

Other popular connector styles include screw-down M8, M12, and IP68-rated circular threaded RJ45 connectors and assemblies. "Some popular connector types our customers are specifying into their designs are fiber LC (multimode and single mode), Fiber MTP, multi-core styles, and IP67- and IP68-rated RJ45 copper assemblies for use in Ethernet systems," Hearn continues. "Also, there is still a need for coax, high-frequency RF connectors like 3.5- and 2.92-millimeter types, which are still used in many new designs.

"For applications involving ground-based vehicles and seagoing vessels, we are seeing the continuing trend toward fiber-optic interconnects and copper-based Gigabit Ethernet connectors and assemblies," Hearn says. "In aerospace applications, we are seeing a trend toward lighter cables with higher temperature ratings. In all these scenarios, we still see the requirement for low-smoke, zero-halogen cable jackets and secure connectors, with either threaded screw-on, such as M12; latching, like fiber LC connectors; or twist-style connectors, like fiber ST, for example."

Aerospace and defense applications and innovations today are so diverse, connector and cabling providers are continually expanding their product portfolios. "We have been adding to our product portfolio with products that are normally custom orders that can take weeks or months," Hearn says.

Embedded interconnectivity

In the evolution toward smaller packaging, increased functionality, and faster processing, the OpenVPX embedded computing standard in the VITA (VMEbus International Trade Association) is rapidly evolving as a standard architecture for next-generation critical embedded computing that enables gains in bandwidth and functionality for tomorrow's systems, TE officials say.

"TE is actively working alongside technology leaders within the embedded computing industry to develop interconnects that break barriers for tomorrow's systems [and] will enable increases in processing capability within smaller systems packaging," says Michael Walmsley, global product manager at TE Connectivity, which partners with companies like Curtiss-Wright to integrate advanced embedded computing connectors into current defense applications.

"Curtiss-Wright Defense Solutions is working closely with key partners like TE to enable the next generation

Connector and cable sizes continue to shrink to help lighten the warfighter's load in the field.

of VPX using fabrics like PCIe Gen 4.0 and 100G-KR4 Ethernet," explains Lynn Bamford, senior vice president and general manager, defense solutions division at Curtiss-Wright. Coupling the latest interconnects and cables with "advanced high-speed module and system design rules will enable VPX system designers to deploy previously unreachable levels of performance in support of new applications and capabilities," she says.

Makers of advanced interconnect and cabling systems encourage aerospace and defense engineers to continue innovating without limitation. "Don't' limit yourselves to what's in our catalog," ITT Cannon's King recommends. "If you don't see what you're looking for, chances are, we can get it done for you."

"We're always focused on the evolving needs of the military and so are continuing to expand our portfolio to better serve its multi-domain strategy on land, air, sea, and space, with a particular focus on connectivity and the unique challenges of the future battlefield," ITT Cannon's Savage adds.

TE Connectivity regularly supports customers with new and innovative product options, McAlonis says. "If engineers are not finding what they need for their applications, [they should contact us] to help bring these new ideas to life." ←

COMPANY LIST

Advanced Interconnections Corp.
West Warwick, R.I.
www.advanced.com

AE Petsche Co.
Arlington, Texas
www.aepetsche.com

Aerospace Aviation 360
Pittsburgh, Pa.
www.aerospace-aviation360.com

AirBorn Inc.
Georgetown, Texas
www.airborn.com

Amphenol
Wallingford, Conn.
www.amphenol.com

Carlisle Interconnect Technologies
St. Augustine, Fla.
www.carlisleit.com

Coaxial Components Corp (Coaxicom)
Stuart, Fla.
www.coaxicom.com

Data Bus Products
Manhasset, N.Y.
www.databusproducts.com

Delphi
Washington
www.delphi.com

Diamond USA
North Billerica, Mass.
www.diausa.com

Digi-Key Electronics
Thief River Falls, Minn.
www.digikey.com

Eaton
Camarillo, Calif.
www.eaton.com/interconnect

Esterline
Bellevue, Wash.
www.esterline.com

Fischer Connectors
Alpharetta, Ga.
www.fischerconnectors.com

Harwin Inc.
New Albany, Ind.
www.harwin.com

HIROSE Electric
Downers Grove, Ill.
www.hirose.com

Huber+Suhner Inc.
Charlotte, N.C.
www.hubersuhner.com

IEH Corp.
Brooklyn, N.Y.
www.iehcorp.com

Interstate Connecting Components
Lumberton, N.J.
www.connecticc.com

Ironwood Electronics
Eagan, Minn.
www.ironwoodelectronics.com

ITT Cannon
Irvine, Calif.
www.ittcannon.com

Kensington Electronics
Austin, Texas
www.keiconn.com

LEMO USA
Rohnert Park, Calif.
www.lemo.com

March Electronics Inc.
Bohemia, N.Y.
www.marchelectronics.com

MilesTek
Denton, Texas
www.milestek.com

Mill-Max
Oyster Bay, N.Y.
www.mill-max.com

Molex
Lisle, Ill.
www.molex.com

ODU-USA
Camarillo, Calif.
www.odu-usa.com

OFS
Norcross, Ga.
www.ofsoptics.com

Omnetics Connector
Minneapolis
www.omnetics.com

Pasternack Enterprises
Irvine, Calif.
www.pasternack.com

PAVE Technology
Dayton, Ohio
www.pavetechnologyco.com

PIC Wire & Cable
Sussex, Wis.
www.picwire.com

Positronic
Springfield, Mo.
www.connectpositronic.com

Powell Electronics
Swedesboro, N.J.
www.powell.com

Reflex Photonics
Kirkland, Q.C.
www.reflexphotonics.com

Schurter Inc.
Santa Rosa, Calif.
www.schurterinc.com

Smiths Interconnect
Stuart, Fla.
www.smiths.com

Southwest Microwave
Tempe, Ariz.
www.southwestmicrowave.com/interconnect

SV Microwave
West Palm Beach, Fla.
www.svmicrowave.com

TE Connectivity
Berwyn, Pa.
www.te.com
www.designsmarterfaster.com

Timbercon Inc.
Tualatin, Ore.
www.timbercon.com

TT Electronics
Perry, Ohio
www.ttelectronics.com

Winchester Interconnect
Norwalk, Conn.
www.winconn.com

WL Gore & Associates
Landenberg, Pa.
www.gore.com

Military wants to develop RF phased array common modules for the defense industry

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are trying to move promising enabling technologies in RF phased arrays for radar, communications, and electronic warfare (EW) form the laboratory to the design floor.

DARPA is trying to commercialize promising RF phased array common module technology available to the defense industry for radar, communications, and electronic warfare (EW).

Officials of the U.S. Air Force Research Laboratory Sensors Directorate at Wright-Patterson Air Force Base, Ohio, issued a request for information (FA8650-18-S-5009) in April for the DARPA ACT Technology Transition project, which seeks to turn promising RF phased array common modules technology over to a commercial supplier to make it widely available to the defense industry.

This technology transition involves the Arrays at Commercial Timescales (ACT) Common Modules (CM) project of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., which has been in progress since early 2013 to create a shared hardware basis for future military phased array development programs.

The ACT Common Modules project seeks to save time and money in developing RF phased arrays by creating common building blocks to help designers avoid starting from scratch every time they build a new RF array.

The Air Force Research Lab is working on this technology transition program with DARPA to bring this newly created RF phased array common building blocks technology to fruition. Experts want to make sure the ACT Common Modules technology is upgraded continually and made available to the defense industrial base.

DARPA ACT contractors have developed a common module solution that serves as a broadband 32-channel digital receiver, exciter, and beamforming

Cree buys Infineon RF power business

Power electronics specialist Cree Inc. in Durham, N.C. has acquired the assets of Infineon's RF power business for approximately $428.2 million. Cree's acquisition of Infineon RF Power expands the wireless market opportunity of the Cree Wolfspeed business unit in Research Triangle Park, N.C. Infineon continues to drive key growth areas, such as electro-mobility, autonomous driving, renewables, and technologies for a connected world. The transaction has closed and is effective. The acquired Infineon RF Power team and capabilities will complement Wolfspeed's existing offerings and expertise with additional technology, design, packaging, manufacturing, and customer support. For more information, visit **Cree** online at *www.cree.com*.

Gallium nitride RF and microwave amplifier for X-band radar introduced by Comtech PST

Comtech PST Corp. in Melville, N.Y., is introducing the model BPMC928109-1000 gallium nitride (GaN) RF and microwave amplifier for X-band radar applications. The AB linear design operates over the 9.2-to-10.0 GHz radar frequency range. The amplifier design features options for control of phase and amplitude to allow for integration into high-power systems that use conventional binary or phased array combining approaches for power levels to 10 kilowatts. Features include AB linear gallium nitride (GaN) technology; high output power dynamic range; RF input and output sample detectors; pulse width and duty factor protection; thermal and load voltage standing wave ratio (VSWR) protection; optional *[PAGE 28]*

module that could replace large sections of analog array and other RF front-end electronics, Air Force officials say. These common modules are adaptable to a range of frequency bands and are programmable to fit a wide variety of U.S. military applications.

Now military researchers want to move this technology to a third party for commercializing and production manufacturing. In addition to phased-array applications, these common modules also could be adapted to industry-standard form factors for broad application use cases.

Military experts expect the technology to become an off-the-shelf solution that defense contractors could use to serve a variety of military purposes.

DARPA has spent more than $100 million and involved seven defense companies in nine separate contracts for the ACT program to speed development of electronic RF phased array antennas to re-invent how the military develops RF and microwave technology for a broad variety of applications that include advanced radar, electronic warfare, communications, and electronic intelligence.

Among the ACT contractors are Raytheon, Northrop Grumman, Lockheed Martin, Boeing, Rockwell Collins, HRL Laboratories, and Georgia Tech Applied Research. These organizations have spent the last five years trying to move beyond the traditional specialized and time-consuming array design process and focus on new ways of developing RF phased array antenna transmit and receive modules.

RF phased arrays use numerous small antennas to steer RF beams without mechanical movement. Their lack of moving parts enables them to look in several directions at once. Still, this technology is extremely expensive and can take many years to engineer and build.

The ACT program has created shared hardware for future military phased arrays, and has the potential to save the Pentagon billions of dollars, and years of research and development time.

The Raytheon Co. Space and Airborne Systems segment in El Segundo, Calif., won a $19.5 million ACT contract on 17 Dec. 2013. The Northrop Grumman Electronic Systems segment in Linthicum Heights, Md., followed with a $21.9 million ACT contract, and the Lockheed Martin Corp. Rotary and Mission Systems segment in Moorestown, N.J., won an $18.5 million ACT contract on 19 Dec. 2013.

In early 2014, Rockwell Collins in Cedar Rapids, Iowa, won an $11.5 million contract, followed by a $5.9 million ACT contract to the Raytheon Integrated Defense Systems segment in Tewksbury, Mass. A $7.4 million contract went to HRL Laboratories LLC in Malibu, Calif.; a $4.6 million contract to the Boeing Co. in Seattle; a $5.5 million contract to Georgia Tech Applied Research Corp. in Atlanta; and a $5.5 million to Raytheon Integrated Defense in Tewksbury, Mass. In all, Raytheon scooped up three separate DARPA ACT research contracts.

The DARPA ACT contractors sought to push past the traditional barriers that lead to 10-year array development cycles, 20-to-30-year static life cycles, and costly service life extension programs by developing new technology for custom arrays that takes advantage of constantly evolving digital components.

Experts from Raytheon Integrated Defense Systems (IDS) in one contract focused on developing a common hardware module applicable to many different array functions, as well as combining arrays on separate platforms into a larger aperture with precise timing and localization. Rockwell Collins also is working on this first thrust of the DARPA ACT program.

In a second separate contract, Raytheon IDS experts sought to develop a reconfigurable electromagnetic interface for different polarizations, frequencies, and bandwidths by creating a customizable electromagnetic interface to a common module. Boeing, Georgia Tech, and HRL Laboratories also are working on this second thrust of the DARPA ACT program.

Georgia Tech researchers worked on a reconfigurable electromagnetic interface (REI) with an integrated reconfigurable ground plane that can be optimized in-situ for frequency, bandwidth, beam pattern, steering, null placement, polarization, and input impedance.

The goal was to capitalize on the gain of the array to match the gain

[FROM PAGE 27]

digital interface for control and status monitoring; optional phase and amplitude control; and building block for phased array systems. Performance specifications include frequency range of 9.2 to 10.0 GHz; peak output power of 1000 watts; power gain of 60 dB nominal; power gain variation of ±2 dB (9.2-10 GHz); pulse width of 0.25 to 100 microseconds maximum; duty cycle of 10 percent max; pulse drop of less than 0.5dB; Pulse Rise and Fall Time of less than 60 nanoseconds typical; input VSWR of less than 1.5:1; and output load VSWR of less than 2:1. These devices measure 9.6 by 6.8 by 2.15 inches, and weigh five pounds. For more information, visit **Comtech PST** online at *www.comtechpst.com.*

of the standard array, but with added ability to reconfigure for different missions, to train to its environment, and to require a lower feed density and lower common module density than a traditional array.

Boeing, meanwhile, focused on a novel RF phased array antenna (PAA) composed of reconfigurable wideband elements. Boeing researchers will scale the device for configurability within the 2-to-12-GHz frequency range but this technique could be scaled to other frequency bands as well.

Boeing sought to design a reconfigurable array that could be modifiable in the field to support common module changes or emergent mission requirements. Reconfigurable arrays have persistent challenges in four main technological categories: array element performance; low-loss switches; controlling switches without hurting array performance; and fabricating interconnect structures.

The DARPA ACT program also sought to combine arrays on separate platforms into a larger aperture with precise timing and localization. The goal is to create electromagnetic interface arrays that can be fielded at a rate to match that of commercially developed electronic components.

Companies interested in commercializing and producing ACT common modules technology should send responses to the Air Force's Jamie Hoff, 2977 Hobson Way, Building 653, Room 215, Wright-Patterson Air Force Base, Ohio, 45433-7734. Email questions or concerns to the Air Force's Thomas Dalrymple at Thomas.Dalrymple@us.af.mil.

More information is online at https://www.fbo.gov/spg/USAF/AFMC/AFRLWRS/FA8650-18-S-5009/listing.html.

Two Six Labs using IoT technology to prevent terrorists from placing atomic bombs

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are turning to sensor data analysts at Two Six Labs LLC in Arlington, Va., to capitalize on Internet of Things (IoT) technology to help prevent terrorists from placing and detonating atomic bombs in or around the nation's large metropolitan areas.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a $13.2 million contract to Two Six Labs for the SIGMA project.

The company will help DARPA apply IoT technologies to potential networks of thousands of low-cost radiation sensors linked throughout U.S. cities by Wi-Fi and cellular phone systems to a cloud-based network backbone.

DARPA and the agency's industry partners have been working on the SIGMA system for the past several years. It consists of small and large mobile and static radiation sensors to support agile deployment.

The project also seeks to develop the network infrastructure to connect as many as 10,000 of these small radiation-detection sensors, as well as a cloud-computing infrastructure to analyze streaming spectroscopic data automatically from these sensors in real-time. Then the project seeks to store many billions of these spectra for spatiotemporal and forensic analyses in an easily retrievable manner.

This part of the SIGMA program focuses on data storage, ingestion, and networking; and component capabilities to detect weapons of mass destruction using low-cost, high-capability radiation sensors, automated detection algorithms, and real-time alerts of potential nuclear terror threats.

Researchers want to capitalize on Internet of Things (IoT) technology to foil terrorist attempts at placing atomic bombs.

DARPA experts are interested in new software and network infrastructure that can ingest, analyze, and store data for thousands of spectroscopic sensors connected with bidirectional communications and sensor fusion algorithms that run in real-time with minimal latency.

This sensor network should be able to manage inventory and device status; display device status, sensor output, and location in real time; query recent historical data; store several years of sensor data; simulate thousands of sensors to replay historical sensor data; carry out security and encryption; and deploy on several commercial cloud infrastructures.

On this contract, Two Six Labs will do the work in Arlington and Falls Church, Va.; Bowie, Md.; and Andover, Mass., and should be finished by March 2020.

For more information, visit ***Two Six Labs*** *online at* www.twosixlabs.com.

Kratos continues low-rate production of BQM-177A target drones

Kratos Defense & Security Solutions Inc. is continuing with low-rate initial production of a new subsonic aerial target designed to help U.S. Navy aircraft and surface warship crews learn to defeat enemy cruise missiles. Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $24.4 million order to the Kratos Unmanned Systems Division in Sacramento, Calif. (formerly Composite Engineering Inc.), for low-rate initial production (LRIP) of 30 BQM-177A subsonic aerial targets. The BQM-177A is the Navy's next-generation subsonic aerial target (SSAT), which is designed to mimic the behaviors and radar cross sections of dynamic, high-subsonic, sea-skimming anti-ship cruise missiles to help naval personnel practice air-to-air engagements. In November 2016, Kratos Unmanned Systems officials announced they had achieved the final development program milestone for the BQM-177A target drone leading up to low-rate initial production. Last June, Kratos began LRIP on the BQM-177A with a Navy order for 45 of the high-performance target drones.

Air Force to begin testing drone-zapping laser mounted on an F-15 fighter jet this summer

This summer, the U.S. Air Force will begin testing a laser mounted on an F-15 warplane. The Pentagon last year awarded a $26 million contract to Lockheed Martin for a laser weapons program called Self-protect High Energy Laser Demonstrator

Army wants armored combat vehicle to demonstrate unmanned technologies

BY **John Keller**

PICATINNY ARSENAL, N.J. — U.S. Army armored combat vehicle experts are making plans to ask industry for military vehicle prototypes to demonstrate promising enabling technologies for a future generation of tracked unmanned combat vehicles.

Officials of the Army Contracting Command at Picatinny Arsenal, N.J., announced their intention (W15QKN-17-Z-021X) to issue a request for prototype proposals (RPP) for the Combat Vehicle Robotics (CoVeR) program. The Army Contracting Command issued the RPP on behalf of the Army Tank Automotive Research Development and Engineering Center (TARDEC) in Warren, Mich.

The upcoming CoVeR request for prototypes will be issued to the National Center for Manufacturing Sciences (NCMS) in Ann Arbor, Mich., which will make the RPP available to members of the National Advanced Mobility Consortium (NAMC) in Warren, Mich.

The Army's CoVeR program seeks to develop autonomous vehicle mobility technologies to enable military tracked autonomous vehicles to operate in tough military environments at realistic speeds.

CoVeR is developing technologies that enable scalable integration of multi-domain robotic and autonomous systems, and is expected to develop foundational technologies for weaponized robotic platforms.

CoVeR is an outgrowth of the Army's Wingman Joint Capability Test Demonstration, which applied autonomous

An unmanned version of the Army M113 armored personnel carrier is expected to demonstrate promising enabling technologies for a future generation of heavy tracked unmanned combat vehicles.

technologies to Army unmanned Humvee wheeled combat vehicles.

The ultimate goal is to enable soldiers of the future to team up with new kinds of robotic battlefield vehicles that will allow for increased stand-off between themselves and enemy forces.

The Wingman project involved autonomous Humvees equipped with 7.62-millimeter machine guns. The project demonstrated the ability for soldiers to pilot these armed autonomous Humvees, and shoot the vehicles' machine guns accurately.

The Wingman Humvees use the Robotic Technology Kernel, a TARDEC-developed autonomy system with driving cameras, sensors, and other electronics that give the unmanned vehicles teleoperated or autonomous operation.

The Wingman Humvees also use the Autonomous Remote Engagement System that reduces the time necessary to identify targets using vision-based

automatic target detection and user-specified target selection.

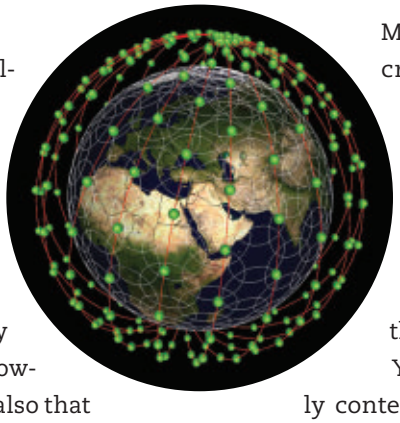
Technologies developed for Wingman will feed into the CoVeR program, which will use larger combat vehicles for manned and unmanned teaming. These new autonomous technologies may enable the future soldier to manage several different unmanned combat and reconnaissance vehicles, as well as unmanned aircraft.

E-mail questions or concerns to the Army's Sean McAvoy at sean.p.mcavoy.civ@mail.mil. For additional information, contact the National Advanced Mobility Consortium online at www.namconsortium.org, or the National Center for Manufacturing Sciences at www.ncms.org.

More information on the upcoming CoVeR request for prototypes is online at https://www.fbo.gov/notices/7545bb865da5b8057f1855d6bf5fad9b.

DARPA asks industry to develop small, secure military satellites to operate in low-Earth orbit

BY **John Keller**



ARLINGTON, Va. — U.S. military researchers are asking for industry's help in developing a constellation of small, secure, and affordable military satellites that not only are able to operate in low-Earth orbit (LEO), but also that capitalize on modern commercial satellite technologies.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a broad agency announcement (HR001118S0032) for the Blackjack program to develop SWaP-optimized military communications and surveillance satellites designed to operate in LEO.

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

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

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

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

Historically, U.S. Department of Defense (DOD) satellites have been custom-designed, with lengthy and

(SHiELD). The idea is to put a laser system on aircraft with an output of about 50 kilowatts to test their ability to zap drones or cruise missiles. By focusing a laser beam on a target, the technology rapidly heats it up inside, causing it to crash or explode.

Descent of the machines: Australian firm boasts of underwater drone swarms

An Australian company has developed a fleet of underwater drones capable of swarming the seas. Aquabotix Technology Corp., based in Sydney, Australia, and in Fall River, Mass., has produced the Swarmdiver unmanned underwater vehicle (UUV), which can function as a coordinated swarm with one human operator, diving below the sea's surface to collect valuable intelligence, company officials say. The drone itself weighs about four pounds, is 30 inches long, can dive to depths of about 170 feet, and is said to can sense its depth to within less than an inch. A multi-constellation GPS installation lets the Swarmdiver figure out where it is in the world, while a wireless data feedback system is installed on it so it can relay its gathered data home when it surfaces.

Unmanned ground vehicles replace soldiers in breaching exercise

Humans have taken a backseat at a base exercise in which robots cleared obstacles for manned tanks and fighting vehicles. U.S. and British troops participated in the Robotic Complex Breach Concept demonstration, during which several unmanned remote-controlled combat vehicles performed a task usually carried

expensive design and upgrade cycles. The evolution of commercial space, however, has led to LEO broadband Internet communications satellites that could offer attractive economies of scale.

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

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

The Blackjack program has three primary objectives:

- develop payload and mission-level autonomy software with on-orbit distributed decision processors that can operate autonomously with on-orbit data processing, and perform shared tasks on-orbit;
- use advanced commercial manufacturing for military payloads and the spacecraft bus, including high-rate manufacturing using commercial off-the-shelf (COTS)-like parts, reduced screening and acceptance testing for individual spacecraft, and reduced expectations for spacecraft life; and
- demonstrating satellite payloads in LEO that operate on par with current GEO systems with the spacecraft at costs of less than $6 million per satellite.

To reduce integration risk, Blackjack will develop an avionics unit called Pit Boss for each spacecraft with high-speed processor and encryption devices that will function as a common network and electrical interface.

Not only will Pit Boss provide a common electrical interface to each payload, but it also will provide mission level autonomy functions, enable on-orbit edge computing, manage communication between Blackjack satellites and ground users, provide a command and telemetry link to the bus, and encrypt payload data.

Every Blackjack satellite will consist of one commoditized bus capable of broadband rate global communications to other nodes, one Pit Boss control unit, and one or more military payloads that can operate autonomously for more than 24 hours.

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

The program has three phases: defining bus and payload requirements; developing bus and payloads for a two satellite on-orbit demonstration; and demonstrating a two-plane system in low-Earth orbit for six months. A future Blackjack demonstration constellation will involve 20 spacecraft in two planes with one or more payloads on each satellite.

Companies interested should submit full proposals no later than 6 June 2018 to the DARPA BAA submission website at https://baa.darpa.mil. E-mail questions or concerns to DARPA at HR001118S0032@darpa.mil. ←

More information is online at https://www.fbo.gov/spg/ODA/DARPA/CMO/HR001118S0032/listing.html.

out by soldiers. "We did a robotic breach today, which has never been done before. This is a historic moment," says 1st Lt. Cody Rothschild, an officer with the 1st Infantry Division's 2nd Armored Brigade Combat Team, currently on rotation in Europe. "This is a great step forward for the Army, and for robotics." The rotational armor brigade was the main armor element during the exercise. It provided suppressing fire with M1A2 Abrams tanks and Bradley Fighting Vehicles, while remote-controlled U.K. Terrier engineering vehicles cleared a simulated minefield and bridged a tank trench.

Electronics cooling expert develops heat pipe to support spacecraft

As humans continue to explore space, their spacecraft require newer technologies. Often, these new technologies generate more heat, which can be a problem if the structures can't withstand it. Mohammed Ababneh, PhD, thinks he has found the solution for managing these higher temperatures. Ababneh, a research development engineer at Advanced Cooling Technologies Inc. (ACT) in Lancaster, Pa., specializes in electronics cooling and thermal management for space and terrestrial applications. He worked as the principal investigator of the program and part of a larger ACT team made up of Calin Tarau, PhD; William Anderson, PhD; and Corey Wagner. Jeff Farmer, PhD, technical monitor from NASA's Marshall Space Flight Center and Jesse Fisher from Lockheed Martin also assisted with the tests. Ababneh and the team at ACT created a new high-heat-flux heat pipe that more than triples the existing heat capacity of standard heat pipes used in spacecraft. ←

Navy chooses thermal-imaging sensors from FLIR for patrol boat nighttime operations

BY **John Keller**

CRANE, Ind. — Long-range, electro-optical sensor designers at FLIR Systems Inc. in North Billerica, Mass., are building additional maritime thermal imaging sensors to enhance nighttime operational capabilities for U.S. Navy and Coast Guard patrol boats.

Officials of the Naval Surface Warfare Center in Crane, Ind., announced a $10.7 million order to FLIR for the Patrol Boat Electro-Optics System (PB-EOS). The primary mission of the PB-EOS is to provide enhanced visual imagery to augment existing electronic sensors.

The U.S. Navy is buying the Patrol Boat Electro-Optics System (PB-EOS) from FLIR Systems, which is based on the FLIR SeaFLIR 280-HD maritime imaging system.

FLIR experts are designing the PB-EOS to enhance low-visibility and night navigation; maritime interception; coastal observation and surveillance; insertion and extraction operations; visit, board, search, and seizure operations; combat search and rescue; identification friend or foe; real-time situational awareness and threat warning; reconnaissance and surveillance; and documenting navigational hazards.

This order is a modification to a $49.9 million, five-year contract the Navy awarded to FLIR in September 2013 for as many as 142 of the PB-EOS electro-optical sensor payloads for small maritime vessels. The order increases the number of PB-EOS sensors from 142 to 168, including cable kits.

The primary mission of the PB-EOS is to provide enhanced visual imagery to augment existing electronic sensors that will enhance low-visibility and night navigation, maritime interception, coastal observation and surveillance, insertion and extraction operations, combat search and rescue, identification, real-time situational awareness and threat warning, reconnaissance and surveillance, documenting navigational hazards, as well as visit, board, search and seizure operations.

The PB-EOS is a variant of the FLIR SeaFLIR 280-HD maritime imaging system, which provides critical capability to enhance navigation, intelligence, surveillance, and reconnaissance.

The system weighs less than 55 pounds, and offers 982-millimeter focal length camera on a stabilized platform. It has a multi-field-of-view spotter scope; split screen; picture-in-picture; medium-wave infrared (MWIR) thermal camera; and short-wave infrared (SWIR) camera to see thorough mist, smog, smoke, and haze.

On this PB-EOS order, FLIR will do the work in North Billerica, Mass., and should be finished by October 2019. ←

*For more information, visit **FLIR Systems** online at* www.flir.com, *or the **Naval Surface Warfare Center Crane** at* www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Crane.

Northrop Grumman wins $209 million for large aircraft infrared countermeasures

Northrop Grumman Corp. has won a modification to a previous contract to provide the U.S. Air Force and foreign customers with Large Aircraft Infrared Countermeasure (LAIRCM) equipment and support. The LAIRCM contract, announced by the Department of Defense, is for $209.7 million and increases the total value of the contract to $1.5 billion. LAIRCMs are pods integrated onto aircraft to assist pilots with detecting and avoiding incoming threats, including man-portable missiles. They are capable of countering advanced missile systems with no action required by the crew. Northrop Grumman is to provide LAIRCM equipment and support for 2018, with work to be performed at Northrup Grumman's plant in Rolling Meadows, Ill., and is projected to be finished by 30 April 2020. Three percent of the contract involves foreign military sales for South Korea.

Long-range thermal cameras for military surveillance introduced by Sierra-Olympic

Sierra-Olympic Systems Inc. in Hood River, Ore., is introducing the Vinden LR series of long-range thermal cameras with powerful continuous-zoom optics for security, surveillance, military and defense imaging, and border, port, and base security applications. The camera series is for integrators who design thermal and multi-sensor imaging systems with advanced image processing, video recording and storage, H.264 IP encoding, and Ethernet control connectivity. The OEM camera modules have several zoom lens options that

Leidos to enhance semiconductor lasers for infrared countermeasures

BY **John Keller**

KIRTLAND AIR FORCE BASE, N.M. — U.S. Air Force electro-optics experts needed new ways to enhance technology for high-brightness semiconductor lasers for future applications in infrared countermeasures. They found their solution from Leidos Inc. in Reston, Va.

Officials of the Air Force Research Laboratory's directed energy directorate at Kirtland Air Force Base, N.M., announced a $13.9 million contract to Leidos for the COmpact Semiconductor Mid- and long-wave Opto-electronic (COSMO) research project. The COSMO program seeks to advance semiconductor lasers for current and future infrared countermeasures systems to deny enemies the use of infrared sensors like missile guidance, night-vision devices, and nighttime targeting systems.

The COSMO project is part of the Air Force's Semiconductor Laser (SCL) program to advance the state-of-the-art in compact high-brightness semiconductor laser devices emitting at the mid- and long-wave infrared wavelengths. Mid-wave infrared emits in the 3-to-5-micron bands, and long-wave infrared emits in the 8-to-12-micron bands.

Leidos will concentrate on developing and packaging mid- and long-wave infrared semiconductor laser devices, including development and testing of individual and multi-device format quantum cascade laser (QCL) and diode laser (DL) component technology. Engineers will use expertise in exercising beam combining strategy to achieve higher output power, and switching high brightness QCL and DL modules for test, evaluation, prototyping, and incorporation into infrared countermeasures systems.

The Air Force is asking Leidos to provide high-brightness semiconductor lasers for future applications in infrared countermeasures.

Leidos engineers will work primarily at Kirtland Air Force Base, which has specialized equipment like molecular beam epitaxial system; focused ion beam and scanning electron microscope system; X-ray diffractometer; Fourier transform infrared spectroscopy system; reactive ion etching system; plasma-enhanced chemical vapor deposition system; and evaporative metal deposition system. Research work will involve advanced concept analysis, QCL material design and development; laser prototype and final packaging; and laser system design and integration.

Leidos should be finished with this contract by April 2023. ←

For more information, visit ***Leidos*** *online at* www.leidos.com.

provide a narrow horizontal field-of-view (HFOV) as small as 1.5 degrees without compromising image quality, optical speed, or sensitivity. It also features a tuned one-touch autofocus. The Vinden LR camera series features pixel resolution of 640 by 480 by 12 microns, sensitivity to 60 Hz frame rate, and athermalized and parfocal continuous-zoom lens options between 17.5 and 1.5 degrees field of view. Sierra-Olympic's longwave infrared (LWIR) long-range zoom cameras are non-ITAR controlled, and are available with continuous zoom lenses of 25 to 150 millimeters, 25 to 225 millimeters, or 40 to 300 millimeters.

Air Force plan to put a laser cannon on a battle plane has hit an obstacle

Air Force Special Operations Command (AFSOC) has been itching to add a laser beam to the already brimming arsenal of its AC-130J Ghostrider gunships, yet plans for a high-powered add-on to the Air Force's "ultimate battle plane" may have hit a significant obstacle. The laser weapons program is $58 million behind what's required for a full program to start outfitting Ghostrider gunships with 60-kilowatt lasers by fiscal 2022, AFSOC commander Lt. Gen. Marshall Webb told lawmakers in April. By comparison, the laser-outfitted Strykers currently undergoing testing by the Army's 2nd Cavalry Regiment for intercepting missiles and drones only fire at around 5 kilowatts. What does 12 times the power get you? A 60-kilowatt high-energy laser able to "achieve high-precision lethal effects on targets with little to no acoustic signature and very low collateral damage," emphasized Webb in his opening statement. ←

PRODUCT applications

RAD-HARD SPACE ELECTRONICS

Air Force chooses radiation-hardened atomic clock from Frequency Electronics

U.S. Air Force positioning, navigation, and timing (PNT) experts needed cyber- and radiation-hardened atomic clock technology for space satellites like the global positioning system (GPS) that require a high degree of synchronization. They found their solution from Frequency Electronics Inc. in Uniondale, N.Y.

Officials of the Air Force Research Laboratory's Space Vehicles Directorate at Kirtland Air Force Base, N.M., announced a $19.4 million seven-year contract to Frequency Electronics in April for the Space Qualified Atomic Clocks program. Frequency Electronics engineers will build and demonstrate a space-qualified atomic frequency standard (AFS) system for satellites that require a high degree of synchronization. Enabling technologies from this project will lend themselves to timing applications in Air Force space systems, and lead ultimately to demonstration of a space-qualified clock aboard a spacecraft flight experiment.

The AFS must be able to survive and operate through harsh-launch environments including high g-loads, vibration, and pyro-shock events in addition to severe on-orbit thermal cycling. The AFS also will be initially space radiation hardened sufficiently to survive a two-year lifetime at middle earth orbit (MEO). The traceable PDR design is envisioned as fully radiation hardened and survivable up to a 10-year lifetime at MEO. The AFS traceable preliminary design review (PDR) design should be fully radiation hardened and survivable to a 10-year lifetime at MEO.

This radiation-hardened space-based atomic clock is for demonstration aboard the future Navigation Technology Satellite (NTS)-3 space experiment. Air Force researchers expect that one heritage Rubidium Atomic Frequency Standard (RAFS) and two AFS clocks plus thermal control will fit into a hosted payload port of an evolved expendable launch vehicle (EELV) secondary payload adapter (ESPA) ring.

The AFS will support the standard 13.40134393 MHz Sinewave output, but also may need to support faster rates as necessary for other experiments with the future On-Orbit Reprogrammable Digital Waveform Generator (ORDWG). Company engineers also will develop the AFS to be impervious to cyber attacks — or cyber-hard by design for key mission-critical functions. They also will conduct a manufacturing readiness assessment for system manufacturability and affordability.

Frequency Electronics will do the work in Uniondale, N.Y., and should be finished by September 2025. For more information, visit **Frequency Electronics** online at *www.freqelec.com.*

SHIPBOARD COMMUNICATIONS

Navy chooses HF radios from Rohde & Schwarz for shipboard and mobile long-range communications

U.S. Navy communications experts needed HF radios for fixed-site, mobile, and shipboard applications. They found their solution from Rohde & Schwarz USA Inc. in Columbia, Md.

Officials of the Space and Naval Warfare Systems Center Atlantic in Charleston, S.C., announced a potential $16 million, seven-year contract to Rohde & Schwarz in late March for HF radio transceiver systems from the company's series 2000 and 4100 radio communications families.

The contract includes training, technical, and repair services for existing HF systems for the Navy and allied forces. Rohde & Schwarz will deliver two XK2900L HF transceivers and related equipment for $482,888, and the Navy will order the remaining radios through 2025.

The Rohde & Schwarz series 2000 HF transceivers consist of 1000-watt, single-channel narrowband radios with link capabilities and 200-microsecond quick tune capability. The company's series 4100 HF transceivers consist of 1000-, 500-, and 150-watt single-channel narrowband software-defined radios with link capabilities and 200-microsecond quicktune capability. The Rohde & Schwarz series 4400 are VHF and UHF software-defined transceivers systems.

The Rohde & Schwarz series 2000 radio family is for shortwave telephone applications, data transmission as fast as 9.6 kilobits per second. These radios can enable users to set up high-power broadband communications systems on several channels with low-frequency separation and in different emission modes.

The core of the series 2000 family is the XK2100 150-watt transceiver and GX2900 receiver-exciter for the 500- and 1000-watt base station units. These units include six exchangeable modules and spare slots for options.

The Rohde & Schwarz XK2900L 1000-watt HF transceiver comes as a desktop version or as a sturdy rackmount, and covers the frequency range 1.5 MHz to 30 MHz. It can be operated locally as well as remotely via an integrated, multistandard serial interface.

The Rohde & Schwarz XK2100L 19-inch 150-Watt HF desktop transceiver covers 1.5 MHz to 30 MHz can be operated locally as well as remotely via an integrated, multistandard serial interface.

The series 2000 central control unit has a microprocessor that coordinates all internal control sequences for the modules via the SERBUS and communicates with external equipment via RS-232-C and RS-485 data interfaces, as well as via the keypad. The microprocessor also generates the messages and indications output on the graphic display.

The Rohde & Schwarz series 4100 500- and 1000-watt HF transceivers are for stationary and shipborne communications that must cover large distances. These radios offer high radio link availability, even under moderate propagation conditions. These radios are for use aboard ships and on shore, and appropriate for civil air traffic control, embassy radio systems, and tactical applications.

The series 4100 HF radios support frequency hopping for security and provide interoperability with the Rohde & Schwarz M3TR family of tactical radios in all HF operating modes. These radios can support future communications waveforms through software updates. For more information, visit **Rhode & Schwarz** online at *www.rohde-schwarz.com.*

RADIO COMMUNICATIONS

DARPA chooses small radio from ViaSat for optical fiber communications

U.S. military researchers needed secure small-form-factor Link 16 radio terminals to support a project to back-up military communications links with buoy and undersea optical fiber networks. They found their solution from ViaSat Inc. in Carlsbad, Calif.

U.S. Defense Advanced Research Projects Agency (DARPA) officials in Arlington, Va., announced plans to buy ViaSat Battlefield Awareness & Targeting System-Dismounted (BATS-D) AN/PRC-161 handheld Link 16 radio terminals sole-source for the agency's Tactical Undersea Network Architectures (TUNA) program.

The ViaSat radios will support an at-sea demonstration as part of the second phase of the TUNA program, which aims at using optical fiber to restore radio frequency (RF) tactical data networks temporarily in a contested environment via an undersea optical fiber backbone.

The concept involves deploying RF network node buoys dropped from aircraft or ships that are connected via thin underwater fiber-optic cables. These very-small-diameter, fiber-optic cables will be able to last 30 days in the rough ocean environment, which is long enough to provide essential connectivity until primary methods of communications are restored.

The idea is to restore military communications links with buoy and undersea optical fiber networks when normal communications channels go down because of battle damage, electronic jamming, or other interference.

The TUNA program requires the smallest available radio solution to keep equipment size, weight, and power consumption (SWaP) to a minimum to improve deployability, increase endurance, and minimize observability.

The TUNA program's second phase specifies Link 16 radios for the projects phase-two at-sea demonstrations because Link 16 is the best fit for the program, and helps take advantage of existing Navy radios. DARPA awarded a $19.3 million contract for the TUNA program's second phase in March 2017 to Oceaneering International Inc. in Hanover, Md., to develop and demonstrate TUNA designs to restore connectivity for tactical data networks using small-diameter optical fiber and buoy relay nodes at sea. When the TUNA program's second phase began last year, the smallest certified Link 16 radio was the ViaSat Small Tactical Terminal (STT), DARPA researchers explain. While this radio is smaller than Navy shipboard radio installations, it still is quite large with significant power requirements. The STT resulted in TUNA communications buoys that were cumbersomely large, heavy, and power-hungry.

The recently certified ViaSat BATS-D AN/PRC-161 handheld Link 16 radios, on the other hand, have begun production and are small enough to design TUNA buoys with significant SWaP reductions, and represent the only source to meet TUNA program objectives, DARPA officials say.

Certified as a Type 1 cryptographic device by the U.S. National Security Agency (NSA), ViaSat has just begun production of these ground-breaking radio, DARPA officials say. The BATS-D design and production comes just in time to offer a hardware solution that facilitates the fielding of small, high-endurance communications buoys.

The ViaSat BATS-D AN/PRC-161 radio fuses air and ground situational awareness in a handheld size. The ruggedized radio delivers real-time Link 16 communications small enough to be vest-worn, handheld, or mounted.

The radio offers users access to air and ground situational data and can provide secure target data and position location, identification, and status information to the network. The radio has J-Voice capability for direct voice communications with other Link 16 users.

The ViaSat BATS-D AN/PRC-161 radio provides a very small form factor and low-power tactical data link for unattended use in TUNA communications buoys that permit cross-domain communications that capitalizes on transferring communications and data for long distances over undersea fiber optical cable, DARPA officials say.

The small size and diminutive power requirements of the radios significantly reduce the size, improve the endurance, and improve the deployability of the communications buoys, which are critical to the functioning of the TUNA system.

For this demonstration project, DARPA officials say the plan to buy four BATS-D radios from ViaSat at a cost of about $300,000. For more information contact **ViaSat** online at *www.viasat.com*, or **DARPA** at *www.darpa.mil.* ←

new PRODUCTS

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

NETWORKING EQUIPMENT

Mini PCI Express network interface card introduced by Curtiss-Wright

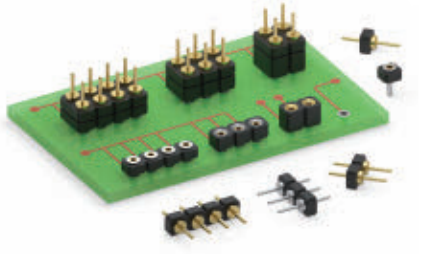
The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the rugged Parvus mNIC-210 Mini PCI Express Gigabit Ethernet network interface card for adding dual Gigabit Ethernet interfaces to the Parvus DuraCOR and DuraWORX embedded computing mission com-

puters to support in-platform local area network (LAN) connectivity. The mNIC-210 is for use as a network control module in systems deployed on unmanned vehicles, helicopters, ground vehicles, and industrial applications. The rugged small form factor (SFF) module delivers the network capabilities of two individual mini PCI Express network interface card modules in one slot. The card has industrial temperature-rated Intel I210 network interfaces and on-board Ethernet magnetics. The card is available as an add-on integration option for Curtiss-Wright's family of SFF rugged DuraCOR and DuraWORX modular mission processors (with Intel Xeon, Core i7 and Atom processors), as well as in other systems used in customer specific industrial and military applications. For more information, visit **Curtiss-Wright Defense Solutions** online at *www.curtisswrightds.com.*

INTERCONNECT PRODUCTS

Strip sockets for small-form-factor wearable devices introduced by Mill-Max

Mill-Max Manufacturing Co. in Oyster Bay, N.Y., is introducing low-profile strip sockets to provide a



reliable way to connect boards or devices in rugged small-form-factor electronics like wearable devices for military and medical applications. The strip sockets offer an above-board height of 0.083 inches. The 315-43-1XX-41-004000 (single row) and 415-43-2XX-41-004000 (double row) sockets have 0.1-inch pin spacing with a low profile of 0.083 inches. They are designed for through-hole mounting in boards as thick as 0.062 inches, providing a secure connection to the circuit board. These sockets are for board stacking and wire-to-board applications where minimizing package height is paramount. When mated with Mill-Max low profile headers, 335-10-1XX-00-160000 (single row) and 435-10-2XX-00-160000 (double row), the total between the boards height is 0.155 inches. For wire-to-board connections the Mill-Max 380-10-1XX-00-002000 (Single row) and 480-10-2XX-00-002000 (Double row) solder cup headers combine with the super low-profile sockets to achieve a total height of 0.268 inches. For more information, visit **Mill-Max** online at *www.mill-max.com.*

DIGITAL SIGNAL PROCESSING

FPGA embedded computing for radar signal processing introduced by Abaco

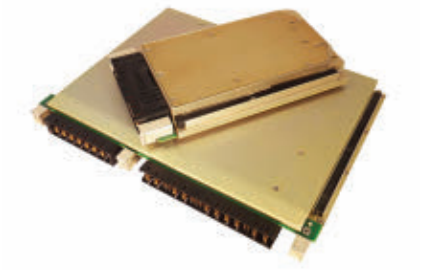
Abaco Systems in Huntsville, Ala., is introducing the VP430 direct RF processing embedded computing system with the Xilinx ZU27DR RF system-on-chip (RFSoC) technology for advanced electronic warfare (EW) applications including multiple input/output (MIMO), beamforming, sensor processing, and radar signal processing. The dense analog field-programmable gate array (FPGA) digital signal processing (DSP) board has eight A/D converter and D/A converter synchronized channels, and can synchronize several boards. When combined with Abaco's 3U VPX processing boards, the VP430 enables systems designers to build systems from high performance, interoperable commer-

cial off-the-shelf (COTS) components. The VP430 can enable the use of fewer boards and much less power while delivering increased processing throughput, company officials say. It occupies one-fourth of the slots that earlier-generation solutions would require. The VP430 can be built with a FireFly 8-channel VITA 66.4 fiber-optic interface for transfers faster than 12 gigabytes per second for applications in which the throughput of the native VPX PCI Express Gen3 data plane is inadequate or when a remote client requires streaming data. For more information, visit **Abaco Systems** online at *www.abaco.com.*

POWER ELECTRONICS

6U and 3U VPX military power supplies introduced by Milpower Source

Milpower Source Inc. in Belmont, N.H., is introducing the MILVPX VPX 6U and 3U VPX power supplies for a broad range of military applications. Tested to meet military standards, the MILVPX line of VPX power conversion units features several outputs and embedded EMI filters. The 3U VPX30600 offers as much as 600 watts steady state power for all input and temperature ranges. 6U Form factor units offer as much as 1 kilowatt of total power. Available in a baseline configuration, the

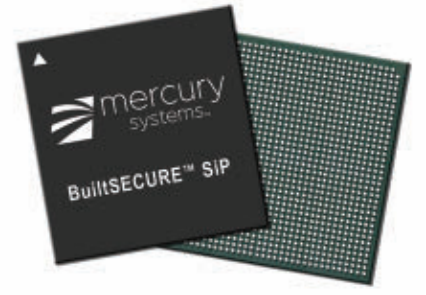


MILVPX product family meets the VITA specifications to support open-architecture system designs. In addition, MILVPX offers flexibility to address customer-unique specifications common in rugged military applications. "Our defense clients increasingly require a power conversion solution compatible with the new generation of embedded systems based on the VITA standards," says Milpower Source Program Manager Joseph Widman. For more information, visit **Milpower Source** online at *www.milpower.com*.

MICROELECTRONICS

Microelectronics packaging for SWaP-constrained military systems introduced by Mercury

Mercury Systems Inc. in Andover, Mass., is introducing the BuiltSECURE system-in-package (SiP) microelectronics packaging technology for high-performance, SWaP-constrained defense embedded computing systems. Combining the company's domain expertise in systems security engineering and 3D microelectronics packaging, this packaging is for platform management systems, mission management systems, and command, control, and intelligence applications. Mercury's BuiltSECURE SiP technology addresses the most complex, multi-faceted challenges for the defense industry today with one, ruggedized ball grid array (BGA) package. It offers agile customization and accelerated time to market with



rapid prototyping of microprocessors, field-programmable gate array (FPGA) devices, memory modules, sensor components, and security. The technology also offers advanced thermal management through design tools that enable each device to dissipate more than 100 Watts of power. For more information, visit **Mercury Systems** online at *www.mrcy.com*.

RUGGED DATA STORAGE

Rugged network-attached data storage systems introduced by Phoenix

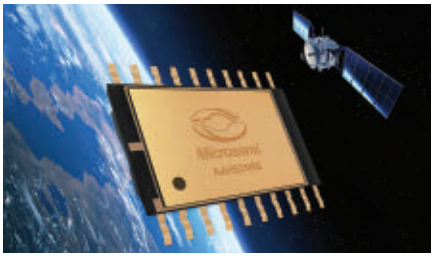
Rugged data storage experts at Phoenix International Systems in Orange, Calif., is introducing the Phalanx II rugged network-attached storage (NAS) file server with removable solid-state disks for unmanned aerial, underwater, and surface vehicles (UAVs, UUVs, and USVs) and manned airborne ISR applications. The Phalanx II is SWaP optimized and provides high performance, high capacity, and secure data storage in a small form factor NAS that weighs less than eight pounds, provides up to 16 terabytes of storage capacity with two solid state disks (SSDs) and supports

RAID 0 (mirroring) and RAID 1 (stripping). System configuration and management is provided via a Web-based GUI or CLI. The Phalanx II houses two removable media modules, which can be removed quickly to offload data and declassify the system. The removable media modules can move to separate locations and plugged into another Phalanx II NAS (or compatible ground station) on any other network. When used with a network switch, the Phalanx II can communicate with any other network enabled device to store and retrieve data. This eliminates the need for separate direct attached storage devices for each computer or workstation in a network centric environment. For more information, visit **Phoenix International** online at *www.phenxint.com*.

RAD-TOLERANT ELECTRONICS

Radiation-tolerant, eight-channel source driver for space applications introduced by Microsemi

Microsemi Corp. in Aliso Viejo, Calif., is introducing the radiation-tolerant AAHS298B eight-channel source driver for space applications. The source driver has been qualified and certified by the U.S. Defense Logistics Agency (DLA) as Qualified Manufacturers List (QML) Class V and Q, with four Standard Microcircuits Drawings (SMDs) listed, is in production. Offered in two package types with screening options, the device has met the key requirements to operate in space environments, as the qualifications are mandatory



for design-ins for space programs and for manufacturers to be listed on the QML by the DLA. Microsemi's high-performance AAHS298B source driver provides an interface between spacecraft bus electronics and other subsystems, with the highest output source current for space applications requiring radiation tolerance. Command signal outputs from the spacecraft's digital control electronics are typically TTL (5 volt) (V), CMOS (3 volt) and high-level (12 volt) logic and are not directly compatible with users' command input requirements. These user requirements occur in payload, power, thermal, and housekeeping subsystems and range between 14 volts and 45 volts. The AAHS298B is an interface between these systems, providing a continuous 700 milliamps current to switched high side-drivers on the output. For more information, visit **Microsemi** online at *www.microsemi.com*.

RF AND MICROWAVE

E- and W-band RF and microwave PIN diode waveguide switches introduced by Fairview

Fairview Microwave Inc. in Lewisville, Texas, is introducing a line of E and W-band RF and microwave PIN diode waveguide switches for radar front ends, telecommunications, test instrumentation, and research that involve general switching, receiver protection, pulse modulation, and antenna beam switching. These single-pole single-throw (SPST) and single pole double-throw (SPDT) millimeter-wave waveguide switches offer an ultra-broadband frequency range with fast switching performance. Fairview's four new PIN diode waveguide switches feature integrated WR10 and WR12 waveguide ports that support a UG387/U flange and cover E-band (60 to 90 GHz) and W-band (75 to 110 GHz) frequencies. These designs use high-performance gallium arsenide (GaAs) beam-lead diodes and low-loss Fin-line technology, resulting in performance of 4 dB typical insertion loss, 25 dB of isolation and fast switching speed of less than 300 nanoseconds. Integrated TTL driver circuitry with an SMA connector control port provides ease of use. These waveguide PIN diode switch models require a dual voltage bias of +5/-5 volts DC and have a maximum rated CW input power level of 0.5 dBm. For more information, visit **Fairview Microwave** online at *www.fairviewmicrowave.com.* ←

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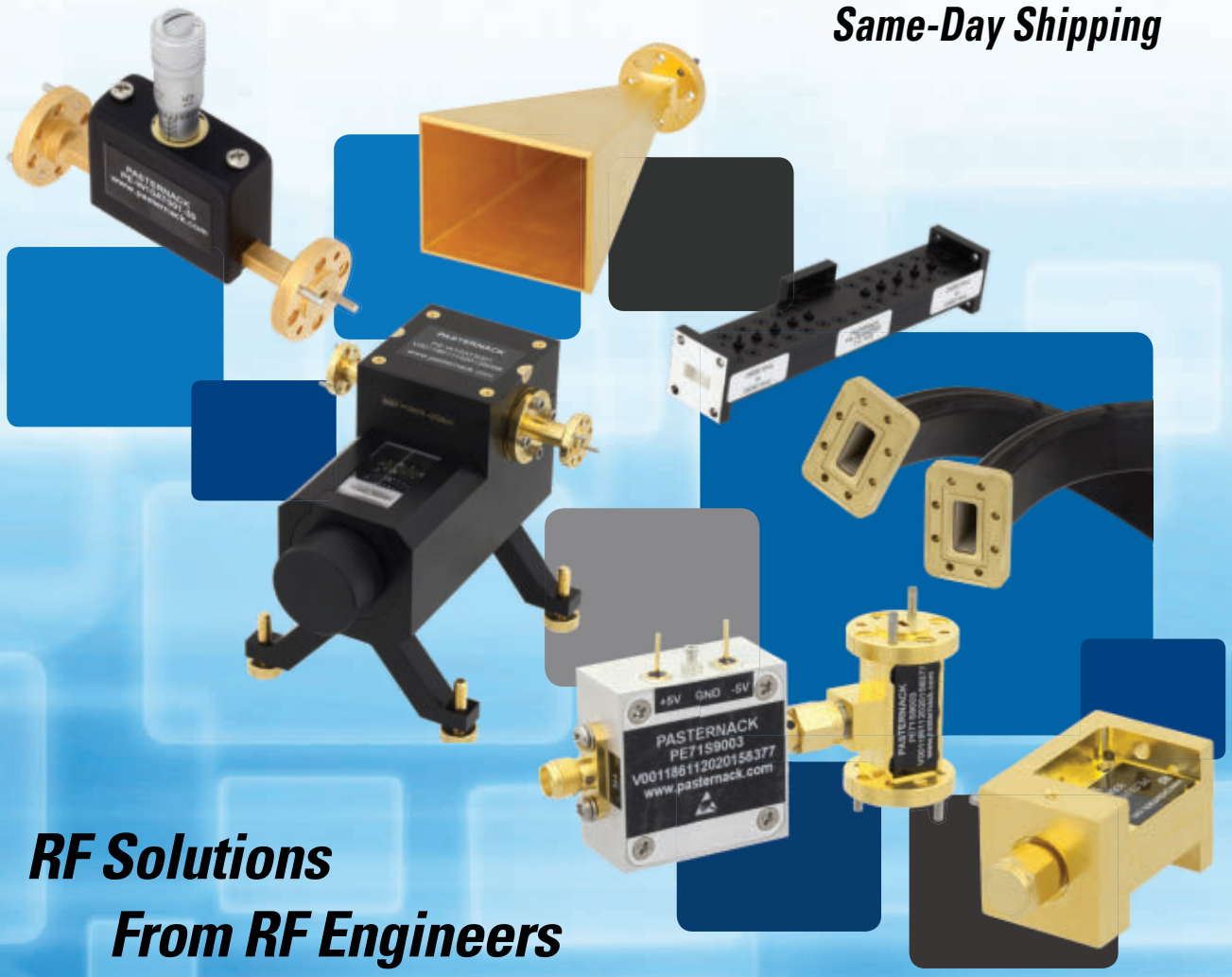

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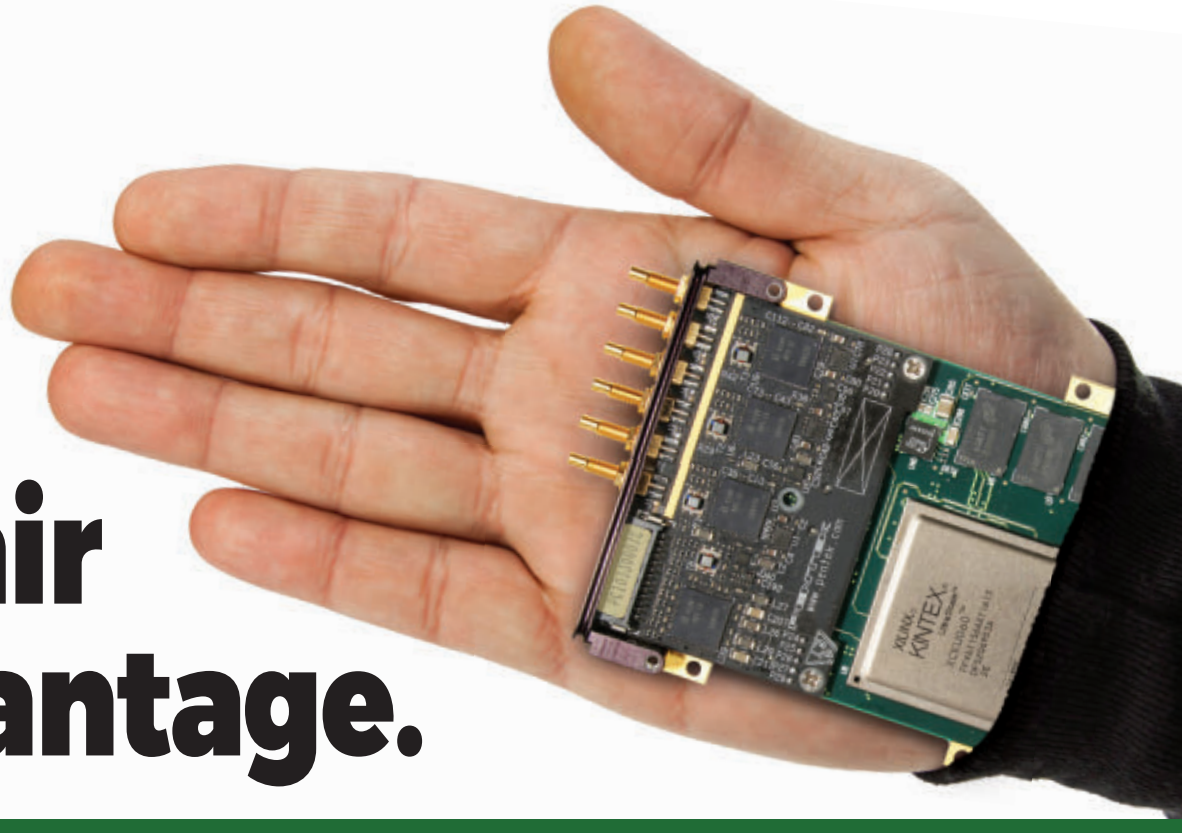

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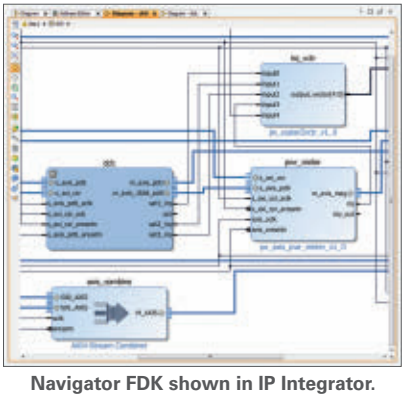

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