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Laser weapons

At long last, laser weapons are nearing deployment. PAGE 10

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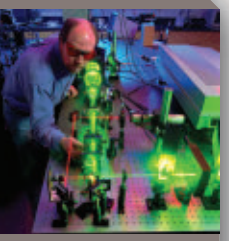

COVER STORY

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BY **JOHN KELLER**, EDITOR IN CHIEF

Defense procurement and research headed in opposite directions

I'm seeing a trend in the U.S. defense budget that I don't normally see, and I'm trying to make sense of it. It's this: The Pentagon's procurement budget is declining, while the research and development budget is growing rapidly.

First, we shouldn't make more of this than what it is. The fiscal 2018 U.S. Department of Defense (DOD) budget submitted to Congress contains $125.23 billion for procurement, which is down 6.2 percent over 2017's procurement request of $133.5 billion.

This is odd in itself — in a new era where President Donald Trump has pledged to grow the military budget to rebuild U.S. defense forces. The procurement budget generally contains spending for new military ships, aircraft, land vehicles, and other military equipment.

In addition, the procurement budgets for the U.S. Army, Navy, and Air Force all have cuts next year compared to this year — including across-the-board cuts to military aircraft procurement.

Once again, I don't want to make too much of this, because overall the 2018 DOD budget proposal is up year-over-year. It asks Congress for an overall increase of nearly 9 percent to the fiscal 2018 Pentagon budget, or $639.1 billion, up from 2017's request of 586.7 billion, and is the largest DOD topline budget request since 2012.

Still, I have to wonder about cuts in military procurement — especially in light of big... really big... proposed increases in next year's Pentagon budget for research, development, test, and evaluation (RDT&E). DOD wants $82.33 billion next year for RDT&E, which is up more than $11 billion — or 15.2 percent — over 2017's RDT&E request of $73.32 billion.

It's the biggest RDT&E budget request in more than 10 years. So where does that leave us, with military procurement and research headed in opposite directions?

I don't know the answer for sure, but I'll speculate: I think the U.S. military may be at a substantial transition point when it comes to defense technology. Many of the nation's front-line military platforms, such as the M-1 Abrams main battle tank, AH-64 Apache attack helicopter, UH-60 Black Hawk helicopter, and Ticonderoga-class cruiser, have been in the inventory for decades.

It's not that these relatively old platforms are being left to atrophy; far from it, in fact. Many of these older systems are being upgraded and recapitalized at very fast rates, and some of today's most promising enabling technologies in sensors, embedded computing, and machine control are being brought to bear on these systems.

Still, putting the brakes on procurement, while hitting the accelerator on research and development, could mean that it's time to start moving from the old to the new. Could it be that the next five or 10 years could see major new platforms on land, in the air, and at sea?

It might seem so. The Air Force is in the early stages of developing a new, long-range, stealthy jet bomber. The Army is ramping-up production of the Joint Light Tactical Vehicle, Armored Multi-Purpose Vehicle, and Family of Heavy Tactical Vehicles. The Navy is taking delivery of its first new class of aircraft carriers since the mid-1970s.

Meanwhile, deliveries of new Virginia-class attack submarines are proceeding swiftly, the Army is proposing major upgrades to the M-1 Abrams tank, and the Air Force is making big improvements to the F-15 combat jet.

Optimistically, I think that major increases in the military research budget may indicate a refilling of the technology development pipeline. I think we'll see improvements in military capabilities over the next five years that we haven't seen for decades. If you're in the military technology business, I think this is reason for celebration.

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IN BRIEF

U.S. Navy taps Lockheed Martin for seven additional electronic Consolidated Automated Support System avionics test sets

Test and measurement experts at Lockheed Martin Corp. will provide seven more eCASS advanced combat avionics test instruments to the U.S., Australian, and Japanese navies under terms of a $17.8 million order. Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., are asking the Lockheed Martin Rotary and Mission Systems segment in Orlando, Fla., to build seven electronic Consolidated Automated Support System (eCASS) full-rate initial production (LRIP) units. The eCASS equipment is designed to help sailors and Marines troubleshoot and repair aircraft assemblies at sea or ashore, and return the avionics to service quickly. This contract includes sustaining logistics and engineering support. This order also involves mission equipment kits, self-maintenance and test calibration operational test program sets, calibration equipment suites, shore installation kits, genie lifts, and rack rail kits.

Braxton Technologies to handle NTS-3 satellite navigation ground control

BY JOHN KELLER

KIRTLAND AIR FORCE BASE, N.M. — U.S. Air Force space experts are asking Braxton Technologies in Colorado Springs, Colo., to build the ground control segment of an upcoming research project to enable U.S. satellite navigation systems to operate reliably amid electronic jamming, spoofing, and cyber attacks expected in future military conflicts.

Officials of the Air Force Research Laboratory at Kirtland Air Force Base, N.M., announced a $9.5 million contract to Braxton Technologies to provide the Navigation Technology Satellite (NTS)-3 ground control segment.

The NTS-3 project will use space- and ground-based systems to develop and demonstrate advanced global positioning system (GPS) technologies that are resilient in contested environments. U.S. defense officials believe that conditions in future military conflicts could deny or severely degrade the use of GPS navigation systems.

Braxton Technologies experts will provide the NTS-3 ground control segment to support orbit operations, while demonstrating and maturing innovative and affordable satellite navigation ground-based command and control capabilities to ensure resilient positioning, navigation, and timing in contested and denied environments.

Company experts also will demonstrate satellite ground-control technologies that eventually could be used in future GPS ground-control systems. They will use the Multi-Mission Space Operations Center (MMSOC) open architecture

Braxton Technologies will build the ground control segment for a research project to enable U.S. satellite navigation systems to operate reliably amid electronic jamming, spoofing, and cyber attacks.

standard, as well as the Air Force Satellite Control Network (AFSCN) for primary direct and secure communications with the future NTS-3 space payload.

The NTS-3 project will look into different ways to reconstitute the ground control segment in the event of an attack; experiment with automated and lights-out operations; demonstrate space vehicle command and control through commercial ground antennas; show compatibility with the Enterprise Ground System (EGS) standards and the Joint Space Operations Center (JSpOC) Mission System (JMS); and investigate modern processes to manage cyber risks.

NTS-3 builds on 40 years of GPS developments, and should help shape the future of military satellite navigation capabilities in tested environments. NTS-1 and NTS-2 were flown in 1974 and 1977 respectively, and qualified the rubidium and cesium clocks that form the backbone of today's modern GPS architecture.

On this contract, Braxton Technologies will do the work in Colorado Springs, Colo., and should be finished by June 2022.

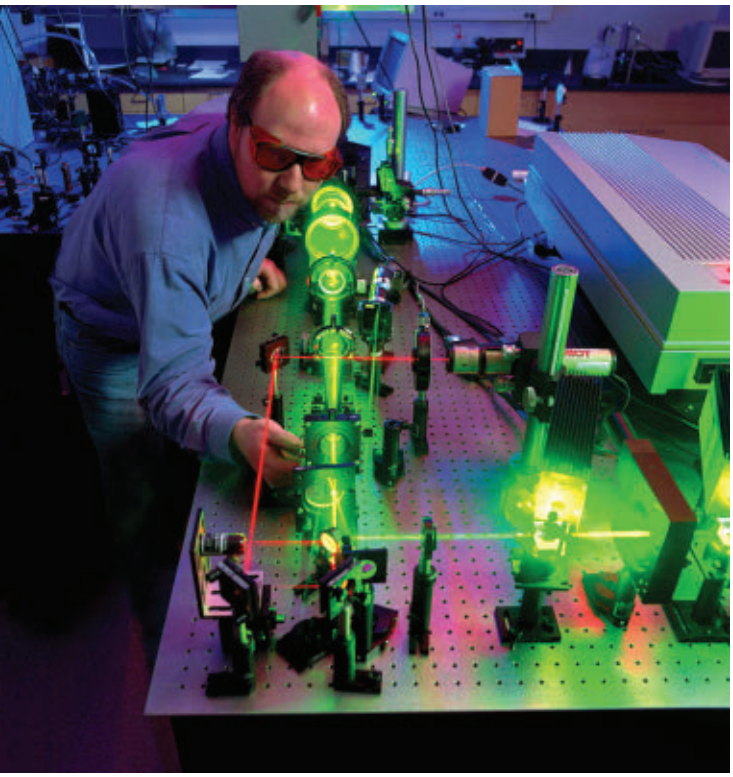
For more information, visit Braxton Technologies online at www.braxtontech.com, or the Air Force Research Laboratory-Kirtland at www.kirtland.af.mil/Units/AFRL-Space-Vehicles-Directorate.

Nuclear, command and control, information security top DOD budget research priorities

BY JOHN KELLER

WASHINGTON — The U.S. Department of Defense (DOD) could see its largest research and development DOD budget in more than a decade next year, as military planners are seeking sizable research increases in nuclear forces, command and control, sensors, information security, and many other areas.

DOD is asking for $82.33 billion in fiscal 2018 for research, development, test, and evaluation (RDT&E), which is up 15.2 percent from 2017 levels of



$72.32 billion. The Pentagon's research budget handles weapons and enabling technologies from the basic laboratory level through to advanced systems development. This budget is intended to create cutting-edge military technologies, capabilities, and defense systems.

The RDT&E budget also is expected to influence future-year procurement and operations and maintenance budgets, as research typically is at the beginning of the long military systems development, procurement, and maintenance pipeline.

All the U.S. military services except the U.S. Navy have increases to their research budgets next year. Federal fiscal year 2018 begins next October 1.

The U.S. Army's proposed research budget for next year is $9.54 billion, up 18.5 percent from 2017's $8.05 billion; the Navy is asking for $17.8 billion, down 4 percent from 2017's $18.53 billion; the Air Force is asking for $35.05 billion, up 34 percent from 2017's $26.08 billion; and defense agencies are asking for $20.72 billion, up 6.5 percent from 2017's $19.46 billion.

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Research big spenders

Among the big-spending defense research agencies, the Missile Defense Agency is asking for $6.2 billion in 2018, up 3.9 percent from 2017's $5.97 billion; the Office of the Secretary of Defense (OSD) is asking for $4.07 billion, up 7.8 percent from 2017's $3.77 billion; the Defense Advanced Research Projects Agency (DARPA) is asking for $3.17 billion, up 6.6 percent from 2017's $2.97 billion; the Chemical and Biological Defense Program is asking for $1.1 billion, up 23.8 percent from 2017's $8.85 million; Special Operations Command (SOCOM) is asking for $644.2 million, up 21.6 percent from 2017's $529.9 million; and the Defense Information Systems Agency (DISA) is asking for $256.5 million, up 3.1 percent from 2017's $248.7 million.

Among 2018's big research plus-ups for the Army are $160.7 million for aviation advanced technology, up 70.5 million from 2017's $94.3 million; $52.2 million for advanced tactical computer science and sensor technology, up 18 percent from 2017's $44.2 million; $27.7 million for the tactical Electronic Surveillance System, up 76.3 percent from 2017's $15.7 million; $76.2 million for the Lower Tier Air Missile Defense Sensor (LTAMDS), up 118.4 percent from 2017's $35.1 million; and $56.5 million for cyberspace operations forces and force support, up 39.5 percent from 2017's $40.5 million.

The Army also is asking for $336.4 million for the Army Integrated Air and Missile Defense (AIAMD) system, up 23 percent from 2017's $272.8 million; $199.8 million for the Armored Multi-Purpose Vehicle (AMPV), up 8.4 percent from 2017's $184.2 million; $175.1 million for the Indirect Fire Protection Capability Increment 2 Block 1, up 108.4 percent from 2017's $84 million; $71.7 million for electronic warfare development, up 92.4 percent from 2017's $37.2 million; and $33 million for radar development, up 106.3 percent from 2017's $16 million.

The Army also wants $102.8 million for the Guided Multiple-Launch Rocket System (GMLRS), up 170.2 percent from 2017's $38 million; $132.4 million for the Information Systems Security Program, up 246 percent from 2017's $38.3 million; and $16.9 million for tactical unmanned aerial vehicles, up 106 percent from 2017's $8.2 million.

Navy research

The Navy next year wants to spend $143.5 million on frigate development, up 69 percent from 2017's $84.9 million. Navy officials are considering adapting a version of the littoral combat ship for blue-water frigate service. The Navy also wants $776.2 million next year for the Ohio Replacement program to develop a new fleet ballistic missile submarine, up 10.8 percent from 2017's $700.8 million.

Other Navy research plans on tap for 2018 include $632.9 million for the Next-Generation Jammer, up 9.5 percent from 2017's $577.8 million; $106.4 million for the Joint Precision Approach and Landing System demonstration and validation, up 2.2 percent from 2017's $104.1 million; $229.4 million to modernize the RQ-4 Global Hawk long-range unmanned aerial vehicle, up 26.6 percent from 2017's $181.3 million; and $107.3 million for directed-energy and electric weapons development, up 228.2 percent from 2017's $32.7 million.

Topping the U.S. Air Force's research priorities for 2018 are: $2 billion for the Long-Range Strike bomber program, up 76.5 percent from 2017's $1.1 billion; $231.7 million for cyber operations technology development, up 42.4

percent from 2017's $162.7 million; $215.7 million for the Ground-Based Strategic Deterrent project to develop a new intercontinental ballistic missile to replace the Minuteman III, up 89.4 percent from 2017's $113.9 million; $417.2 million for the Joint STARS recapitalization program to rebuild the Joint Surveillance Target Attack Radar System aircraft to like-new condition, up 255.9 percent from 2017's $128 million; and $451.3 million for the Long-Range Standoff Weapon, up 372 percent from 2017's $95.6 million.

Air Force missiles

In other research projects, the Air Force plans to upgrade several aircraft and missile systems. For these upgrades, the Air Force wants $610.9 million for F-22 fighter squadrons, up 57.6 percent from 2017's $387.6 million; $181.5 million for F-35 Joint Strike Fighter squadrons, up 118.6 percent from 2017's $153 million; $210.8 million for Minuteman intercontinental ballistic missile squadrons, up 15.2 percent from 2017's $183 million; $201.4 million for the MQ-9 Reaper attack drone, up 33 percent from 2017's $151.4 million; $151.7 million for the Airborne Warning and Control System (AWACS) aircraft, up 75.1 percent from 2017's $86.6 million; and $108.6 million for the UH-1N helicopter replacement program, up 669.4 percent from 2017's $14.1 million.

DOD research agencies next year want to spend $428.9 for network-centric warfare technology advanced development, up 2.4 percent from 2017's $428.9 million; $465.5 million for improved homeland defense interceptors, up 69.8 percent from 2017's $274.1 million; $219.8 million for microelectronics technology development and support, up 124.7 percent from 2017's $97.8 million; $79.1 million for advanced electronics technologies, up 59 percent from 2017's $49.8 million; $75.3 million for a new item, hypersonic defense; and $130.7 million for the Sea-Based X-Band Radar (SBX), up 41 percent from 2017's $93.3 million.

U.S. Special Operations Command, meanwhile, wants to spend $259.9 million next year on special forces aviation systems, up 58.9 percent from 2017's $163.5 million.

At long last, laser weapons are nearing deployment

BY **J.R. Wilson**

Once the stuff of science fiction, U.S. military laser weapons now are considered the future successors to missiles and gun systems to protect military forces from enemy boats, unmanned aircraft, ballistic missiles, mortars, and rockets.

From the mythical burning mirrors of ancient Greek inventor Archimedes to the Martian death rays of H.G. Wells to Flash Gordon's raygun to Capt. Kirk's phaser, humans have been fascinated by the possible use of light beams as weapons for at least two millennia.

But it was not until the invention of the laser in 1960 that the true potential of that concept led to serious research programs, which led quickly to major size, weight, and power (SWaP) limitations. Laser is short for light amplification by stimulated emission of radiation.

In the decades that followed the construction of the first laser prototype at Hughes Research Laboratories in Malibu, Calif., numerous types of lasers have been developed, based on a variety of power sources and light generation materials, for a wide breadth of applications ranging from barcode scanners to cutting and welding in manufacturing, light shows, DNA sequencing, optical communications, laser printers, and surgery.

One of the first potential laser weapons involved using laser beams as "dazzlers" to blind opponents temporarily. Still, the narrow gap between temporary and permanent blinding led an early ban on that aspect under the Protocol on Blinding Laser Weapons, issued by the United Nations in 1995. Many governments, however, have used loopholes in the Protocol — or simply ignored it — to develop blinding lasers.

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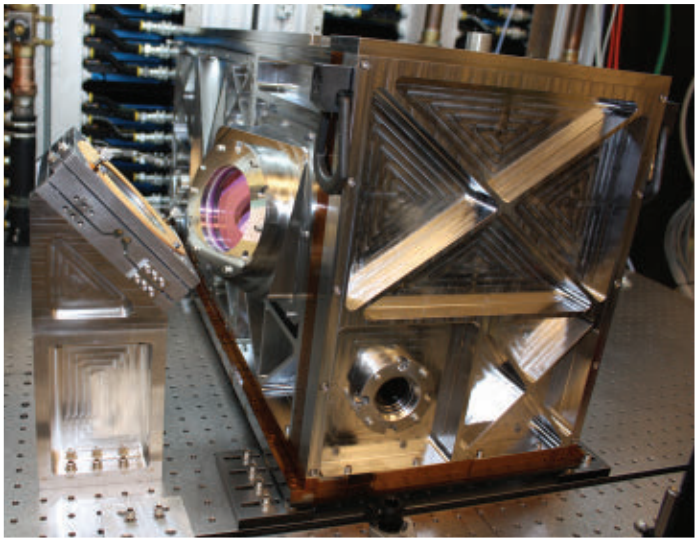
The first real laser weapon was the U.S. Air Force/Boeing YAL-1 Airborne Laser (ABL), a megawatt-class chemical oxygen iodine laser (COIL) mounted inside a modified Boeing 747-400F jumbo jet. Designed to shoot down tactical ballistic missiles during their boost phase, it first was test-fired at an airborne target in January 2010 and soon after intercepted three test missiles, destroying two of them.

While technically successful, several limitations led to the ABL's cancellation in 2011. Limitations included the short operational range of the laser beam; the massive size of the system; the aircraft's limited dwell time; the need to refuel the chemicals powering the laser; the number of ABL-equipped aircraft necessary to cover even a portion of the potential threat areas; the number of fighter aircraft needed to protect the ABL; and an overall price tag in the billions of dollars.

While the ABL's chemical laser was "magnificently efficient," its size and pricetag were unacceptable, points out Paul Shattuck, director of directed energy systems at Lockheed Martin Space Systems in Sunnyvale, Calif. "The advent of fiber lasers has allowed us to reduce SWaP to the point where a system can be carried on military platforms on the move — land, air, and sea."

Laser weapons today

Today's enabling technologies for laser weapons are leading to demonstration of 50-to-100-kilowatt lasers that can fit on a majority of existing military platforms, Shattuck says. The 60-kilowatt Robust Electric Laser Initiative (RELI) laser, for example, was designed to go into the Mobile High Energy Laser (HEL) vehicle."



The Lockheed Martin 30-kilowatt Accelerated Laser Demonstration Initiative (ALADIN) prototype spectral beam combining fiber laser combines many fiber lasers into one near-perfect quality beam of light.

The COIL's size and logistics requirements fell far short of meeting the requirements of the Army, Navy, and Marine Corps, much less the Special Operations Command (SOCOM). Just as that effort was being abandoned, however, new technologies opened possibilities that would meet the demands of the Office of the Secretary of Defense's (OSD's) HEL Joint Technology Office.

"A principal objective of the HEL JTO is to ensure and facilitate the development of HEL technologies to apply across the services and MDA [Missile Defense Agency], then provide avenues to encourage the sharing of information to make sure we are not duplicating efforts across the services or agencies," says Adam Aberle, HEL technology and development demonstration lead at the Army Space & Missile Defense Command's (SMDC) Technical Center in Huntsville, Ala.

The Army's goal is to fit an entire laser weapons system — laser, beam controller, power system. and thermal management — onto today's military trucks, from tactical vehicles, such as the Heavy Expanded Mobility Tactical Truck (HEMTT) to smaller combat vehicles such as the Stryker.

"They must be able to maneuver with the maneuvering force, but we don't want to design a new Army platform to handle a HEL system," Aberle says. "The top-level desire is to have an affordable way to address various threats that endanger the lives of soldiers, such as counter rocket, artillery and mortar (C-RAM) and UAVs. Through the analyses we've done, high-energy lasers provide a means of negating those threats in an affordable way.

"Our primary effort for maturing the state of HEL is the HEL Mobile Test Truck [HELMTT], which ties into the HEL Tactical Vehicle Demonstrator [HEL TVD]," Aberle continues. "The test truck integrates a high-power laser, beam control system, command and control system, power for the laser, and a thermal system to control the heat — all on the HEMTT."

In March 2017, SMDC announced completion of acceptance testing on the Lockheed Martin 60-kilowatt Spectrally Combined High Power Solid State Fiber Laser, which had demonstrated a sustained power of 57.5-kilowatt for a duration of 200 seconds with good beam quality. It was the first successful demonstration of a high-power fiber laser at that power level for defense applications.

Army officials say the tests exceeded the contract threshold for success and, with the addition of three more channels planned before delivery, power will exceed the 60-kilowatt program objective. The laser will be integrated with the HELMTT and used in test environments relevant to warfighting applications.

The rise of solid-state lasers

"Currently, we are using solid-state lasers — specifically combinable fiber lasers that can be ganged together to create a single beam coming out of a beam director. For example, if I had a 1-kilowatt fiber laser and could combine 50 in such a way to create a single defraction-limited beam, I effectively have a 50-kilowatt system," Aberle says. "There are multiple means of combining those and the limits are still being explored.

"There are non-linear effects that limit power scaling of individual fibers and one of our research investments is to develop techniques that can overcome those. We have, in partnership with the HEL JTO, developed a fiber combined laser at the 60-kilowatt class level. That laser has been delivered and we are working on integrating it into the HELMTT and demonstrate it in 2018."

During the Maneuver Fires Integrated Experiment (MFIX) last April at Fort Sill, Okla., an Army specialist with no prior experience with the system became the first soldier to shoot down a UAV — approximately 18-by-10 inches in size — at 600 meters with a laser, the 5-kilowatt Mobile Expeditionary High Energy Laser (MEHEL) mounted on a Stryker armored vehicle. The test was designed to determine how well the average soldier can adapt and effectively use the new technologies.

"One day we want this capability to transition into the hands of the warfighter," Aberle says. "So we gain feedback — 'this worked well, this didn't' — so we can make the technology more useable to a soldier at the end. We don't want to have to create a whole new MOS [military occupational specialty]; it would be additional training they would receive.

"At SMDC, we have done the most development work in how to make the laser very efficient, from the standpoint of power and thermal," Aberle continues. "In the last 10 years, we have gone from systems that were less than 10 percent efficient to our 60-kilowatt, that is greater than 40 percent efficient — that is, transferring electrical energy going into the laser into photon energy coming out of the laser. That advancement has enabled power and thermal systems that are available to fit on platform."

The Navy also has stated it expects laser weapons to become major elements on combat ships.

Laser weapons at sea

"Laser weapons will prove to be a critical factor in future warfare and the Navy is setting the pace for development and procurement of these weapons," says Navy spokeswoman Lt. Kara Yingling. "The specifics of Navy laser needs and requirements are not releasable due to classification. However, they are generally spread across the mission areas of integrated air and missile defense, counter-intelligence, surveillance and reconnaissance and anti-surface warfare. These areas may be enhanced by transformational technology like laser weapons."

This Mobile High-Energy Laser-equipped Stryker was evaluated last during the 2017 Maneuver Fires Integrated Experiment at Fort Sill, Okla.

The Navy has been testing a new generation of SWaP-improved laser weapons. A 2011 demonstration by the Office of Naval Research (ONR) saw a destroyer-mounted laser defeat several small boat threats. The following year, ONR's Laser Weapon System (LaWS) downed several unmanned aircraft during naval exercises.

"Laser weapons are powerful, affordable and will play a vital role in the future of naval combat operations," retired Navy Rear Adm. Matthew L. Klunder, then chief of naval research, said at the time. "We ran this particular weapon, a prototype, through some extremely tough paces and it locked on and destroyed the targets we designated with near-instantaneous lethality."

ONR describes LaWS as a low-power prototype never intended to be a deployed weapon, but the Naval Sea Systems Command took it when ONR had completed its tests, upgraded it — including linking its targeting system to radar tracks from an MK15 Phalanx Close-In Weapon System — installed the resulting 30-kilowatt, solid-state XN-1 laser on the USS Ponce, deployed in the Persian Gulf, and, following some on-board tests, declared it operational.

"The LaWS was given the task, if needed, to defend the ship. It is probably larger than what the Navy wants in the future, but in terms of putting it on a destroyer, you probably don't need to drive it much smaller. It also has the biggest 'eyes' on the ship and can allow the commander to see things further out than any other sensor on the ship, which is a collateral benefit," says Lockheed Martin's Shattuck.

The Navy's Yingling confirms that sailors on the Ponce used the powerful optics of the LaWS system for intelligence, surveillance, reconnaissance, and combat identification.

"LaWS deployed in 2014 as the U.S. military's first deployed laser weapon system. Still installed on USS Ponce today, LaWS has provided the Navy — and the directed energy community writ large — with lessons that will inform future iterations of laser weapons," Yingling says. "LaWS exceeded all operational requirements and provided valuable lessons in atmospheric propagation of lasers, performance and reliability of a laser

system in a maritime environment, integration of laser weapons within existing combat systems architectures, laser safety and airspace deconfliction, tactical employment of lasers, lethality against air and surface targets, and much more."

Navy officials now hope to test a 150-kilowatt-class laser by 2018, with a deployment goal of 2020.

"As the Navy continues to develop laser weapons, there may come a time when they can fully subsume the role currently provided by short- and medium-range interceptor missiles and gun systems. Until such a time as the tactics and capabilities of our laser weapons are proven for the longer term, laser weapons will continue to complement existing weaponry on currently fielded platforms," Yingling adds. "Additionally, laser weapons have the potential to augment maritime domain awareness, improving the overall capabilities of our afloat platforms even when not using them for a high energy laser engagement."

Laser weapons tests

Last April, the Naval Surface Warfare Center Dahlgren Division (NSWCDD) in Dahlgren, Va., announced the transformation of a long-dormant, 100-meter tunnel, crucial to gun range operations during World War II, into a vital new capability for testing laser technologies by the Navy's state-of-the-art Laser Lethality and Development Laboratory.

"A capability such as this allows us to stay in front of HEL weapon lethality testing, modeling, and simulation to support the current and growing number of Navy laser weapon programs," notes Christopher Lloyd, NSWCDD's HEL Lethality lead. "We'll be able to expand the tunnel's range further, up to 300 meters, with some unique test configurations.

"It will soon enable testing in controlled environmental conditions to better replicate weather conditions in regions where deployed HEL systems may operate. We'll be able to study aspects such as beam propagation effects from turbulence and scattering/absorption and how that affects overall system performance."

NSWCDD's commanding officer, Capt. Godfrey Weekes, says adding the tunnel to the LLDL's existing capabilities will enhance innovation and the evaluation of future HELs interoperable with Navy ships and electric weaponry.

"As we continue to develop and deploy laser weapons to the fleet with the inherent advantages of directed energy — speed-of-light delivery, engagement precision, magazine depth, and scalable effects — our warfighters will have a significant technological advantage over our adversaries," Weekes says.

The Navy's program executive office for integrated warfare systems (PEO IWS) is working with industry to develop and field a laser weapon system for installation onboard a late-model Arleigh Burke-class destroyer in the shortest time possible through a full and open competition, says a spokeswoman for Naval Sea Systems Command (NAVSEA).

The controller used on the Hunter and Killer vehicles are like that of a video-game controller and was experimented with during the Maneuver Fires Integrated Experiment (MFIX) in April at Fort Sill, Okla.

The Hunter (right) and Killer vehicles drive up a road toward the experimentation area of the Maneuver Fires Integrated Experiment.

"The Surface Navy Laser Weapon System, Increment 1, will leverage mature technology to deliver a new laser weapon capability to the fleet, which will consist of a HEL, along with a Counter-ISR dazzling capability."

The Air Force has been closely monitoring advances in HEL technology — especially significant improvements in SWaP.

The Lockheed Martin ATHENA laser weapon system defeats a truck target by disabling the engine, demonstrating its military effectiveness against enemy ground vehicles.

Ready for the battlefield

The most vocal proponent of a new attempt at an airborne laser weapon is Lt. Gen. Bradley Heithold, former head of the U.S. Air Force Special Operations Command (2014-16) and current principal deputy director in the Pentagon's Office of Cost Assessment and Program Evaluation. "I'm a firm believer that it's time we take directed energy in the form of high-energy lasers and move it into the battlefield on an AC-130 gunship," he says. "The next weapon is a directed energy weapon. This is an evolution. It's do-able. The bottom line is, this is a game changer."

His successor at AFSOC, Lt. Gen. Brad Webb, says he hopes to begin testing a laser on an AC-130 within a year, which could set the stage for meeting Heithold's original deadline for deployment in the early 2020s.

In testimony before the U.S.-China Economic and Security Review Commission hearing in February 2017, Richard D. Fisher, Jr., a senior fellow at the International Assessment and Strategy Center, warned of China's rapid advances in laser weapons and how the U.S. must work hard to hold onto its lead.

Lockheed Martin's transportable ground-based prototype Advanced Test High Energy Asset (ATHENA) serves as a test bed for demonstrating technologies required for military use of laser weapon systems.

"For the United States, decades of technology investments in directed energy weapons — lasers, railguns, and high-power microwave — are finally nearing the point of providing next-generation capabilities over potential enemies," Fisher told Congress. "Effective early defensive laser weapons plus defensive-offensive railguns could be deployed in the early 2020s, while multi-platform, high-power but compact laser weapons could be realized in the 2030s. However, it appears increasingly likely that any period of advantage from these weapons could be shorter than expected.

"China's energy weapons program has a breadth and intensity that should greatly concern American and Allied defense planners," Fisher continued. "Some Chinese military experts expect that energy weapons will become more prevalent in 10 to 20 years and will dominate the battlefield in 30 years. As such, it is imperative that the United States redouble its focus to achieve technology breakthroughs needed to realize decisive energy weapon capabilities and be ready to cooperate with critical allies to accelerate co-developments.

"Boeing and Northrop-Grumman are developing a defensive laser pod that by the early 2020s could enable U.S. combat aircraft to disrupt or jam anti-aircraft missile seekers. U.S. officials envision a reduction in laser system size, to 5 kilograms per kilowatt, as enabling tactically sized 300-kilowatt SSLs [solid-state lasers]. By the early 2030s, these may allow 'hard kill' against air or ground targets from F-35B fighters, future tankers or from ship or land platforms."

Directed-energy roadmap

The U.S. Department of Defense (DOD) is drafting a Directed Energy Roadmap to identify those areas where lasers could play a role in the future of warfare. That will include looking at threats, development plans, and concepts of operations, evaluating the current state-of-the-art in laser technology and assessing the advancements necessary to meet service and warfighter

needs, Heithold said in an interview with the Institute for Defense & Government Advancement (IDGA) prior to the Spring 2017 Directed Energy & Next-Generation Munitions Conference.

"The study will identify those areas of development that could be consolidated, as well those that need to be expanded. Finally, for the various mission areas, it will identify the technical maturity levels at which transition to the acquisition process is appropriate. The potential to field operational directed energy weapons is exciting and the Department plans to continue to making investments in this area, [although] the overall programmatic organization of the Department's laser development is still TBD," Heithold said.

"Directed energy has the potential of providing DOD with capability advancements in several areas. These include the potential of engaging targets more rapidly than conventional techniques, at greater ranges and with a lower cost per shot. Directed energy offers the potential for silent, precision attack options with reduced signature, and the potential to minimize collateral damage. They also offer the potential of scaling effects from target destruction to disruption, providing warfighters with greater flexibility to adapt to their situation."

Adm. William Moran, vice chief of naval operations, at the 2016 Directed Energy Summit, said the Navy is "fully committed" to lasers and other directed-energy weapons to deal with emerging threats, but added the technology must be pushed forward faster than previous fieldings of new capabilities.

"These technologies are being developed and fielded by a lot of countries. If we don't go forward, we will fall behind," Moran warned. "Low-cost directed energy weapons have to be part of our future. If we have to continue to rely on projectiles, we will run out of the ability to defend ourselves in the future, [so] we are fully committed to taking this into the future."

In testimony before the Senate Appropriations Committee's Subcommittee on Defense on 12 June 2017, Army Chief of Staff Gen. Mark A. Milley noted that rapid advances in technology already are and will continue to change the face of warfare. "For five centuries, armies have depended upon powder propellants to project projectiles through space. Now there is a possibility of alternative means," he told lawmakers. "There are a whole series of technologies out there, all of which are going to impact the character of war. I anticipate within 10 years, maybe 15, a significant increase in the use of lasers, electromagnetic weapons, rail guns, and other things, like robotics and artificial intelligence."

A soldier stands next to a High Energy Laser Mobile Test Truck, which is planned to be integrated with a 60-kilowatt laser that completed testing earlier in March.

Work to be done

Lockheed Martin's Aberle says much work remains to be done before lasers become truly battle-ready. But even then, and for the foreseeable future, he does not see lasers as being a military "holy grail," completely replacing kinetic weapons.

"There are conditions where you would like to have the ability to make sure the laser beam can propagate appropriately through whatever environmental conditions it faces, with turbulence being a significant one. That is a technology in which we are investing significantly to assess how effective an adaptive optics system can measure that turbulence and what the phase front of the laser looks like. We also are assessing what technologies can be leveraged out of astronomical systems to apply to an HEL," Aberle explains.

"There are certain targets lasers will affect appropriately in the constraints of the battlefield, others that are more challenging. We view laser weapons as complementary to kinetic systems, one where a commander in the field is able to determine which weapon will be most effective in the environment in which they are fighting."

Shielding against electromagnetic and RF interference for safety and mission success

Aerospace and defense engineers opt for innovative EMI and RFI shielding solutions and materials to protect safety- and mission-critical systems from intentional and unintended electronics emissions.

BY **Courtney E. Howard**

ITT Cannon provides ARINC 600 filter connectors for various commercial aerospace applications.

Aerospace and defense applications, platforms, and environments are undergoing a digital transformation, and the proliferation of portable electronics devices and embedded electronics systems is contributing to a significant increase in RF emissions that could cause interference, data corruption, or worse.

The number and complexity of electronics equipment and the threat of electronic countermeasures (ECM), ranging from radar jamming and deception to a devastating electromagnetic pulse (EMP) attack, are on the rise. All these factors are driving the need for greater protection from electromagnetic interference (EMI) and radio-frequency interference (RFI), both of which challenge aerospace and defense engineers today and could have disastrous effects on safety- and mission-critical systems.

Noise nuisance

All aerospace and defense equipment has to be able to operate in an electromagnetic spectrum, explains Chad Hutchinson, director of engineering at Crystal Group in Hiawatha, Iowa. "All electronics radiate in some way, shape, or form." EMI and RFI are more of an issue in this day and age, with so many personal electronics devices (PEDs) and embedded electronics systems throughout each vehicle – and all of it radiating.

"All those electronics radiate," Hutchinson says. "The problem is: If two pieces of gear were not designed to operate together, you have the potential for electromagnetic incompatibility issues, where the emissions of one device can cause a disruption in the operation or the failure of another piece of equipment." It's a serious concern, especially when lives or missions are on the line.

"When you talk about safety- and mission-critical systems, many have been designed some time ago, and now they are being put into an electromagnetic environment or spectrum for which they were not designed or where other radiators are now present," Hutchinson continues. "Those have the potential for

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causing disruption, loss of operation, or outright failure of those systems. When you are talking about the loss of a safety- or mission-critical system, that means somebody could die, a piece of equipment could be destroyed, or that the mission has failed."

"EMI protection is always a concern as 'more electrified' aircraft and vehicles bring potentially noisy components in the form of numerous and higher-voltage motors with attendant power supplies," says J. Grant Lawton, application engineer, military wire and cable, at W.L. Gore in the Philadelphia area. "At the same time, these components are being placed next to many high-speed data cables that have additional concerns for alien cross-talk.

ITT Cannon Fiber Optic Connector Saver

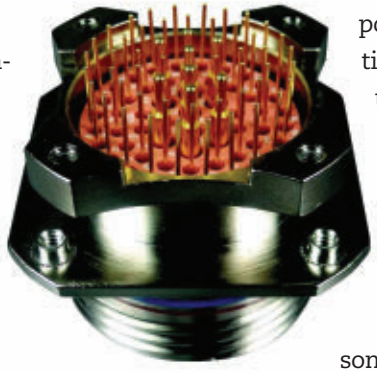
"If system designers are concerned about noise resistance to adjacent data cables operating around 1.5 volts and with milliamp (mA) currents, then we can appreciate their concern when adjacent motor power cables could be operating over 270 volts and tens of amps," Lawton adds. "Specific to military applications, these concerns can be elevated by unique needs such as separating classified data from unrestricted data and meeting Tempest requirements. Highly effective EMI/RFI shielding is essential for assuring signal integrity and system integrity in today's data-intensive platforms."

EMI and RFI requirements

"We are in an environment where electronic warfare is a key component of the battle space. There are other adversaries who are specifically using electromagnetic emissions to interrupt or disrupt military equipment. In this case, EMI/RFI shielding is important to be able to ground those emissions — provide essentially a ground plane around the equipment where the equipment inside is protected from those harmful emissions," Hutchinson says.

"Almost all military applications require some form of EMI emissions control; that's why we have a military specification called MIL-STD-461," Hutchinson explains. U.S. Military Standard MIL-STD-461 describes how to test equipment to ensure electromagnetic compatibility. "It has been around for many, many years because [interference] has been a critical concern since really the advent of emissions.

"Aerospace and defense platforms are designed with compact, high-power units used very close together, sometimes developed by different manufacturers and integrated at the weapons platform level." As a result, Hutchinson says, "it is very important that everybody meets their own electromagnetic emissions and susceptibility requirements," such as those described in MIL-STD-461.



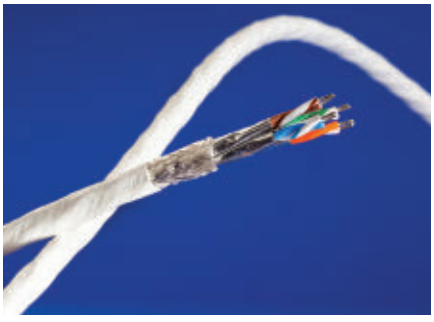
ITT Cannon Double Flange Receptacles for PCB mounting

"If I am making a piece of electronics, I have limitations on what it is allowed to emit" and how much it is susceptible to, Hutchinson describes. "If we both meet our specifications, the emissions I put out will not affect them because they have to be able to withstand at least that level of emissions to which I am limited." Problems arise when a device's emissions exceed the limitation and/or a device falls short of its susceptibility requirements. In short, one device emits more than another device can handle, resulting in the failure of the equipment.

"You have really four pieces in MIL-STD-461 that are critical: conducted emissions and conducted susceptibility, which is actually put on the physical power lines that connect the equipment together; and radiated emissions and radiated susceptibility, which is the stuff that is being put out in space," Hutchinson continues. "You have potential for constructive interference where two pieces of gear would join at a particular frequency to put out emissions. If I'm radiating at 200 MHz at a certain amplitude and someone else is radiating in the same area at 200 MHz and you had a piece of equipment that was susceptible at that frequency, you have the potential for a serious problem.

"Passing MIL-STD-461 does not guarantee you will not have an EMI compatibility problem. Likewise, failing MIL-STD-461 does

not guarantee that you will have an interference issue," Hutchinson says. "If you are radiating and have an outage at a frequency no one is listening at, there's not a compatibly issue. If you are emitting within the limits of MIL-STD-461 at a frequency which another piece of gear, maybe a commercial off-the-shelf (COTS) piece of equipment, happens to have a susceptibility, you will have an interference problem, even if you are underneath the limit, if that other piece of gear wasn't designed and rated for this susceptibility in that environment. It's about spectrum management. Consider who is radiating at what amplitude and intensity at what frequency, and who is listening at those amplitudes and frequencies."



Gore Aerospace Ethernet Cat6a cable

Design challenges

One of the big problems is the system designer's inability to eliminate all the noise, Hutchinson says. "Ulti-mately, from an RF perspective, we would prefer not to generate noise if at all possible. If you can't [avoid generating] it, you try to filter it and prevent it from getting to the outside world. That normally helps on the conducted side. On the radiated side, you should provide shielding.

"With the higher frequencies of electronics, antenna lengths are getting shorter — inverse with frequency," Hutchinson adds. "That means these very small components turn into antennas, and they start radiating and making noise that gets picked up. By nature of some designs, when you are dealing with electronics, you cannot eliminate all the noise from being generated."

A way of mitigating RF nose is using a switching power supply, in which switching controls voltage levels. "That switching transient [produces] noise at the frequency of the switching, so that translates to noise that gets out of the unit. Proper filtering and EMI shielding is what keeps

that inside the box," Hutchinson says. "There's no way to get around it; by nature of making a switching power supply, it has to make that noise."

The generation of electronic emissions, or noise, can be unavoidable, but EMI and RFI issues can be avoided if protections, such as EMI/RFI shielding solutions, are put in place.

"You can do all the magic in the world to have a quiet box where it is properly shielded and all the emissions stay inside the box, but then you connect the cable. If you don't have it properly bonded and shielded at the cable interface, those emissions are now out into the same space just as if your box is creating it; they are leaking at the cables. So proper 360-degree coverage on the back cells, proper bonding of your cables is absolutely critical. Don't forget the cables and your peripherals," Hutchinson advises. In fact, he says, "watch for any place where two or more surfaces come together. Those are apertures; you need to watch the geometry of those things to make sure you don't emit."

Critical communications

"Mission-critical signals are increasingly in need of greater EMI and RFI protections in both military and commercial aviation applications," acknowledges Mike Savage, director of aerospace and defense product management at connector specialist ITT Cannon in Irvine, Calif. "As the rate and frequency of signals continue to increase, the likelihood of interference or crosstalk also increases, which could result in inaccurate data leading to incorrect mission intelligence and even possible loss of life.

"In military environments, any interference could potentially be leveraged by the enemy, resulting in dangerous scenarios affecting soldier safety. Another example on the commercial aviation side is the challenge posed by lightning strikes," Savage adds. One response he and his colleagues at ITT Cannon are seeing is an increased focus on utilizing composite materials and filters, when possible, to shield critical interconnects. "At ITT Cannon, our aviation customers have many high-power, high-bandwidth application requirements in interconnects and these increasingly complex demands are driving the latest advances in our technologies."

ITT Cannon MKJ Clip Lock connector for avionics and cabin systems

Crystal Group RPS425DC1U rugged power supply

In commercial aerospace, the proliferation of in-flight entertainment and communications (IFEC) and wireless broadband connectivity in-flight potentially could cause interference with critical systems on the aircraft, Savage says. "Additionally fly-by-wire and the constant introduction of new electronics into the aircraft inevitably increase the complexity and density of the overall infrastructure, including cables, boxes, and connectors, which then requires more shielding."

At the same time, Savage explains, "damaged shielding can cause signals to short in cables, resulting in interference. For example, in avionics, interference from stray signals can cause misreadings and interference with ground-to-ground signals, telemetry, and global positioning systems (GPS). In military applications, EMI/RFI shielding is needed to protect mission-critical communications impacting soldier safety and situational awareness.

"Any interference can result in inaccurate radar signals, weapons systems deployment, and potential jamming by enemies. It is imperative that interconnects have optimal shielding to protect systems from outside signals that could damage or jam signals and make equipment inoperable," Savage stresses. ITT Cannon technologies support up to 10 gigabits per second in ruggedized packaging with 360-degree EMI shielding, he says. "In defense and military, customers require reliable and robust interconnects to ensure the safety and effectiveness of modern soldiers, military aircraft, as well as missile defense applications."

Composite conundrum

EMI/RFI shielding has become very important for several reasons, says Robert Moore, senior principal engineer at TE Connectivity in Redwood City, Calif. "Over the years, airframes

Aging platform protection

Relatively old Qualified Products List (QPL) solutions are not meeting EMI protection requirements, explains Dennis Brondi, communications manager at Eaton Interconnect and Power Communications Manager in Camarillo, Calif. "For example, MIL-DTL-55181 QPL power connectors were designed over 30 years ago when there was a much lower density of electronics equipment, including radios, and less breadth of transmission frequencies and electronics component operating frequencies that need to be protected against when compared to today's military vehicles.

"The original MIL-DTL-55181 QPL design contributes to today's EMI-protection problems because it only provides incidental shell-to-shell grounding continuity," Brondi continues. "To reduce the electrical resistance through the shell-to-shell interface, Eaton is introducing MIL-DTL-55181 power connectors with patented conductive-insert arrangements (U.S. patent #9437979 B2, published 9/6/16). Incorporating conductive inserts, instead of adding grounding pins facilitates backward compatibility with the large installed base of MIL-DTL-55181 power connectors, albeit mating receptacles, plus both need conductive inserts to facilitate lower-resistance ground paths."

Mobile missile-defense systems and artillery are key applications, requiring connectors that facilitate accelerated set-up times, provide exceptional EMI protection, and withstand high levels of shock and vibration. To meet these requirements, Eaton's MIL-DTL-38999 Series IV connectors incorporate 360-degree grounding fingers that reduce shell-to-shell electrical resistance and improve electromagnetic and radio-frequency interference (EMI/RFI) protection, Brondi says.

"Connectors must have 360-degree electromagnetic compatibility (EMC) screening, and the distance between differential electrical pairs must comply to certain rules in order to prevent cross talk, information loss, or signal degradation," says Serge Buechli, marketing manager at LEMO Connectors in Ecublens, Switzerland.

have moved to more and more composite structures making up the whole aircraft. In the past, the aluminum airframe itself acted as a big shield to keep EMI out from outside the aircraft. Composite airframes themselves offer no shielding. Because of that, it becomes more important to provide shielding on the cables and overall harnesses to keep the EMI from coupling onto the wires.

"Shielding on the cables and harnesses has also become more important in the mitigation of lightning strikes as the shields are required

Fiber optics for EMI and RFI immunity

"Fiber-optic interconnect solutions are ideally suited for high-speed, high-reliability, EMI/RFI-immune, digital data transmission in harsh environment applications, such as airborne avionics and computers, battlefield communications, and weapon systems," officials at Amphenol in Wallingford, Conn., say. "A large amount of data, voice, and video has to be securely transmitted in these applications, sometimes over long distances. Fiber-optic links, with large bandwidth and a small diameter, provide a fast, reliable, lightweight, and simple method to transmit a huge amount of information between various systems.

"Fiber-optic links only carry light pulses making them immune to electromagnetic or RF interferences, which are a threat to the integrity of the transmitted information. Fiber-optic links suit battlefield communication systems exceedingly well where secrecy and data integrity are paramount," Amphenol officials explain. "Light pulses from fiber-optic links can't be detected or hacked, making the link virtually invisible."

Some aerospace and defense applications have made strides using copper for high-speed connections, while others have migrated to fiber, depending on the environment, admits Mike Savage, director of product management, aerospace and defense, at ITT Cannon in Irvine, Calif. "In more and more applications, fiber is the preferred option, such as on certain ground-to-ground missiles and smart munitions, military aircraft such as cargo and transport planes driven by weight restrictions and anti-jam requirements, as well as in shipboard systems."

Distance, size, and weight are prime considerations. "Anywhere that requires high data rates over significant distance or with weight, security, or electromagnetic interference (EMI) concerns can benefit from, or may require, fiber," says Ben Reed, general manager at Amphenol Fiber Systems International in Allen, Texas.

Despite their immunity to EMI and RFI, fiber optics have not achieved widespread adoption in aerospace and defense applications to date. "When it comes to fiber optics, their inherent problem is that fiber-optic cables are susceptible to shock – from sonic booms, IED hits, and so on – where metal cables are more sturdy," says Scott Gunderson, global aerospace/defense market manager at Parker Chomerics in Woburn, Mass.

Savage disagrees, explaining that "many of the historical limitations of fiber, such as durability and field serviceability, have been addressed and the demand for faster, lighter, and more EMI/RFI-resilient solutions will continue to push manufacturers to make investments in fiber technology."

Regardless, aerospace and defense applications are switching from copper to fiber for high-speed transmission, space savings, and security, says Jeremy Ruff, director of business development at Amphenol Borisch Technologies and Amphenol Griffith Enterprises in Providence, R.I.

to safely shunt the lightning energy where in the past, the metal airframe would serve that function," Moore continues. "Another reason that EMI shielding has become important is that the signals running on the aircraft have changed.

"ARINC 624/MIL-STD-1553 were the workhorse of data communications. Compared to other data standards used today, these are slow but robust," Moore says. "With the introduction of 100BaseT, gigabit Ethernet, 10 gigabit Ethernet, and IEEE 1394, the data rates are higher, the frequencies that make up the digital signal square waves are now in the gigahertz range so the cables themselves become a source of EMI. Since the data cables can be a source as well as susceptible, the shielding needs to keep signal in and protect from nearby

ITT Cannon
Nemesis Quick Term

cables. Even circuits that are used to change the position of a flap or aileron can be susceptible, and the use of Raychem FilterLine (AS85485) hook-up wire provides additional protection from EMI that couples onto the wire and would otherwise conduct along the wire by attenuating the EMI along the length of the wire."

Effective filtering

Filtering at the connector interface is often the most effective line of defense against the effects of EMI/RFI, admits ITT Senior Product Manager Dom Lecce. "However, the next level of signal integrity is in advanced shielding materials, and it is advisable to use multiple shielding options in certain applications."

ITT Cannon's D38999 filter connectors are employed in military applications like light control and radar systems for advanced unmanned aerial vehicles (UAVs), military aircraft, as well as weapon systems and improvised explosive device (IED) high-frequency detection systems. "Our high-density ARINC 600 TBKA filter-style interconnect is an established standard for navigation and control system protection for the worldwide commercial aircraft industry," Lecce says.

ITT Cannon engineers are using advanced Chip-on Flex technology, which enables them to package

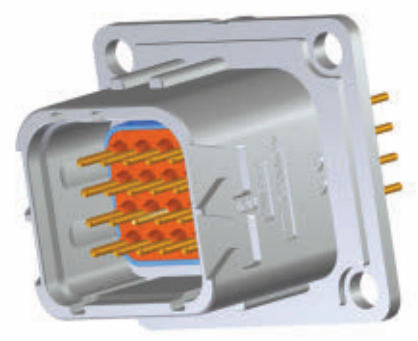
capacitors for filtering as well diodes and metal oxide varistors (MOVs) for transient voltage surge (TVS) associated with lightning — "all within the same connector, resulting in a very lightweight and high-performance, compact design," Lecce explains. Further, customers are opting for "ITT Cannon Filter MDM Microminiature designs in both C- and Pi-Filter configurations... for missile guidance systems where connector size is critical."

"Engineers and engineering managers should seek out partners who have a solid knowledge of high-frequency, voltage surge suppression, and filtering solutions, as well as experience designing, testing, and qualifying highly-engineered interconnect products," Lecce advises. "Today's modern shielding demands require a company that has a combined perspective of electronics and connectors." Indeed, more aerospace and defense engineers are opting to take a more holistic approach.

"Many factors affect the choice of the best EMI shielding materials for an application," a materials expert at W.L. Gore in Newark, Del., explains. "These factors include the materials used in the enclosure, the environment in which the product will be used, performance requirements for the shielding materials, quantity to be manufactured, and preferred installation equipment."

RFI shielding

"As electronics become more complex, they require more radio-frequency (RF) shielding. Fly-by-wire systems in aircraft, safety systems, and even passengers carrying tablets or phones, and there's more electronic interference around than there was just a few years ago," says Scott Gunderson, global aerospace and defense market manager at Parker Chomerics in Woburn, Mass. "All platforms and vehicles, components, and systems need EMI/RFI shielding. Aircraft, combat vehicles, ships, communications equipment, safety equipment, missile systems and launchers — everything needs shielding to operate functionally."



ITT Cannon RPR EN4165-style connector with PCB contacts

Parker Chomerics' shielding solutions help make military aircraft less susceptible to damage from lighting strikes, whereas its coatings and EMI shielding gaskets protect mission-critical missile systems from RF interference. "Obviously, you wouldn't want an enemy to be able to remotely launch your missile with an RF transmitter," Gunderson adds. "Chomerics also makes shielded coatings for low observable aircraft, allowing for radar to be absorbed — making the plane nearly invisible to radar."

"You never want to go cheap on EMI/RFI shielding. You always want to select the highest-quality shielding you can afford for an application — because of how much more RF radiation is in the air, even compared to a decade ago. It really does depend on your application, but choosing a premier supplier for EMI/RFI shielding helps combat and protect your mission-critical systems," Gunderson says. "Aerospace and defense vehicles and systems all need to be protected from the barrage of electronic transmissions today and well into the future."

"The design engineer should not settle for cables and components that they suspect are 'good enough,'" Gore's Lawton says. "Today's platforms are increasingly dependent upon electronic systems, which must communicate reliably and accurately. Cables are the lifeline of these systems."

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Navy readies contract to Rockwell Collins for high-power transceivers

U.S. Navy radio communications experts are making plans to upgrade existing radios with 721S fixed-site VHF-UHF radio transceivers from Rockwell Collins in Cedar Rapids, Iowa. Officials of the Naval Sea Systems Command Corona Division in Corona, Calif., have announced their intention to buy commercial 721S radios from Rockwell Collins to replace existing UHF/VHF radios in the field that are obsolete and cannot be upgraded to remain relevant with current and future technologies. The 721S high-power AM/FM VHF-UHF radio transceiver provides long-range communications that operators can optimize for RF-congested operational conditions. These radios have an optional full-color display and software-definable touchscreen. The removable radio controller unit provides radio control, status, and voice audio and keying connections. The 721S radio transceiver is configurable to support several voice and data operating modes in AM and FM over frequencies from 30 to 512 MHz; features Ethernet-based command and control, and industry-standard severe cosite operation; and operates in fixed-frequency or frequency-hopping modes. One radio control unit can manage several transceivers.

General Dynamics to upgrade Army SIGINT and EW vetronics

BY **John Keller**

ABERDEEN PROVING GROUND, Md. — Military signals intelligence (SIGINT) and electronic warfare (EW) experts at General Dynamics Corp. will maintain and upgrade combat vehicle SIGINT vetronics systems to enhance the ability to detect, identify, locate, and deter a wide range of signal emissions on the battlefield.

Officials of the U.S. Army Contracting Command at Aberdeen Proving Ground, Md., announced a $250 million contract in June to the General Dynamics Mission Systems segment in Scottsdale, Ariz., to modify, test, train, and sustain the AN/MLQ-44 Prophet-Enhanced SIGINT vetronics systems.

General Dynamics also will continue development and integration of technology insertion capabilities for the Prophet-Enhanced system to keep the systems up to date against an evolving threat, officials say.

The Prophet system is composed of electronic components that are vehicle-mounted or soldier-transportable. Prophet offers a near-real-time picture of the battlespace through SIGINT sensors and high-performance computing.

The program is structured with the ability to incorporate new technologies as they become available. For example, General Dynamics is using the RS112 1U rugged server from Crystal Group Inc. in Hiawatha, Iowa.

Prophet is the Army division and armored cavalry regiment commander's principal SIGINT and electronic warfare (EW) system. It also enhances the tactical commander's capabilities in electronic intelligence battlespace visualization, target development, and force protection. Prophet offers electronic attack and navigation attack capability.

The Prophet system also provides near-real-time digital information to the Army division's common operating picture (COP), and is integrated with battlefield sensors, such as the Joint

General Dynamics will maintain and upgrade the Army's fleet of Prophet signals intelligence and electronic warfare vehicles.

Surveillance Target Attack Radar System (Joint STARS), the Guardrail Common Sensor, Artillery Counter Mortar/Battery radars, and Forward Area Air Defense Command and Control/FAADC2.

Prophet's primary mission is to map radio-frequency (RF) emitters on the battlefield electronically from 20 MHz HF frequencies to 2000 MHz SHF frequencies. Electronic mapping detects, identifies, locates, and tracks all RF emitters operating within range, and helps coordinate these RF signatures with other battlefield surveillance and reconnaissance systems.

Prophet helps protect global positioning system (GPS) satellite navigation, helps detect intrusion or false GPS signals, and helps attack the enemy's ability to use the GPS or other satellite navigation and timing systems. The system also can intercept, disrupt, or eavesdrop on enemy radio communications.

On this contract, General Dynamics will do the work at locations determined with each order, and should be finished by June 2022.

FOR MORE INFORMATION visit **General Dynamics Mission Systems** online at *https://gdmissionsystems.com*, and the **Army Contracting Command at Aberdeen Proving Ground** at *http://acc.army.mil/contractingcenters/acc-apg*.

Army mulls COTS radios to help detect radioactive materials and nuclear weapons

BY **John Keller**

ABERDEEN PROVING GROUND, Md. — U.S. Army researchers are approaching industry to find rugged commercial off-the-shelf (COTS) radios that can help detect and characterize radioactive materials that could indicate the presence of terrorist nuclear weapons, dirty bombs, or other radioactive weapons of mass destruction.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., have issued a sources-sought notice (W911SR-17-MRDS-Radio) for the Man-portable Radiological Detection System (MRDS) project.

MRDS seeks to find COTS or government off-the-shelf (GOTS) radio products to support a system able to detect and characterize radiological threat materials.

These radios should be able to work in an RF-restricted environment, and should be mature products that meet Technology Readiness Level (TRL) 8, or that are completed and qualified through test and demonstration.

Army researchers particularly are looking for contractors and suppliers with knowledge and experience in military communications, who can supply ready-to-use rugged, reliable, high-throughput Internet Protocol (IP) radio communications solutions.

Army researchers are considering COTS radios to help detect and pinpoint the presence of radioactive materials that could indicate the presence of nuclear weapons.

The Army Contracting Command is issuing this source-sought notice on behalf of the Joint Project Leader for Radiological and Nuclear Defense (JPL-RND) at the Joint Project Executive Office for Chemical Biological Defense (JPEO-CBD) at Aberdeen Proving Ground.

These experts are trying to establish a knowledge baseline to help form a radio communications solution strategy, and may use this information for a future solicitation or to incorporate into existing contracts.

Industry responses may consist of white papers, capability statements, product brochures, specifications, or other relevant information focusing on possible communications solutions.

Companies interested should e-mail responses in .pdf format to the Army's Diane Dei at diane.v.dei.civ@mail.mil and Adam Sheir at adam.d.sheir.civ@mail.mil.

E-mail questions or concerns to the Army's Adam Sheir at adam.d.sheir.civ@mail.mil.

MORE INFORMATION IS ONLINE at *http://bit.ly/1hoBTQK*.

Marine Corps to receive RQ-21 UAS for reconnaissance

U.S. Navy unmanned aircraft experts are buying one additional RQ-21A Blackjack small tactical unmanned aircraft system (UAS) to provide battlefield reconnaissance capability for U.S. Marine Corps field commanders. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced an $8 million order in June to Boeing Insitu Inc. in Bingen, Wash., for one full-rate-production, lot-1 Blackjack UAS, which includes air vehicle, ground control station, launch-and-recovery equipment, and air vehicle support equipment kit. The Navy announced separate $70.1 million and $71.6 million orders last January and last June for a collective 12 new RQ-21A Blackjack small tactical UAVs for the Navy and Marine Corps. The Boeing Insitu RQ-21 is a twin-boom, single-engine, monoplane UAS for surveillance and reconnaissance. Users can launch and recover the reconnaissance UAS on land or at sea without runways by using a pneumatic launcher and net-type recovery system. Boeing Insitu will do the work in Bingen, Wash., and Hood River, Ore., and should be finished by January 2018.

FOR MORE INFORMATION visit **Boeing Insitu** at *insitu.com*.

Navy ramps-up production of unmanned airborne counter-mine systems

BY **John Keller**

WASHINGTON — Naval Sea Systems Command officials in Washington are asking the Raytheon Integrated Defense Systems segment in Portsmouth, R.I., to build, test, and deliver low-rate initial production (LRIP) Airborne Mine Neutralization Systems (AMNS) and engineering services and support. Raytheon is doing the work under terms of an $11 million contract, which has options that could increase its value to as much as $58.1 million.

The Raytheon Airborne Mine Neutralization System uses a mine-destroying unmanned underwater vehicle (UUV) that takes its control from the helicopter's common console.

The AMNS will provide littoral combat ship (LCS) commanders with a rapid, organic mine neutralization capability against bottom and moored sea mines. The AMNS deploys explosive mine-destroying vehicles from a launch and handling system (LHS) on the Navy MH-60S helicopter as part of the LCS mine countermeasures mission module. The mine-destroying unmanned underwater vehicle (UUV) takes its control from the helicopter's common console; it identifies mines before controllers on the helicopter command it to explode and destroy the mine nearby.

The AN/ASQ-235 AMNS consists of two major subsystems: the LHS and the neutralizer. The LHS connects with the carriage stream tow and recovery system (CSTRS) and can carry as many as four neutralizers on each mission. Each of the four neutralizers can launch one at a time without recovering the LHS. The neutralizer communicates with the common console via a fiber-optic data link and provides sonar and video data to operators using the common console. The neutralizer contains a sonar, video camera, and light to find, identify, and attack enemy sea mines. Operators determine the neutralizer's position with an Integrated Track Point II acoustic tracking system in the LHS.

FOR MORE INFORMATION visit **Raytheon** online at *www.raytheon.com*.

Special Operations Command chooses Textron and Insitu for UAV surveillance

McDILL AIR FORCE BASE, Fla. — Two U.S. unmanned aerial vehicle (UAV) designers will share as much as $475 million over the next five years to provide mid-endurance UAVs and support surveillance services for U.S. military convert Special Operations units.

Officials of the U.S. Special Operations Command (SOCOM) at MacDill Air Force Base, Fla., announced contracts to the Textron Systems Unmanned Systems segment (formerly AAI Corp.) in Hunt Valley, Md., and to Insitu Inc., a Boeing company in Bingen, Wash., for mid-endurance unmanned aircraft systems intelligence, surveillance, and reconnaissance services at locations worldwide.

The two companies will receive $150,000 up-front, and compete for mid-endurance UAV services contracts for four 1-year ordering periods, followed by one 6-month ordering period. The contracts collectively are worth $475 million.

The Textron catapult-launched RQ-7B Shadow tactical UAV is designed to provide reconnaissance, surveillance, targeting, and assessment. It can see targets from as far away as 78 miles from the tactical operations center, and recognize tactical vehicles from altitudes as high as 8,000 feet above the ground at more than two miles slant range, day or night. The Shadow can deploy using three C-130 Hercules aircraft four-engine turboprop cargo aircraft. Short-duration operations require only one C-130. Operators launch the UAV from a trailer-mounted pneumatic catapult, and recover it with arresting gear like those that stop jets on aircraft carriers during emergencies. The Shadow has a gimbal-mounted, digitally stabilized, liquid nitrogen-cooled infrared camera that relays video in real time via a C-band line-of-sight data link to the UAV's ground control station. The UAV is 11 feet long, has a 14-foot wingspan, weighs 375 pounds with payloads and fuel, flies as fast as 110 knots at altitudes as high as 15,000 feet, and can remain aloft for more than six hours.

The Textron Aerosonde small UAV is designed for expeditionary land- and sea-based operations and equipped for simultaneous day-and-night, full-motion video, communications relay, and intelligence in one flight. The Aerosonde has an 11.9-foot wingspan, can carry a 20-pound sensor payload, and can fly for as long as 14 hours with a range of 75 nautical miles.

The Boeing Insitu RQ-21 Blackjack is a twin-boom, single-engine, monoplane UAV for surveillance and reconnaissance. Users can launch and recover it on land or at sea without runways by using a pneumatic launcher and net-type recovery system. The 81-pound Blackjack is eight feet long with a 16-foot wingspan, and is designed to carry multi-sensor payloads in a large pod below its nose. The UAV can fly as quickly as 104 miles per hour, cruises at 63 miles per hour, can fly for as long as 24 hours, and can fly as high as 19,500 feet. Users can customize the RQ-21A Blackjack's multi-mission, open-architecture payload bays with visible-light and infrared cameras, communications, and other tools to provide situational awareness information to warfighters.

The RQ-21A can integrate new payloads quickly and offers roll-on, roll-off capability to move the system quickly from ship to shore, as well as to and from cargo aircraft. It can carry sensor payloads as heavy as 39 pounds. The Blackjack's standard sensor payload consists of a visible-light imager, mid-wave infrared imager, laser rangefinder, infrared marker, communications, and automatic identification system.

The Boeing Insitu ScanEagle UAV is 5.1 feet long with a 5.6-foot wingspan, weighs as much as 48.5 pounds, and can carry a 7.5-pound sensor payload. The UAV can fly for more than 24 hours at altitudes as high as 19,500 feet and at speeds to 80 knots. It can carry a sensor payload consisting of visible-light camera, medium-wave infrared imager, or both integrated in one turret. The ScanEagle also has an analog digitally encrypted video data link, as well as encrypted or unencrypted command-and-control data link. The UAV can be launched autonomously and uses a no-nets recovery system that recovers with its wing tip on a rope that hangs from a boom.

FOR MORE INFORMATION visit **Textron Systems** at *www.textronsystems.com* and **Boeing Insitu** at *https://insitu.com*.

Fast thermal cameras for research introduced by FLIR

FLIR Systems Inc. in Wilsonville, Ore., is introducing the FLIR X6900sc SLS and FLIR X8500sc SLS high-speed, longwave thermal cameras for demanding military and aerospace science and research applications. The two electro-optical cameras provide fast frame rates, short snapshot speeds, and wide temperature ranges. The thermal cameras are based on FLIR's X6900sc and X8500sc midwave thermal cameras, yet feature strained layer superlattice (SLS) detectors filtered for longwave infrared. These SLS detectors produce high frame rates and wide temperature ranges, as well as integration times that are more than 12 times faster than their midwave counterparts. FLIR included remote triggering and precise synchronization for applications like aerospace research to composite materials testing.

FOR MORE INFORMATION visit **FLIR Systems** online at *www.flir.com/science*.

Thermal camera introduced by Sierra Olympic

Sierra-Olympic Technologies Inc. in Hood River, Ore., is introducing the Viento HD IP67 1080-pixel thermal camera for military and security electro-optical applications that need the maximum possible resolution. The thermal camera has an environmentally rated enclosure and high-definition, longwave-infrared imager in a rugged housing that protects against dust and water. The Viento HD IP67 delivers 1920-by-1200-pixel resolution.

FOR MORE INFORMATION visit **Sierra Olympic** at *www.sierraolympic.com*.

Four companies to design software-reconfigurable, multifunction imaging sensors

BY **John Keller**

ARLINGTON, Va. — Military researchers are working with four U.S. defense contractors to develop software-reconfigurable, multifunction imaging sensors with simultaneous and distinct imaging modes in different regions of the sensor array to provide capabilities that previously required several different sensors.

U.S. Defense Advanced Research Projects Agency (DARPA) officials in Arlington, Va., have awarded contracts to DRS Network & Imaging Systems in Melbourne, Fla.; Voxtel Inc. in Beaverton, Ore.; BAE Systems Electronic Systems in Merrimack, N.H.; and Lockheed Martin Corp. Missiles and Fire Control in Orlando, Fla., for the Reconfigurable Imaging (ReImagine) program.

ReImagine seeks to develop a software-reconfigurable, multimode imaging system with functions not normally accessible within one focal plane array: configurable regions-of-interest that not only operate independently of other regions of the array, but also that reconfigure the array's measurements in response to the scene.

The idea is to develop an imaging focal plane array that can adapt to different conditions and operating modes to collect the most valuable information in the scene. The focal plane array on the ReImagine imaging sensor would function similarly to a field-programmable gate array (FPGA) processor by using several modes of imaging that may be defined after the array has been designed.

This artist's rendering depicts an imaging sensor simultaneously operating in three potential ReImagine modes: 3D-mapping at the lower left, vehicle detection and tracking, and thermal scanning for industrial activity — in different regions of the same field of view.

Lockheed Martin won a potential $10.2 million ReImagine contract; DRS won a potential $10.1 million contract; BAE Systems won a potential $7.5 million contract; and Voxtel won a potential $5.2 million contract.

These contractors also will try to develop algorithms that learn to collect the most valuable information when the sensor can be configured for a variety of measurements. Three-dimensional (3D) integration may enable the ReImagine sensor to interface with virtually any type of imaging sensor, such as photodiode, photoconductor, avalanche photodiode, or bolometer.

Reconfigurable capability also could enable users to optimize this imaging sensor for any spectral band, such as ultraviolet (UV) through very long-wave infrared (VLWIR). Separate regions of the focal plane array could run

separately at high resolution, or at a high frame rate. In this way, the sensor could perform real-time analysis on much more complex scenes than traditional systems to produce more actionable information to the warfighter than ever has been possible from a single imaging sensor.

An imaging system that autonomously extracts the most relevant information with one sensor, and based only on the context in the scene, would revolutionize a wide variety of military and commercial applications, experts say. A software-configurable array that enables simultaneous and distinct imaging modes in different regions of interest might be able to do this.

The ReImagine program has three technical areas. The first technical area seeks to design a single-color or multicolor passive camera that works in spectral bands ranging from ultraviolet to very long-wave infrared. The second technical area seeks to design a hybrid active/passive imager architecture, where passive mode is based on traditional intensity measurements across an image array, and active mode is based on time-of-flight measurements for 3D range information. The third technical area seeks to develop adaptive algorithms for reconfigurable imaging systems.

FOR MORE INFORMATION visit **DRS Network & Imaging Systems** online at *http://bit.ly/2tSlrdT*; **Voxtel** at *http://voxtel-inc.com*; **BAE Systems Electronic Systems** at *www.baesystems.com*; and **Lockheed Martin Missiles and Fire Control** at *www.lockheedmartin.com/us/mfc.html*.

Army chooses turret imaging systems from Palomar for armored combat vehicle

BY **John Keller**

ALEXANDRIA, Va. — U.S. Army combat vehicle experts needed binocular image control units for to meet a broad range of electro-optical turret applications for armored ground vehicles. They found their solution at Palomar Display Products in Carlsbad, Calif.

Officials of the Army Contracting Command in Alexandria, Va., announced a $9.3 million contract to Palomar for additional production quantities of the company's Binocular Image Control Unit (BICU).

Palomar's family of binocular displays delivers large virtual images in small, rugged, militarized enclosures. The company's BICU presents a very large virtual image from a very small real image at the designed focal length.

The total volume necessary for a binocular display is a fraction of the volume required to display a comparable image by a direct view flat panel display. It offers a brow pad on which users can place their heads at the proper distance from the binocular display and enables synchronized movement of the user and the display.

The Palomar BICU features a dual display; bright, large, high-quality images; small volume; wide field of view; high system optical magnification; and combat proven designs that are highly reliable in military vehicle environments. It has input power of plus-or-minus 15, plus 5, and plus 70 volts DC; power dissipation of 45 watts, more than 500 foot-lamberts of brightness, symbology compatible with the day site, 32.2-degree field of view with normal eye relief, and 40.8-degree field of view with no eye relief. The unit has built-in test, weighs 29 pounds, and meets military standards.

Palomar Display Products is supplying the U.S. Army with the Binocular Image Control Unit (BICU) for armored combat vehicles like the M1 Abrams main battle tank.

On this contract, Palomar will do the work in various locations, depending on each order, and should be finished by February 2020.

FOR MORE INFORMATION visit **Palomar Display Products** online at *www.palomardisplays.com*.

PRODUCT applications

BOARD PRODUCTS

Curtiss-Wright to provide single-board computers for Navy surface warships

U.S. Navy aerial warfare systems designers needed VME single-board computers for the AN/UPX-29(V) identification-friend-or-foe (IFF) interrogator system aboard surface warships. They found their solution at the Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., announced a $9 million contract to Curtiss-Wright for 142 single-board computers in support of the AN/UPX-29(V) shipboard interrogator set. Curtiss-Wright will provide its VME-183 VME single-board computer with NXP Power Architecture MPC7447A/7448 processor for the Navy's AN/UPX-29(V) system. The contract calls for 92 VME-183 for the U.S. Navy and 50 units for the Japanese navy, as well as end-of-life components and one year of component storage.

The VME-183 general-purpose embedded computing processor board uses one or two NXP (formerly Freescale) MPC7447A/7448 Power Architecture processors with AltiVec technology and as much as 1 gigabyte of DDR1 SDRAM. The card has two 64-bit PCI Mezzanine Card (PMC) and I/O that includes Ethernet, as many as six serial ports, as many as two MIL-STD-1553 channels, SCSI, SATA and two USB 2.0 ports.

The AN/UPX-29(V) can process and store as many as 400 targets, provide instantaneous interrogation on a target within 25 microseconds, electronically evaluate Mode 4 replies, call up operator-designated target information, display IFF targets synchronized with as many as four radars at 22 displays, and interface with shipboard computers. The Curtiss-Wright VME single-board computers will go into an AN/UPX-29(V) subsystem called the AN/UPX-24(V), the core IFF processor of the AN/UPX-29(V) shipboard interrogator system.

Curtiss-Wright will do the work at the company's facility in Kanata, Ontario, and should be finished by April 2022. ←

FOR MORE INFORMATION visit **Curtiss-Wright Defense Solutions** online at *www.curtisswrightds.com*.

AVIONICS

Navy chooses IFF avionics from Telephonics for P-8A Poseidon maritime patrol aircraft

U.S. Navy avionics experts needed an identification friend-or-foe (IFF) system for the P-8A Poseidon maritime patrol jet. They found their solution at Telephonics Corp. in Farmingdale, N.Y.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.Y., announced plans to buy the AN/UPX-43(V)1 identification friend or foe interrogator (IFFI) shipset and IFFI Mounting Tray from Telephonics in support of the P-8A aircraft.

The AN/UPX-43 is a Mark XIIA monopulse and AIMS-certified IFF interrogator for command and control. It enables air traffic controllers and air defenders to identify aircraft, verify forces as friendly, and determine their bearing and range.

The upcoming sole-source contract includes technical data, initial spares, repair of repairables, and technical support. Telephonics is the sole designer, developer, and manufacturer of the AN/UPX-43(V)1 shipset for use on the P-8A.

The AN/UPX-43 provides multichannel automatic dependent surveillance-broadcast (ADS-B), and complies with U.S. and international specifications that define interrogator modes, performance, control, reporting and interface. The system uses common module hardware and software for the detection,

interrogation, identification, tracking, and data extraction of small targets in severe environments.

FOR MORE INFORMATION visit **Telephonics** at *www.telephonics.com*.

EMBEDDED COMPUTING

Navy chooses rugged VPX from LCR for counter-terrorist technology experiments

U.S. Navy aviation experts needed low-cost, near-term embedded computing technologies that could be integrated quickly to counter terrorist or other asymmetric electronic threats. They found their solution at LCR Embedded Systems Inc. in Norristown, Pa.

Officials of the Naval Air Warfare Center Weapons Division at Point Mugu, Calif., chose LCR to supply a 3U VPX solution in support of the Joint Electronic Advanced

Technology (JEAT) program. JEAT identifies and evaluates low-cost and near-term technologies where commercial or military off-the-shelf components can be integrated quickly to counter asymmetric electronic threats.

LCR will deliver a custom, rugged VPX-based embedded computing system that enables the latest high-speed technologies to withstand harsh environments in support of electronic warfare advancements.

JEAT serves as a catalyst often combining several technologies, thereby leveraging and increasing the capabilities for warfighters. Significant JEAT efforts include coordinating the Black Dart Experiment, the largest counter unmanned aerial vehicle (UAV) experiment in the U.S. Department of Defense, and serving as technical coordinator/sponsor for the Trident Spectre exercise, where new technologies of interest to special operations and intelligence community operators are evaluated.

FOR MORE INFORMATION visit **LCR Embedded Systems** online at *www.lcrembeddedsystems.com*.

COMMAND AND CONTROL

Northrop Grumman to provide cockpit control for P-8A survivability

Military avionics integrators at Northrop Grumman needed a cockpit control unit to integrate an aircraft survivability equipment sensor and other aircraft core functions aboard the U.S. Navy P-8A Poseidon maritime patrol aircraft. They found their solution from Terma North America Inc. in Arlington, Va.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., announced a $14.3 million contract to the Northrop Grumman Mission Systems segment in Rolling Meadows, Ill., for 38 Terma ALQ-213 electronic warfare management systems for the P-8A aircraft.

Terma's ALQ-213(V) electronic warfare management unit offers a non-ITAR controller for a military aircraft survivability equipment (ASE) suite, which provides automatic threat reaction and decision support algorithms and on-board training for P-8A aircraft crews.

This contract includes 27 ALQ-213 tactical threat displays for the U.S. Navy; three for the United Kingdom; eight for Australia, as well as 29 OMNI blade antennas for U.S.

Navy; two for the United Kingdom; and eight for Australia. The contract also involves component- and system-level software and hardware integration and testing prior to system delivery.

The low-power ALQ-213(V) electronic warfare management unit uses no forced air cooling, and has a dual-core PowerPC microprocessor, a large field programmable gate array (FPGA), and a Wind River VxWorks operating system. The Terma ALQ-213(V) has an expansion slot for drop-in of one special-purpose circuit card. The slot provides a fast PCI express interface to the dual-core CPU and can be supported by a dedicated external connector, with minimal impact to the unit design.

Northrop Grumman will do the work in Rolling Meadows, Ill.; Seattle; Jacksonville Naval Air Station, Fla.; Whidbey Island Naval Air Station, Wash.; Lossimouth, Scotland; and Edinburgh, Australia, and should be finished by February 2020.

FOR MORE INFORMATION visit **Northrop Grumman** online at *www.northropgrumman.com*.

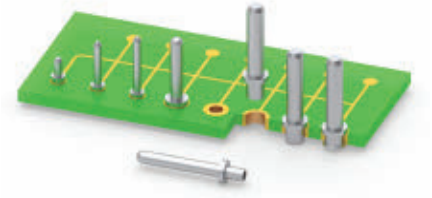
new PRODUCTS

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

BOARD PRODUCTS

Swage-mount circuit board pins introduced by Mill-Max

Mill-Max Manufacturing Co. in Oyster Bay, N.Y., is introducing six swage-mount printed circuit board pins for board-to-board interconnects. These terminals are designed to be fastened mechanically to a board or panel, and plugged into sockets or soldered into mating boards in board stacking and other



interconnect configurations. Swage pins often are thought of as wire-to-board soldering terminals and test points or as hardware such as circuit board standoffs, but they also are for board-to-board interconnects. They don't require the more precise circuit board hole specifications associated with most press-fit pins, and can be processed in volume with semi-automatic or automatic equipment.

FOR MORE INFORMATION visit **Mill-Max** online at *www.mill-max.com*.

TEST AND MEASUREMENT

Analog signal generator introduced by Rohde & Schwarz

Rohde & Schwarz in Munich is introducing the R&S SMA100B analog signal generator with a frequency range to 20 GHz for defense, aerospace, RF semiconductor, and wireless communications test and measurement applications. The device delivers signals with low phase noise and high output power with low harmonics. Engineers no longer need to compromise between output power and a spurious free dynamic range, company officials say. A 6-GHz instrument generates to 38 dBm RF output power, and a 20-GHz instrument generates to 32 dBm in the microwave frequency range. Harmonics are low across the frequency range; above 6 GHz, they are even lower than 70 dBc at 18 dBm output power. Nonharmonics

are below 110 dBc at an output signal of 1 GHz.

FOR MORE INFORMATION visit **Rohde & Schwarz** online at *www.rohde-schwarz.com*.

RUGGED COMPUTING

Small-form-factor rugged computer for military wearable electronics introduced by Themis

Themis Computer in Fremont, Calif., is introducing the third generation of the Nanopak i7, the company's most powerful small-form-factor rugged computer, for unmanned vehicle, ground vehicle, wearable electronics, and shipboard applications. The Nanopak i7 packages an Intel 6th generation Core i7 processor, as much as 32 gigabytes DDR4 memory, and 1 terabyte FLASH storage in a small, lightweight, rugged size. The Nanopak i7 provides several I/O configurations in an environmentally resilient, noiseless chassis. The Nanopak i7 features 2.6 GHZ Dual Core i7; specialized I/O via

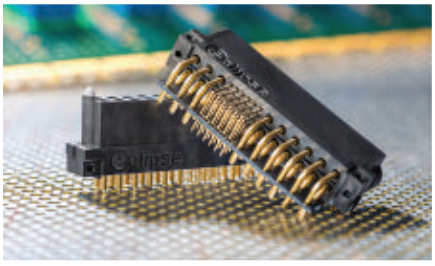
optional internal mini PCI Express; M.2 SSD storage to 1 terabyte; 8-to-36-volt DC power; and hardened-aluminum, conduction-cooled chassis. The computer offers customizable I/O with several networking, storage, and interface options including two Gigabit Ethernet, Wi-Fi, VGA, USB 3.0, USB 2.0, GPIO, serial, UART, or HD audio ports.

FOR MORE INFORMATION visit **Themis Computer** online at *www.themis.com*.

INTERCONNECT PRODUCTS

Hybrid power and signal connectors for server equipment introduced by Positronic

Positronic in Springfield, Mo., is introducing the Eclipse hybrid power and signal connectors for use in power supplies, server equipment, and related applications. Positronic designers use precision machining for low-resistance copper alloys to achieve a high degree of linear current density. The female contact geometry also provides high normal force against the male contact. Although machined contacts



are fundamental to the Eclipse's power density, machining is not required for the signal contact cluster. In some applications, machining the signal contacts results in unnecessary cost escalation without the added value to the application, Positronic officials say. The Eclipse hybrid power and signal connectors offer a minimum of 250 mating cycles; halogen-free insulator; low-profile 11-millimeter height; and a modular design.

FOR MORE INFORMATION visit **Positronic** at *www.connectpositronic.com*.

RUGGED ROUTERS

Rugged edge computer and Cisco router for military and avionics introduced by Elma

Elma Electronic Inc. in Fremont, Calif., is introducing the NetSys-5303 rugged edge embedded computer and Cisco router for applications in ground, ship and air defense equipment, drilling and mining operations, commercial air and ground transport infrastructure, energy distribution, and homeland security and emergency services. The model 5305 incorporates the Intel Core i7 microprocessor, multi-terabyte

data storage, and Gigabit Ethernet ports expansion. It is an extendable and configurable system enabling upgrades for future expansion or system redefinition. The system features dual routing ports, nine Gigabit Ethernet and FE switching ports, a high-capacity, multi-terabyte removable storage bay, and optional CANbus support. Its modular design enables I/O options including video, audio, USB, digital, and GPIO connectivity. Front LEDs indicate power and system status as well as link activity.

FOR MORE INFORMATION visit **Elma Electronic** online at *www.elma.com*.

EMBEDDED SOFTWARE

Software tool to help embedded computing engineers design with GPUs introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing the ImageFlex software tool to enable embedded computing engineers to harness the potential of graphics processing

units (GPUs) from companies like Nvidia, AMD, and Intel for application such as real-time image processing and image visualization. Typical applications for ImageFlex include degraded visual environment (DVE), 360-degree situational awareness, helmet-mounted sight processing, and target identification and tracking. ImageFlex can simplify application creation by delivering a set of high-level application programming interfaces (APIs) that exploit the capabilities of the underlying GPUs, while abstracting the complex details associated with each implementation. The ImageFlex framework API interface provides an abstraction layer on top of OpenGL to enable developers with no OpenGL experience to create high-performance image processing and graphics applications.

FOR MORE INFORMATION visit **Abaco** online at *www.abaco.com*.

CONNECTORS

Protective caps for 38999 circular connectors introduced by Amphenol Socapex

Amphenol Socapex in Thyez, France, is introducing three ranges of protective caps for its circular connectors. These caps protect MIL-DTL-38999 Series I, II, and III; MIL-DTL-26482; RJ Field; and USB Field connectors. The self-closing caps screw onto receptacles. The standard versions with lanyard are compatible with MIL-DTL-38999, MIL-DTL-26482, RJ Field, and USB field connectors. The caps are available in aluminum, stainless steel, and bronze with a range of plating finishes, lanyards, and eyelets to meet IP68. Aluminum caps for the

MIL-DTL-38999 range offer a choice of plating finishes (nickel, black zinc nickel, and cadmium) and protect against corrosion, impacts, and vibration. The metal cap for the MIL-DTL-38999 range is IP67.

FOR MORE INFORMATION visit **Amphenol Socapex** online at *www.amphenol-socapex.com*.

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