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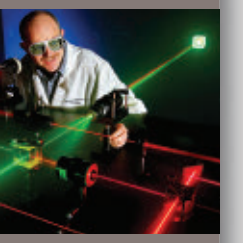
COVER STORY



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BY **JOHN KELLER**, EDITOR IN CHIEF

Airborne laser weapons: Where are we now, and when can we deploy?

Laser weapons have been one of the most important topics of discussion in the Pentagon at least for the past five years, and several weapons programs involving high-energy lasers are in advanced development.

There's the U.S. Navy's shipboard Laser Weapon System (LaWS) which was deployed for operational tests aboard the amphibious transport dock USS Ponce. Then there's the Boeing truck-mounted High Energy Laser Mobile Demonstrator (HEL MD) for use against air and ground targets. The most important potential future applications of tactical airborne laser weapons are jet fighter aircraft and combat helicopters, which confront the designer with some difficult problems.

Airborne lasers on jet aircraft and helicopters must be small enough not to overwhelm the airframes, and powerful enough to shoot down enemy aircraft and missiles, as well as take out ground targets like combat vehicles, radar installations, and missile launchers.

Military agencies have several projects in the works to develop airborne laser weapons for tactical aircraft, yet Air Force systems integrators evidently believe it's time to take stock of what's been developed, and what kind of work still needs to be done before tactical airborne laser weapons can become reality. The Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., issued the Airborne Tactical Laser Technology request for information last month that seeks to determine today's state of the art in airborne laser weapons technology, and the companies best able to provide it.

There's been no lack of tactical laser weapons research projects in recent years. In 2013, there was the Aero-Adaptive/Aero-Optic Beam Control (ABC) program of the U.S. Defense Advanced Research Projects Agency (DARPA) to user laser weapons to protect combat aircraft against attacks from the rear. Lockheed Martin Space Systems in Sunnyvale, Calif. won a $9.5 million contract that year to flight-test an active flow control turret mounted on a business jet to validate turret requirements, design, and predicted performance of previously developed ABC technology.

Earlier this year, DARPA launched the Efficient Ultra-Compact Laser Integrated Devices (EUCLID) project to develop compact, fiber laser diode modules suitable for pumping high-power fiber laser weapons on a variety of manned and unmanned combat aircraft and tactical land vehicles.

Northrop Grumman Aerospace Systems in Redondo Beach, Calif., has started working with the U.S. Air Force to develop beam-control technology to protect current and future fighter aircraft with directed-energy systems under the Self-Protect High Energy Laser Demonstrator (SHiELD) advanced technology demonstration (ATD) program of the Air Force Research Laboratory at Kirtland Air Force Base, N.M.

DARPA hired Northrop Grumman and Lockheed Martin in late 2013 for Project Endurance to develop laser weapons to defend aircraft from missiles. This initiative involved pod-mounted laser weapons to protect manned aircraft and unmanned aerial vehicles (UAVs) from electro-optical and infrared (EO/IR)-guided surface-to-air missiles.

This is far from an exhaustive list of military technology development that aims at tactical airborne laser weapons. There's a lot of energy, plenty of money, and a considerable amount of enthusiasm headed in this direction. Much of the effort thus far has focused on defensive tactical airborne laser weapons. Now it's time for the big stuff: powerful offensive tactical airborne laser weapons.

Perhaps now is a good time to see what's out there, and plan for the difficult technology development necessary in the future to bring about fieldable laser weapons for tactical jets and helicopters.

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news

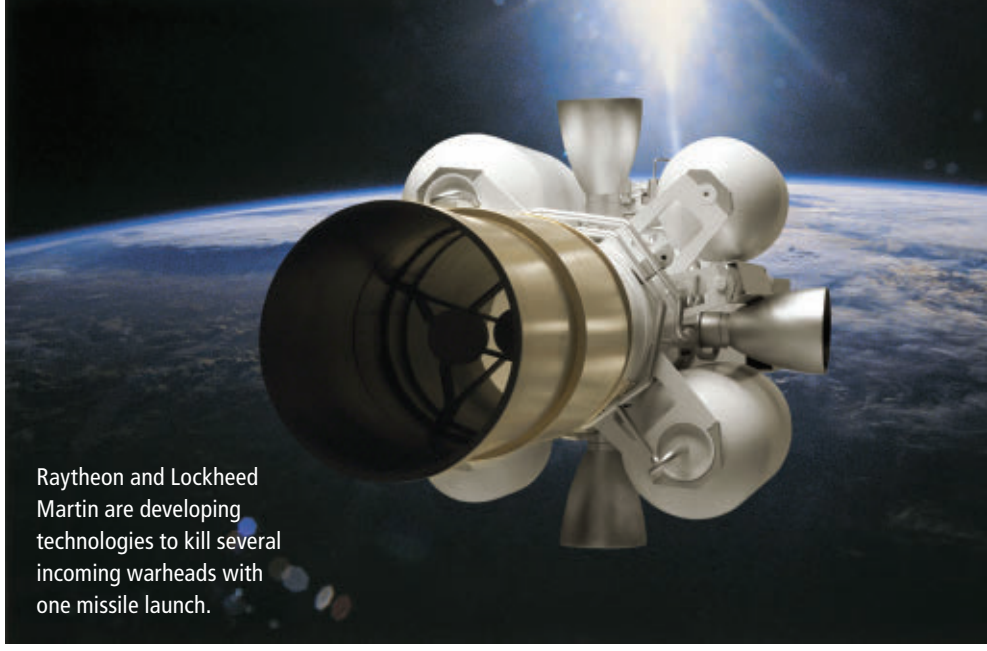
IN BRIEF

GlobalFoundries to fab chips for mission-critical military electronics

Officials of the Defense Microelectronics Activity (DMEA) in McClellan, Calif., announced a $99.8 million contract modification to GlobalFoundries U.S. 2 LLC in Hopewell Junction, N.Y., for access to leading-edge, current, and legacy microelectronics and trusted processes for the U.S. Department of Defense and other federal agencies. The DMEA State of the Art Trusted Foundry Services project seeks to give government agencies access to a range of microelectronics services that will ensure the confidentiality and integrity of specialized military devices.

Booz Allen to apply high-power electromagnetics to cyber and EW applications

The Air Force Research Laboratory Directed Energy Directorate's High-Powered Electromagnetics Division at Kirtland Air Force Base, N.M., awarded a $10 million contract to Booz Allen in McLean, Va., for the High Power Electromagnetics (HPEM) Cyber Electronic Warfare Applications program. Booz Allen experts will develop components, RF devices, software packages, and support systems to find ways to apply HPEM to military cyber and EW applications.



Raytheon and Lockheed Martin are developing technologies to kill several incoming warheads with one missile launch.

Refining the ability to kill several warheads with one missile

BY JOHN KELLER

HUNTSVILLE, Ala. — U.S. missile defense experts are spending $112.7 million to refine capabilities and reduce development risks for a future ballistic missile defense multi-warhead killer intended to detect, track, and kill several different incoming enemy missile warheads and decoys with only one counter-missile launch.

Officials of the U.S. Missile Defense Agency (MDA) in Huntsville, Ala., are asking systems designers at the Raytheon Co. and Lockheed Martin Corp. for technology work related to the Multi-Object Kill Vehicle (MOKV) technology risk reduction effort.

The MOKV is to engage several incoming objects simultaneously with kill vehicles that communicate with one another and destroy several incoming warheads and decoys using advanced sensor, divert and attitude control, and communications technologies.

MDA officials announced a $59.6 million contract in April to the Raytheon Missile Systems segment in Tucson, Ariz., to enhance the MOKV's secure communications systems, high-sensitivity multi-band sensor, survivable processor, kill vehicle divert and attitude control system, bus sensor and sensor pointing, and the engagement management.

In March, MDA announced a $53.1 million contract to the Lockheed Martin Space Systems segment in Sunnyvale, Calif., to enhance the MOKV's gimbaled seeker assembly, integrated avionics assembly, component integration and testing, and an advanced seeker.

Raytheon, Lockheed Martin, and the Boeing Defense, Space & Security segment in Huntsville, Ala., all won MDA contracts in 2015 to define MOKV proof-of-concept prototypes, demonstrate risk mitigation steps, assess the technical maturity of their concepts, and rank enabling technologies to minimize design risks.

MDA officials ultimately are expected to narrow the field to one contractor for advanced development and manufacturing for the MOKV program.

The MDA's ground-based interceptor missile today carries one kill

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warhead that detects, tracks, and attacks an incoming enemy ballistic missile warhead and attempts to destroy it kinetically by force of impact. The MOKV, instead, is expected to launch on one air-defense missile, and deploy several kill vehicles that could engage several incoming enemy warheads. MOKV warheads will be designed to communicate with one another to coordinate their attacks.

As many as six MOKVs will launch on one booster rocket, deploy at the edge of space, and steer toward and destroy several incoming ballistic missile warheads and decoys using separate kinetic hit-to-kill weapons.

The MOKV would function similarly to the MDA's Multiple Kill Vehicle (MKV) program, which was cancelled in 2009. The MOKV is likely to launch on rockets like the U.S. Navy Raytheon SM-3 standard shipboard missile.

When put to use, military forces will load several MOKVs on one missile-defense rocket, such as the three-stage Ground-Based Interceptor (GBI). After launch, each MOKV will steer toward an incoming ballistic missile warhead or decoy to destroy it. Each interceptor rocket will have an advanced sensor and divert, attitude-control, and communications technologies, to enable each MOKV to home-in on its target. Each MOKV will have its own sensor and diverting thrusters.

If MDA officials and other senior military leaders decide to proceed with MOKV development, production of these sophisticated missile-defense warheads could begin in 2022.

On these contracts Raytheon will do the work in Tucson, Ariz., and Lockheed Martin will do the work in Sunnyvale and Goleta, Calif., and in Bethesda, Md. The companies should be finished with phase of MOKV development by spring 2020.

FOR MORE INFORMATION visit **Raytheon Missile Systems** online at *www.raytheon.com* or **Lockheed Martin Space Systems** at *www.lockheedmartin.com/us/ssc.html*.

Air Force seeks best companies to develop next-generation airborne laser weapons

BY JOHN KELLER

EGLIN AIR FORCE BASE, Fla. — U.S. Air Force combat aircraft experts are trying to determine the state of the art in airborne laser weapons technology, and the companies best able to provide it.

Officials at the Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., began the process last month as they issued a source-sought notice (FA8656-17-R-0005) for the Airborne Tactical Laser Technology request for information (RFI). The survey is looking for promising laser weapon system technologies suitable for near-term applications in a prototype airborne tactical laser weapon.

Air Force officials are trying to improve understanding of industry's best laser capabilities and their costs to support weapon system integration studies, as well as identify industry participants in future laser weapon system procurements.

Experts are thinking about developing a fieldable airborne prototype laser weapon to learn about real-world effectiveness and supportability. This request for information will help them assess the feasibility, cost, schedule, and risk

Who will be the companies providing the next generation of aircraft laser weapons? The Air Force is surveying industry to find the answer.

of building such an airborne laser weapon prototype.

Specifically, Air Force experts are looking for more information from industry on currently available technologies in laser sources, electrical power, thermal management, beam control, battle management, and any other subsystems required for system operation.

These subsystems must be able to operate in a flight environment. Although Air Force experts have not yet chosen a specific aircraft type for a future airborne laser weapon prototype, they are trying to keep the laser weapon's weight and volume to a minimum.

The Air Force wants information on airborne laser weapon performance, size and weight, cost, schedule, and risk for each concept submitted.

Air Force officials also are interested in industry's thoughts on airborne laser weapons concepts of operations and concepts of employment.

The Air Force wants any of industry's suggestions on the best approach to conducting a prototype laser weapon acquisition that could speed-up eventual fielding of tactical laser weapons.

Companies interested in the Airborne Tactical Laser Technology RFI were to submit white papers no later than 17 May 2017.

MORE INFORMATION IS ONLINE
at *https://www.fbo.gov/notices/78195c21dac09b9c01b749750632ae16*.

DARPA considers high-capacity military data storage based on molecular technology

BY JOHN KELLER

ARLINGTON, Va. — U.S. military researchers are launching a new project to develop completely new kinds of data storage technologies that operate on the molecular and chemical level to handle vast streams of information from reconnaissance, electronic warfare, (EW), signals intelligence (SIGINT), persistent surveillance, and other data-intensive military applications.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.,

have issued a formal solicitation (HR001117S0027) for the Molecular Informatics program, which seeks to develop and test completely new approaches to store and process information with molecules, DARPA officials say. This will require experts from chemistry, computer and information science, mathematics, and chemical and electrical engineering.

By manipulating properties such as structure, size, charge, and polarity, researchers may develop a vast design space enabling dense data representations and versatile computing concepts that operate outside of the traditional digital and logic-based approach.

Data storage and processing is central to U.S. Department of Defense (DOD) activities across areas like platform design and optimization, sensing, mission planning and logistics, and health care.

While current computational architectures remain essential, new complementary approaches are necessary to provide advanced capabilities as the complexity and volume of data grows, DARPA researchers say. Chemistry offers a yet-untapped rich palette of molecular diversity that could be harnessed for scalable information storage and processing.

Anticipated outcomes of the program include new approaches to represent information and execute computational operations in molecular form; scalable strategies to extract and process information from large molecular data stores; and molecular computing concepts that provide capabilities beyond our conventional computational architectures.

The program is trying to enable information processing directly on molecular data to achieve ultra-high information storage densities and inherent parallel processing. Researchers are interested in approaches that capitalize on complex molecular mixtures, non-natural polymers, and other advantages of molecular structures. Among the program's goals are developing data-storage capabilities beyond binary, digital encoding, and serial, logic-based computation. More conventional ideas based on molecular logic gates, biomolecular computing strategies, and those that are inherently not scalable are not part of the Molecular Informatics program.

DARPA officials say they plan to award several initial Molecular Informatics contracts. Participants will validate information encoding and processing in the first program phase, and then develop ways to integrate their capabilities and demonstrate processing directly on molecular data in the second program phase.

Proposed approaches ultimately must be scalable to encode and process large datasets. Performers will validate their molecular encoding concepts by demonstrating storage densities of at least 1,018 bytes per cubic millimeter with at least 1 gigabyte of data.

Molecular Informatics is a three-year program divided into an 18-month first phase and one 18-month optional second phase. By the end of the Molecular Informatics program, performers will project their ultimate capabilities to define future opportunities for molecules in information storage and processing.

Companies interested should upload full proposals no later than 12 June 2017 to DARPA online at https://baa.darpa.mil/. E-mail questions or concerns to Anne Fischer, the DARPA Molecular Informatics program manager at MolecularInformatics@darpa.mil.

MORE INFORMATION IS ONLINE at *https://www.fbo.gov/spg/ODA/DARPA/CMO/HR001117S0027/listing.html*.

UES seeks materials that protect Air Force sensors and weapons from lasers

BY JOHN KELLER

WRIGHT-PATTERSON AFB, Ohio – Electro-optics experts at UES Inc. in Dayton, Ohio, are conducting materials experiments to help safeguard U.S. and allied sensors and military systems from lasers and laser weapons.

Officials of the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have announced a $44.7 million contract to UES for research work involved in the Laser Materials for Blue Systems Survivability (LaMBSS) project.

LaMBSS seeks to investigate materials interaction effects and response to external sources. UES experts will characterize a variety of materials in support of technology development programs using these materials for a variety of applications, Air Force officials say.

UES will determine the effects of lasers on materials, structures, and sensors, and provide advanced laser-hardened materials and techniques, including existing or newly developed materials for structures, integrated optics, and detector technologies, as well as materials and component configurations for sensing or imaging applications.

Future laser weapons will pose serious threats to U.S. and allied sensors and weapon systems.

UES experts will perform materials-response experiments on several kinds of materials, analyze materials degradation phenomena, characterize emerging hardened materials, and evaluate the system response of components and optical sensing to the effects of lasers.

UES experiments will be in laboratory, field, or range conditions, and simulated atmospheric, flight, and space environments to characterize their effects on the performance of these materials.

UES specializes in characterizing and modeling of advanced structural alloys and intermetallics, light metallic alloys, ceramics, and ceramic matrix composites. The company also conducts advanced analytical and experimental research in aerospace weapons power systems, electrical power systems, energy conversion and storage, and hypersonic structural integrity.

UES will do the work at Wright-Patterson Air Force Base, Ohio, and should be finished by June 2023.

FOR MORE INFORMATION contact **UES Inc.** online at *www.ues.com*.

The puzzle of RF co-site interference

The military relies increasingly on the RF spectrum for information throughput, sensors, and electronic warfare, yet growing demands on RF technology can cause systems in close proximity to degrade each other's signals.

BY **J.R. Wilson**

The U.S. Navy Northrop Grumman E-2D Hawkeye carrier-based aircraft must cram together RF voice and data systems, as well as the plane's powerful air-search radar system on one small platform.

The modern military battlespace is overwhelmed with radio-frequency (RF) signals vying for spectrum. Even without overt RF interference from enemy jamming, radio stations nearby, or even from civilian cell phones, co-site interference has become a major problem for the U.S. military, one that is growing worse by the day. Some refer to this kind of interference as spectral friendly fire.

It can be a problem on military platforms like surface warships, land vehicles, and aircraft where many different RF transmit and receive antennas must share a relatively small space. This can be a communications nightmare in which separate RF systems inadvertently step on each other's signals, causing an RF communications fratricide problem that's only compounded by intentional or accidental RF jamming.

"Having multiple command and control (C2) capabilities on the same platform has instituted a greater awareness of how emitters perform within the same system and platform," says Chief Warrant Officer Jerome J. Foreman, senior strategic spectrum planner at the U.S. Marine Corps Command, Control, Communications, and Computers headquarters in the Pentagon.

"In the broader sense of co-located systems, the problem is even more complex due to dense areas of operations — dense in the sense of space to operate within urban populated areas — as well as the amount of spectrum-dependent systems operating within a concentrated area," Foreman says. "The requirement for multiple spectrum-dependent emitters within a system will continue to increase; therefore, it's likely that co-site interference will continue to increase, as well."

Co-site interference may be most obvious aboard a Navy ship, where growing numbers of powerful emitters and receivers crowd together on

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the ship's masts. It also can be seen, however, at Army and Marine Corps forward operating bases (FOBs), command and control centers, and increasingly on mobile platforms like Mine-Resistant Ambush Protected vehicles (MRAPs) and mobile communications trucks.

One of the lead agencies researching the problem for the Army is the Communications-Electronics Research, Development and Engineering Center (CERDEC) at Aberdeen Proving Ground, Md.

"Technically, it is a problem everywhere — FOBs, communications, and sensor platforms," says John Franklin, lead electronics engineer – electromagnetic interference (EMI) at the Electronic Protection and Interference Mitigation Branch of CERDEC's Space and Terrestrial Communications Directorate. "Sometimes you have to try to optimize one system over another with respect to co-site performance, but there is no consensus among users as to which is most important. You can spread things out on a FOB, but there is little latitude to change things on a platform."

Serious military challenge

"Co-site interference is a very serious challenge for all the services, varying system by system, platform by platform," Franklin continues. "There are some systems that cannot be run at the same time on the same platform. And that is becoming a bigger issue. An aircraft usually won't fly with co-site interference problems, but for the Army, there are innumerable variations, and we won't hold the fielding of a ground platform for co-site interference."

Each military service has its own labs working hard to mitigate the problem. The U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., has been investigating causes and possible solutions across all services and platforms for some time. Two current programs — Advanced RF Mapping (Radio Map) and Shared Spectrum Access for Radar and Communications (SSPARC) — are headed by Joseph Evans, a DARPA Strategic Technology Office program manager.

Advanced research

"SSPARC is looking at the simultaneous operation of radars and communications devices in the same spectrum band, taking a number of different approaches," Evans says. "One looks at spectrum operations, coordinating the activities of radars and communications, motivated by increasingly agile software-defined radios [SDRs] and new technologies. Right now, it is a road with no lane lines; SDRs and radars don't need to stick within traditional boundaries — but how do we make sure we de-conflict between these devices?

"Another part asks how to define shared waveforms that do multiple things at the same time — radar and communications on the same device, waveform, and spectrum," Evans continues. "Finding solutions applicable across services is exactly the direction we're going because, looking out into the future, all those devices will be increasingly agile and capable of multiple purposes."

As the military fields more and more spectrum-dependent devices — including rapidly increasing numbers of unmanned vehicles, with more sensors and transmitters on virtually everything — higher demand for data transmission only will aggravate an already complex issue.

"That is one of our motivations for both parts of SSPARC," says DARPA's Evans. "If every small drone has a radar, you're going to need to deal with that.

The U.S. Army Prophet Enhanced tactical signals intelligence and electronic warfare system relies on several different RF transmitters and receivers to gather crucial battlefield information.

We're looking across the range of devices and technologies, from small UAVs [unmanned aerial vehicles] to big [Navy shipboard] Aegis radars.

"SSPARC has been running for about five years," Evans says. "Slightly before that, we started Radio Map, which is doing spectrum situational analysis. That is transitioning to the Marine Corps this summer, with joint participation by the other services, especially the Army. Those programs are helping us further evolve our capabilities, but DARPA has been working in the spectrum area for decades and has been at the forefront of the agile use of spectrum."

Radio Map is only one of several efforts Foreman says also puts the Marine Corps on the leading edge of 21st Century spectrum-dependent systems. With Radio Map, warfighters will be able to "see" the electromagnetic spectrum, similarly to looking at an infrared image of thermal patterns.

Mapping RF emissions

"The intent of this effort is to give the Marines the ability to understand how their systems are working within a spectrum-dependent co-site and co-located environment, down to the tactical edge. There is still a lot of work to be done to reach this goal, but the Marine Corps is aggressively working toward this end state," Evans says. Another vital effort, he adds, is applying military standards that lay out a system's design and how systems work together, then having the right people and tools in place to mitigate co-site interference.

"The concern, however, is when we're operating outside the parameters captured within a lab or testing facility," Evans says. "This is the question the Marine Corps is addressing through our recent Military Occupational Skill (MOS) modernization efforts. The intent is to align the right people with the right skill sets to effectively manage the electromagnetic spectrum."

The U.S. Navy's Arleigh Burke-class guided missile destroyer must accommodate a wide variety of RF systems and antennas, all crowded tightly together on the ship's masts and superstructure.

In the past quarter-century, the world has seen an almost exponential growth in spectrum needs as military and civil end users seek to connect voice, text, graphics, imagery, and full-motion video communications. This will create demand for terabytes (soon perhaps petabytes) of RF throughput for sensor data, radars, jammers, and more.

With so many different systems competing for spectrum, they can tolerate only so much interference before their performance degrades, notes Alex Lackpour, senior RF spectrum research engineer at Lockheed Martin Advanced Technology Laboratories (ATL) in Cherry Hill, N.J.

"You have high-power emitters operating in the presence of very sensitive receivers, which increases the challenge; there is only so much room for techniques, such as positioning the antennas to increase RF isolation between the transmitter of one and the receiver of another, or changing orientation of an antenna so the EM fields are not coupling with each other or using cross-polarization. But on a platform, there are challenges to make everything fit and operate together simultaneously. We don't want to have to turn off systems; that's not a good solution," Lackpour says.

Among the first efforts to mitigate co-site interference was the use of better power control, radio front-end filtering, and better planning — starting at the initial design phase of new systems. While more can be done in all three, they are not enough to solve the military's problems as experts seek to maintain the U.S. technological advantage in battle.

The role of cognitive radio

"A key feature of system planning is the trend toward cognitive radio and dynamic spectrum access," says Brian Sadler, senior scientist of intelligent systems at the Army Research Laboratory (ARL) in Adelphi, Md. "Full-duplex means being able to receive and transmit

at the same time on the same frequency. The commercial state of the art is sending and receiving simultaneously on different bands. There is a sizeable investment commercially in using the same frequency."

RF technology developers are struggling to keep pace with new trends in how the military uses the RF spectrum. "We are building more intelligence into radios," Sadler says. "Cognitive radio now has a sensing capability and can scan the spectrum of interest. Dynamic spectrum access specifically refers to the dynamic-access use and reuse of spectrum among users and across different systems so they can coexist and we get a lot better use of the spectrum we have."

The tight spacing of massive radars, communications systems, and other electronic gear on a modern naval vessel might seem to make the maritime environment the most vulnerable to co-site interference. It might be ground forces, however, that actually may face the greatest obstacles.

"There are problems in both domains, with good news and bad in each," says the Army's Sadler. "The Navy has a lot of high-power devices on one large platform, but also controls everything about that platform, such as spacing of antennas and their orientation. The Army is totally beholden to how we're operating at the moment as far as spacing of soldiers and vehicles and how many nodes are close by. The propagation environment also varies dramatically depending on where we are operating.

"There are component technologies that can be adapted across the services, down to the component level on radios, antennas, or how you code waveforms," Sadler says. "This extends up to system levels on things such as access protocols for sharing spectrum. Are there overlaps and common technologies and learning from each other? Absolutely."

Civilian technology

Spectrum interference isn't strictly a military problem, with some possible solutions coming from civilian applications.

"The same thing is happening wherever people are trying to pack more users into a tight spectrum, including the commercial world," Sadler says. "But they have the advantage of fixed infrastructure and centralized management in the case of cellular and smart thinking on Wi-Fi. There is a lot of research in the commercial world on how to continuously improve infrastructure and work across bands, such as Wi-Fi, Bluetooth, and cellular co-existing in the same device. The military will follow those trends as we deal with using multiple systems in the same device.

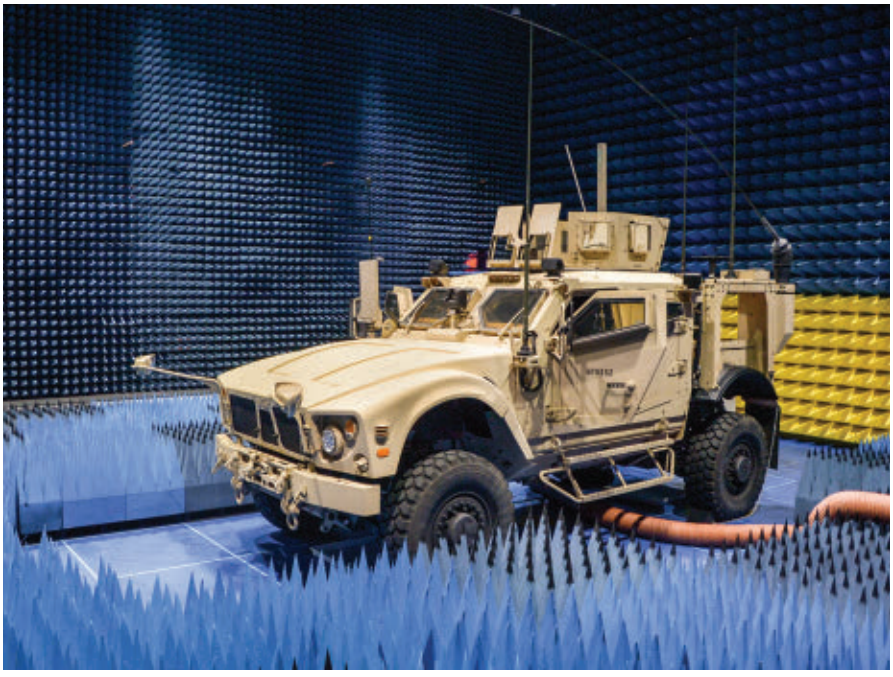
"There are quite a few pieces of technology that potentially can feed into good system designs in the future," Sadler continues. "That ranges from traditional things — antennas and filters — to more exotic technologies, such as same frequency full-duplex, which is coming along commercially and being looked at by the military."

The current state of the art in co-site interference mitigation is advanced modeling and simulation during the design phase of new systems and components to study how much coupling and interference

will occur, based on known operational or test data, says Lockheed Martin's Lackpour.

With an approach like this, "by the time you field it, you have a pretty good idea of what you need to do to address this problem than if you try to retrofit at a later time," Lackpour adds. "We want to have more RF systems — sensors or comms links, more networking, more situational awareness — flowing between all the platforms. That increases the need for spectrum, putting even more stress and strain on the co-site interference problem as our future operations develop new methods using new equipment."

Many experts are watching the commercial RF industry closely to determine which commercial technologies they can harvest for military use.



Experts at the U.S. Army Communications-Electronics Research, Development and Engineering Center at Aberdeen Proving Ground, Md., are on the forefront of mitigating co-site interference.

Government regulations

"Another part of my research is understanding what is going on in the commercial world," points out Lockheed Martin's Lackpour. He's looking into spectral encroachment, where the U.S. Federal Communications Commission (FCC) has taken some dedicated spectrum from the military, and shared it with commercial or civilian users. Some military systems also have problems with spectrum licensed to commercial users in other countries.

"That is not co-site interference, but spectral encroachment, in the U.S. and in other parts of the world, but it leaves less spectrum available to the military, so all our spectrum needs must be further compressed," Lackpour says.

Future developments in resolving co-site interference will require a combination of hardware and software technologies; implementation of standards; greater commonality of systems across services, including allied militaries; more accurate modeling and simulation, from initial design to fielding; more research to better understand and use available spectrum; increasing the dynamic range of receivers so they can better tolerate strong co-channel interference; improved tunable analog filters; development of agile frequency filters; and continued efforts to perfect simultaneous transmit and receive technology on the same frequency with a large dynamic range, possibly using a beam-forming array.

"That's device technology, at the system level," Lackpour says. "At the platform level, instead of having a human manually install, configure, and adjust the co-site interference mechanisms, you would have an automatic system take over to automatically drive that adaptation."

This is where computer-based artificial intelligence (AI) likely will come into play. "There is a lesser version that adapts based on rules, but an engineer in the lab cannot possibly write out all the rules where a system will operate because there are just too many combinations of variables in the real world," Lackpour says. "Further into the future, we can imagine AI driving that adaptation and learning on its own, based on performance of the various systems and what does and does not work. So you have all the degrees of freedom you've built into the various systems, plus AI enabling co-site interference mitigation and mission success in general."

Artificial intelligence

As with every other potential application, AI is subject to many

definitions and constraints, but the speed at which spectrum conflict already occurs eclipses human response time, especially with the continued growth of software-defined (SD) systems and components.

Software-defined systems "are definitely a key to the solution, but it is a double-edged sword; agility brings new capabilities, but also new challenges," says DARPA's Evans. "It really is a new world in terms of the ability to be agile in the spectrum, but that brings a need for more agile allocation than the traditional static allocation we've had for about a century now.

"The decision times on being agile in the spectrum are getting very short, so increasing automation is required," Evans continues. "I view AI as one of the technologies that can be applied in this space, but there are several adaptive technologies, including simple optimization techniques, and neural networks."

Anything that is not software-defined now will be in the future, predicts Lockheed Martin's Lackpour. "Non-SD systems may be fast and economical, but are not flexible," he says. "When you move to software-defined RF, you introduce the ability for the system to understand its environment and adapt its configuration to function better. In the case of co-site interference mitigation, it opens a tremendous freedom to use different frequencies or change transmission characteristics to minimize interference."

Modeling and simulation at the design level, software-defined systems, and artificial intelligence are the three technologies with the strongest potential in the future, Lackpour says. "Any fielded system also will be using, in the early stages of its design, all the different domains of modeling and simulation, which, if done right, reduces cost and improves the success of the design over time. Once fielded, software-defined RF systems and AI will be part of those systems in the future."

Political challenges

There also is a non-technical challenge in mitigating co-site interference: government bureaucracy.

"The biggest problem the Army has is in the acquisition process, which is very stove-piped," says CERDEC's Franklin. "You may have one program manager buying radio A and another buying radio B and there can be a lot of issues when you come up with an interference solution because no one claims ownership of the fix. Another big piece is expectations management. There's not a lot of understanding about integrating two radios on the same platform, such as how closely in proximity and frequency should they operate or what is the acceptable degradation between them if operating at the same time."

Those managing military RF programs should give more thought up-front to how similar systems can work together with a minimum of interference, Franklin says. "It's a very misunderstood topic. The problems are getting worse and as we start to incorporate more and more COTS or non-developmental items into our systems, we really need to think about whether they were ever designed to work around a bunch of 50-watt transmitters. Sometimes if you put communications systems in an electromagnetic environment, you can see interference off the device itself, not necessarily between two systems radiating over the air. You have to be careful what EM environment these COTS [commercial off-the-shelf] components will be asked to work in."

The U.S. Army RC-12 Guardrail special electronic mission aircraft must pack together many different RF antennas on this small twin-engine plane.

DARPA, which takes the longest view into the future, anticipates a similar line of development, but takes perhaps a stronger position than others on leveraging the commercial world at speeds the military could never match.

"In general, what we've been trying to do is make sure the types of technologies we're working on leverage commercial developments," DARPA's Evans says. "The trend in the spectrum area we are most focused on is dealing with the proliferation of RF devices and the coordination of all those functions that will be increasingly common.

"The problem will only grow for spectrum use and we're looking for technologies to address that," Evans says. "We're definitely looking at the issue of deconfliction between devices and view it as an increasingly urgent problem. We are continuing to try to push the technology as far to the edge as we can and believe there are still some great opportunities."

Co-existence in the electromagnetic spectrum has grown from a theoretical exercise to a major key to combat victory in less than two decades — from spectral leakage due to power mismatch to a recent effort to co-locate sensitive directional radars and powerful radios using the same band.

"We are getting smarter and smarter about how we are using spectrum, but it is important to note that this kind of sensing and adapting also implies potential vulnerabilities, a serious security aspect that doesn't really arise in the commercial space," says the Army's Sadler.

"Managing everything together is a significant challenge. As soon as you allow adaptive or cognitive to handle co-site interference, it's really hard to manage those policies," Sadler says. "And when you add on the security issues, we have to be very smart and careful about how we design these things.

"We hope we can bring autonomy to the table in a way that will empower our networks — call it autonomous networking," Sadler says. "The real problem is we don't have a fixed infrastructure or centralized manager with massive computing power to control all the user access.

"The hope is this emerging blend of autonomous and cognitive networking will provide real leap-ahead technology where we have struggled for years," Sadler continues. "But it's still a research question, not something the development centers are embarked on in a wholesale way."

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Making the connection in challenging environments

Modern aerospace and defense applications demand compact, high-speed, and resilient connector and cabling technologies.

BY **Courtney E. Howard**

The world is increasingly digital, interconnected, and driven by data. This trend, which shows no signs of slowing, is growing the demand for technologies that enable integration and connectivity — two essential characteristics of modern systems of virtually any size or scope. Current aerospace and defense projects emphasize the need for high-speed, lightweight, efficient, and resilient cables and connectors.

Smaller, lighter, faster

"The ability to acquire, process, analyze, and communicate information is important to the individual, state, and enterprise," says Ben Reed, general manager at Amphenol Fiber Systems International in Allen, Texas. "Because interconnect enables this communication, there is a continuous need for innovation to provide that link in new and evolving applications. This is particularly true given the increased demand for smaller, lighter, and faster."

High data rates are driving the introduction of optical fiber in applications where copper wire interconnect previously was sufficient, including harsh environments, Reed continues. "Fiber optics are required when data rates, distances, signal integrity, weight and security present challenges that cannot be solved with copper. Combined with a premium placed on mobility — which, by definition, often necessitates connectors — these requirements are driving innovation in fiber-optic interconnect."

Eaton provides umbilical connectors and MIL-DTL-38999 Series IV Wing-Lok connectors, among others, for aerospace and defense applications.

When it comes to fiber-optic interconnects for harsh environments, the reliability of that connection often is the most pressing concern, Reed says. "Our customers spend significant time and capital to ensure a connection will work in their application. This often involves extensive design effort, as well as qualification either at the component or system level. Fiber-optic interconnect often is used for the most sensitive, critical signals. Ensuring the reliability of this signal is essential, especially in aerospace, defense, medical, and various industrial applications that rely on signal integrity."

Applications for harsh-environment, fiber-optic connectors and cabling include: battlefield networking, radar systems, missile defense systems, oil and gas drilling, underground mining, entertainment broadcasting, medical systems, and in-flight entertainment, to name a few, Reed says. "Anywhere that requires high data rates over

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ITT Cannon's ARINC 801 lightweight, fiber-optic connector series is designed for applications in harsh environments that require high-speed and accurate data transfer, such as aviation systems.

significant distance or with weight, security, or electromagnetic interference (EMI) concerns can benefit from, or may require, fiber."

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.

EMI protection

Relatively old Qualified Products List (QPL) solutions are not meeting EMI protection requirements, explains Eaton Interconnect and Power Communications Manager Dennis Brondi 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. LEMO provides an Ingress Protection (IP68) Push-Pull connector that complies with CAT6A, a robust solution for instrumentation, he adds.

Easing the weight burden

Weight is a key concern with virtually any aerospace and defense application, particularly when it comes to airborne and soldier-borne systems. Engineers endeavor to remove weight without sacrificing

system capabilities, functionality, or availability. Even ounces can make a considerable difference.

The commercial aerospace world is pushing connector and cabling innovations faster than the military market, which is more conservative in its approach, says Mike Savage, director of product management at ITT Cannon in Irvine, Calif. "Commercial aerospace is pushing the limits more and more aggressive to drive weight out. In the commercial aerospace market, weight translates directly to dollars."

Savage is seeing growth in and is highly focused on soldier modernization, munitions, commercial in-flight entertainment (IFE), and avionics. "With commercial airplanes, weight is the biggest concern. In the military soldier modernization world, weight is everything," Savage explains.

With an emphasis on saving ounces at a time, ITT Cannon product engineers have "taken a lot of proven circular connectors and made them smaller using different materials, including high-speed friendly and lighter insulator materials," Savage says. "Stainless steel was used in the past for durability, but applications are moving to lighter materials like aluminum. We are constantly looking at new materials and processes, driving technology and innovation to make connectors perform" precisely how customers need."

One strong application area for lightweight composites is commercial aerospace. "Composite material offers significant weight savings when compared to aluminum and steel," explains Amphenol's Ruff. The company now provides composite connectors and backshells, as well as cable clamps known as P-Clamps, which not only weigh less than steel alternatives but also are easier and faster to install, he says.

Designed to disconnect

The warfighter's biggest connector concerns are weight and durability, and the biggest challenge relates to the ability to submerge electronics, connectors, and cables in 20 meters of water, Savage says. ITT Cannon offers submersible versions of the company's Nemesis connectors to meet this need.

Dissipative ETFE dielectric polymer helps control electrostatic discharge in wires and cables

BY CHRIS YUN, *principal engineer of aerospace, defense, and marine at TE Connectivity*

Controlling static electricity in electrical interconnection systems is essential in spacecraft where electrostatic discharge (ESD) events can damage electronics and scuttle the mission. It has been reported that 54 percent of spacecraft anomalies/failures are caused by electrostatic discharging and charging.

In April 2010, for example, the Galaxy 15 telecommunications satellite wandered from its geosynchronous orbit. Reports suggest that spacecraft charging caused the anomaly. Fortunately, a workaround allowed the mission to continue. Worse off was the Advanced Earth Observing Satellite 2 (ADEOS-II), which lost power in October 2003. Forensic research identified that charging by high-energy auroral electrons was followed by a discharge event between power cables. The satellite was never recovered.

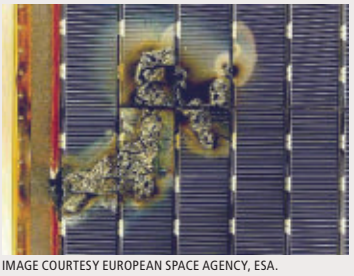

IMAGE COURTESY EUROPEAN SPACE AGENCY, ESA.

An electrostatic charge can build up in any kind of wire and cable insulation. On Earth, a material can become electrically charged when electrically dissimilar materials rub together. In wires and cables used in spacecraft, a static charge can be created by the impact of charged particles on the material. Space is filled with charged particles that can induce a charge in materials. Satellites in geosynchronous orbits and deep space missions are particularly susceptible because of higher charge density in GEO and deep space.

The use of high-resistivity dielectric materials and electrically separated surfaces in conjunction with the connected conducting surfaces of the spacecraft frame promote various forms of spacecraft charging. When the charge builds up in wire and cable of electrical interconnection systems, a sudden discharge can damage connected logic circuits, electronic instruments, and computer chips.

The primary factors that determine the speed and size of an electrostatic discharge are the material's ability to hold a charge (capacitance) and its ability to reduce the flow of electrons (resistance).

There are two ways to handle these factors in wire and cable. One solution employs metallic shielding to create a path that promotes electron flow, which dissipates the charge. The other strategy is to make the insulating materials dissipative, which suppresses the charge build-up.

Read the rest of the exclusive *Intelligent Aerospace* article by TE Connectivity (*http://www.te.com)* at *http://bit.ly/2oNzDTr.*

In many cases, aerospace and defense applications need a breakaway connector, Savage says. If a cable on a soldier's vest snags on a tree, for example, users want it to disconnect without damage to the connector or injury to the warfighter. Different military and aerospace systems designers want separate unmating force in breakaway conditions, he says.

ITT Cannon's Nemesis connectors are designed to be lightweight, robust, and watertight.

"Interconnects designed to disconnect include connectors with integrated release mechanisms that automatically de-mate to facilitate separation of launch vehicles from gantries, in-flight separation of propulsion stages, and separation of satellites and payload modules from propulsion stages," says Eaton's Brondi.

Eaton's umbilical connectors and in-flight disconnects, which include integrated actuators in mechanically and electrically initiated configurations, facilitate separation redundancy through any combination of mechanical lanyard release mechanisms or electrical pin-puller initiators.

Eaton's separation mechanisms incorporate non-explosive initiators that do not require the explosive material handling precautions associated with pyrotechnic initiators. The use of non-explosive initiators is beneficial for applications such as separating payloads from upper propulsion stages of space launch vehicles.

Diameter demands

"In aerospace and defense applications, there is typically a requirement that the smallest American wire gauge (AWG) that can be used is a 24 AWG stranded conductor," says Robert Moore, senior principal

engineer at TE Connectivity in Redwood City, Calif. "Size and weight constraints on newer platforms have pushed that down to 26 AWG, but as the conductor size decreases, the maximum run length — for example, Ethernet — also decreases.

"In order to survive the aerospace environment, the conductor size is typically larger than what is used in commercial applications," Moore continues. It enables longer runs "as long as the AWG of the power line components allows for maximum voltage drop over a longer length and the time delay for the data pair still falls within the data standard requirement," he says.

Aerospace engineers seek smaller and smaller conductor sizes for Ethernet for satellite applications, where weight has a significant impact on launch costs, Moore explains. Cable designs sometimes conflict with the larger conductors required by the customer or application and the need to use standard commercial connectors that have been designed for small conductors and "short" runs, he adds.

"One of the biggest challenges that I have had to meet is limitations on component diameters and the ability to be compatible with a previously chosen connector," Moore says. "For the most part, it results in a slight modification to an existing construction and gives the customer a unique design." A growing number of aerospace and defense applications also call for data cables that will be reeled and de-reeled, prompting Moore and his colleagues at TE Connectivity to configure the components in the cable not to kink or break during the expected lifespan of the cable.

"The cables and connectors that we design and specify have to meet significantly more severe environments than the commercial equivalents," Moore says. "Whether it is temperature extremes, altitude extremes, high electromagnetic interference environments, fluids, or mechanical requirements, the products have to perform in those environments on a daily basis without issue, otherwise mission readiness is compromised."

Enduring the elements

Aerospace and defense connectors

and cables need to withstand a wide variety of harsh environments, including extreme temperatures, shock, and vibration.

"If a connector dislodges in mud, warfighters want to be able to wipe off the front of the connector and mate it again," says ITT Cannon's Savage. For such occasions, ITT Cannon recommends changing from pin-and-socket interconnects to spring-loaded contacts on a pad to be more readily field-capable.

Traditional couplings will unmate under high stress and vibration, Savage says. For these challenging environments, ITT Cannon engineers designed the company's K-Lock coupling system, which he says is "next to impossible to unmate under high vibration."

Aircraft engines are particularly harsh environments that present cable and connector designers with unique challenges. "As aircraft engines move to higher bypass ratios to improve efficiency, it forces cables closer to the engine," Amphenol's Ruff says. "We are seeing an increased need for high/low-temp applications in space and on aircraft engines, where connectors and cables are exposed to high temperatures." Nomex braiding on cables helps address high temperatures.

Amphenol engineers recently worked with an aircraft engine manufacturer working on new engines for commercial aircraft. "On each engine, they would manually place hundreds to thousands of thermocouples to monitor the engine during test. The thermocouples could not be installed until the full engine was assembled. Placing the thermocouples took hundreds of man hours," Ruff says. "In an effort to solve this problem, we developed special thermocouple contacts and 'connectorized' the assembly. It allowed the engine to be built in sections and easily assembled/disassembled with the quick turn of a coupling nut — saving hundreds of hours in assembly and significantly accelerating the development cycle."

Providers offer connector solutions designed to help facilitate testing without sacrificing more costly equipment. ITT Cannon's Connector Savers, for example, help keep connectors on expensive equipment from wearing out quickly. During the test period, the connector is subjected to high mating and unmating, Savage says. "Customers may build and need to test a unit, but want to save the connector from multiple unmating cycles. We build a Connector Saver used only for testing that they can throw away."

Cabling and connector characteristics

Aerospace and defense customers today take into consideration a wealth of connector and cabling characteristics, in addition to size, weight, mating, materials, and EMC.

MIL-STD-1553B in avionics

The landscape of avionics architectures has shifted through the decades from analog to digital system implementations with increased software complexities. As the subsystems of the aircraft grow, so do the complexities in the communications between them. Speed, reliability, safety, cost, and quality of service are all factors that are taken into consideration when choosing a particular data networking standard. The present evolution in technology and data networking — of which MIL-STD-1553B has been and is still a major component — offers a wide variety of options for modern day aircraft.

Increased data throughput requirements for high-definition video and camera services far exceed what MIL-STD-1553B theoretical maximums are, approximately 200 megabits per second. Efforts have been made to provide enhanced speed MIL-STD-1553B, which may still serve some purposes on commercial aircraft. Moreover, technologies such as Ethernet, are more likely to succeed in meeting the latest throughput demands of commercial and, possibly, military avionics.

Read the rest of the exclusive *Intelligent Aerospace* article, by MilesTek (*http://www.milestek.com*), online at *http://bit.ly/2oXa6pr*.

"The finish of the connector is important," ITT Cannon's Savage insists. Warfighters on the ground "can't have a shiny, bright connector; they need a matte finish dark enough to not reflect light. New plating materials and processing enables a move away from cadmium plating in soldier and avionics" applications.

The Reduction of Hazardous Substances (RoHS) directive restricting the use of hazardous substances in electrical and electronic equipment is still a concern. "A big challenge right now is getting complaint to RoHS. It is difficult to get lead out of base materials and plating materials, which are traditionally cadmium and lead," Savage says. The global military community is "still challenged with finding plating materials that perform but still hit a price point."

Accelerated schedules also influence cabling and connector selection. "Many customers are working to bring products to the market as quickly as possible," Amphenol's Ruff says. "To support this effort, we have invested in a three-dimensional (3D) printer which allows us the ability to do fit checks, build demo components such as backshells, and even cold pour molds to offer initial proof of concept assemblies within 48 hours."

Aerospace and defense organizations also are under increasing cost pressure because of competition and other factors. The use of off-the-shelf components and outsourcing produces more competition in the supply chain, Ruff adds. Amphenol's global footprint includes low-cost manufacturing locations in Mexico, India, and China.

Obsolescence management is another major concern in aerospace and defense. "Sourcing specialists continually monitor for obsolescent parts and work to identify issues before it has an impact to schedule," Ruff says. "Prior to notifying a customer, our in-house engineering team will investigate and provide equivalent alternatives when possible."

Miniaturization matters

The continuing trend toward smaller sizes is driving component miniaturization. "Miniaturization is the basis for a vast range of products and applications in areas such as defense, communications systems, homeland security, biomedical equipment, medical diagnostics, industrial, and consumer products," says LEMO's Buechli. "This kind of trend also applies to connectors, in the same way it has for integrated circuits during the last 50 years."

Smaller platform and system sizes, including the need for portability and mobility, are driving the migration from legacy MIL-DTL-38999, MIL-STD-5015, and MIL-DTL-26482 connectors to smaller, higher-density versions, such as 2M Micro-Miniature 38999, HD38999, Pegasus, and Micro-D connectors, Amphenol's Ruff explains. "New smaller connectors offer weight and space savings while maintaining the same level of performance. For example, a 2M series connector is 52 percent smaller and 72 percent lighter than its equivalent D38999 counterpart."

"Military original equipment manufacturers (OEMs) often are specifying compact form factors that connect both power and data with higher contact densities and equivalent or better performance than MIL-DTL-38999," Eaton's Brondi says. To address miniaturization requirements, Eaton micro-military circular connectors are

LEMO's portfolio of connectors is keeping pace with the demand for smaller and smaller sizes. Component miniaturization is a growing trend in aerospace and defense, communications, homeland security, and other applications.

available with as small as 0.39-inch receptacle diameters and integrated backshells.

High speed and density

"Connectors need to be designed for higher speeds," says Mike Walmsley, global product manager for aerospace and defense at TE Connectivity in Harrisburg, Pa. The VITA 46 connector was initially rated for 6.25 gigabits per second (Gb/s) but is now used in 10 Gb/s applications, he says. "As we move to 16 Gb/s and 25 Gb/s, the connector footprint and structure has to be studied and further developed to minimize sources of noise and impedance discontinuities.

"For smaller platforms, higher-density connectivity is needed — more high-speed signals, more radio-frequency (RF) lanes, and more optical links in the same module space, narrower guide hardware," Walmsley continues. With standard platforms, he says, the available space is defined and the challenge is pushing more throughput within that same physical space constraint.

Higher data rates are coming quickly in the military and aerospace market, processors are making significant gains, and applications demand faster data processing and transmission, Walmsley says. Electronic-warfare (EW) programs require high-speed digital (board-level), RF cabling, and other connectivity solutions, for example.

"Industry leaders are looking ahead two generations for data rates, and we are developing solutions now. With a widely accepted industry standard like VPX, the significant challenge is addressing the higher speeds with a solution that is backward compatible with existing architecture (same mating interface)," Walmsley adds.

"In defense, we are seeing an exciting evolution in interconnect technology. Old architecture is being upgraded with new, for higher speed and density. Open standards are being driven to reduce cost and development cycles. No longer are the old designs from 20-plus years ago being re-deployed," Walmsley says. "This invites new technologies and innovative solutions for connectivity."

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Raytheon to upgrade missile-defense radar

The U.S. Missile Defense Agency (MDA) in Huntsville, Ala., has contracted Raytheon to upgrade the AN/TPY-2 ballistic missile defense radar. Under the $10 million contract, Raytheon will develop hardware and software that will add gallium nitride (GaN) semiconductor technology to the AN/TPY-2. Integration of GaN technology is said to increase the radar's range, search capabilities, and reliability while maintaining costs. The upgrade also allows the system to discriminate between threats and non-threats more effectively. The AN/TPY-2 would become the world's first transportable, land-based ballistic missile defense radar to use GaN technology.

Aerojet Rocketdyne to mature UUV recharging

The U.S. Navy awarded Aerojet Rocketdyne a $1.6 million contract to mature a power and energy management system to remotely recharge underwater unmanned vehicles (UUVs) while undersea. The company will mature and demonstrate the system's software to help schedule UUVs that need wireless recharging. The system will support longer UUV travels and help conceal the vehicles' presence. The company designed the platform for UUVs to upload data and download orders without the need to travel to a port or surface ship.

Raytheon redesigns AMRAAM to extend missile's lifetime

BY **John Keller**

EGLIN AIR FORCE BASE, Fla. — Aircraft missile experts at the Raytheon Co. are continuing a project to design a new guidance section for the U.S. Air Force and Navy AIM-120 Advanced Medium Range Air to Air Missile (AMRAAM) in an effort to extend the missile's lifetime well into the 2020s.

Officials of the U.S. Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., announced a $64.6 million contract option to the Raytheon Missile Systems segment in Tucson, Ariz., for phase 4b Form, Fit, Function Refresh (F3R) of the AMRAAM guidance section.

AMRAAM is an active radar-guided intercept missile with inherent electronic protection capabilities for air-to-air applications against massed penetration aircraft. AMRAAM has been in service since 1991.

The Air Force's AMRAAM F3R project is a comprehensive effort to mitigate the effects of parts obsolescence and diminishing manufacturing sources in the missile's guidance section to enable AMRAAM production beyond lot 31.

Raytheon won a $573 million order in March 2016 for AMRAAM lot 30 production. Each AMRAAM lot roughly consists of 400 to 500 missiles.

The Air Force and Raytheon are redesigning the radar guidance section of the AMRAAM missile to extend the weapons' lifetime into the 2020s.

Mitigating the effects of obsolescence and diminishing manufacturing sources can involve the substantial redesign of subsystems by replacing electronic chips and other components that the original manufacturers no longer can produce.

In 2015 Raytheon experienced technical difficulties with the AMRAAM F3R application-specific

integrated circuit (ASIC) design, hardware integration, and guidance section performance demonstration, which delayed the program's critical design review (CDR) for a year.

The Air Force awarded Raytheon an $8.6 million contract modification last December provide additional ASIC work as part of the AMRAAM F3R phase 4a project, which is scheduled to wrap-up this June. Separately, Raytheon won a $104.6 million contract in May 2016 for AMRAAM F3R work on the missile's guidance section.

Last January, Raytheon officials announced a project to develop a new signal processor under the F3R project to help ensure AMRAAM production well into the 2020s. Air Force officials plan to cut F3R technology into the latter part of AMRAAM lot 31 production in 2019 or 2020.

Raytheon will do the work in Tucson, Ariz., and should be finished by April 2018.

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

Passive surveillance to track aircraft using only the RF signals they emit

BY **John Keller**

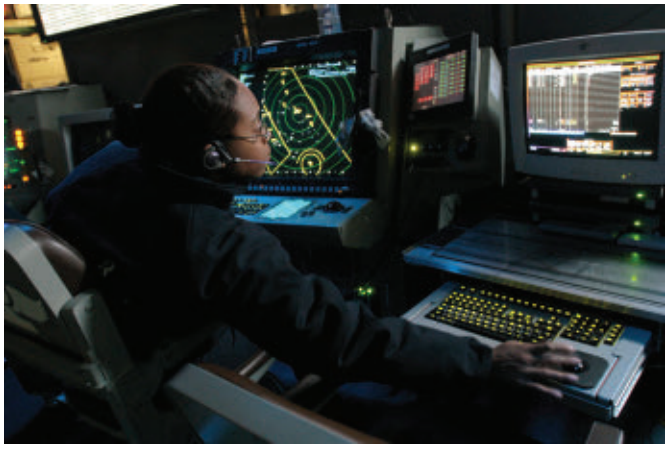
WRIGHT-PATTERSON AFB, Ohio – U.S. Air Force researchers are ready to ask industry for passive surveillance techniques to identify, pinpoint, and track aircraft, land vehicles, and surface ships using only the RF signals they emit.

Officials of the U.S. Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base, Ohio, issued a presolicitation (FA8650-17-S-1022) for the future Radio Identification (RID) program. This initiative seeks to demonstrate and evaluate the benefits of identifying and geo-locating surface and air platforms via reception, processing, and display of their communications, navigation, and identification signals, as well as of other signals of interest.

The RID program will focus on non-cooperative target identification and geo-location via passive reception of RF signals of interest. The project will mature technologies and develop techniques for detection, identification, and reporting of any spoofing attempts, and demonstrate passive reception of at least one cooperative identification system. The automatic dependent surveillance-Broadcast (ADS-B) emitting signals at 1090 MHz is the planned capability.

Air Force researchers are looking for modular RID software architectures based on open-systems standards where practical to support upgrades to algorithms and incorporating additional signals of interest.

The system architecture must be able to support agile multifunction signal processing and fusion of sensor tracks. Researchers are interested in system architectures that could work on a variety of platforms and locations, and that could move to Air Force or U.S. military



U.S. Air Force researchers are looking for ways to track friendly and enemy aircraft passively using only the RF emissions these aircraft generate.

systems using multi-channel, multifunction apertures and receivers integrated with software-defined architectures and equipment.

A formal solicitation for the RID program is expected by late May or early June 2017. The program should run for five years, and could be worth as much as $24.92 million to the contractor or contractors ultimately chosen to carry it out.

This is a presolicitation only, and Air Force researchers are not ready to accept proposals until the formal solicitation comes out in May or June.

For technical questions or concerns contact the Air Force's John Bollinger by e-mail at john.bollinger@us.af.mil. For contracting questions contact Cindy Brocker by e-mail at cynthia.brockert@us.af.mil.

MORE INFORMATION IS online at *https://www.fbo.gov/spg/USAF/AFMC/AFRLWRS/FA8650-17-S-1022/listing.html*.

Aluminum batteries could extend unmanned submarine range

Unmanned underwater vehicles (UUVs), as they are known technically, are employed for applications ranging from prospecting for oil and gas to naval warfare. Ocean-going drones have limited ranges — limits that are often imposed by their batteries, which are typically alkaline or lead-acid. Lithium-ion batteries, fashionable elsewhere, have not conquered the UUV world. Their tendency to catch fire counts against them and they are sensitive to pressure, which is undesirable in devices that operate underwater. A firm in Somerville, Mass., called Open Water Power (OWP) is offering an alternative: batteries based on aluminum. With these, its engineers hope to extend the ranges of underwater drones tenfold.

Navy and General Dynamics test Knifefish mine-hunting undersea drone

The U.S. Navy and General Dynamics Mission Systems have completed an evaluation of the Knifefish autonomous surface mine countermeasure (SMCM) unmanned undersea vehicle (UUV). The tests were conducted in Boston, and made use of submerged mine-hunting test targets supplied by the Navy. “The system performed

Military research projects may be coming together to put large long-endurance UUVs in sight

BY **John Keller**

U.S. military research programs are taking shape to develop enabling technologies for large long-endurance unmanned underwater vehicles (UUVs) able to operate independently for long periods over long distances to deploy surveillance sensors and weapons in global hot spots where necessary.

The Boeing Echo Voyager large unmanned submersible is one of the largest unmanned underwater vehicles, and is helping military experts develop the unmanned submarine mothership of the future.

These projects are led by scientists at the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., and the Office of Naval Research (ONR) in Arlington, Va.

One of the latest developments is an industry solicitation by DARPA for the Hunter program to develop an advanced payload delivery system for extra-large UUVs.

Payloads potentially could involve persistent-surveillance sensors, weapons, or other UUVs and unmanned aerial vehicles (UAVs). Details of the Hunter program are classified and available only to companies with the proper security credentials.

Separately, DARPA is pursuing the Hydra program to develop an unmanned submersible large enough to transport and deploy UAVs and UUVs stealthily in enemy territory to respond quickly to situations around the world.

Enabling technologies to be developed in the Hunter program have the potential to add to the Hydra UUV’s capabilities, and perhaps could expand the Hydra submersible’s mission beyond deploying unmanned reconnaissance submarines and aircraft.

The DARPA Hydra large UUV program has been in progress for nearly three years, and involves the Boeing Co. Defense, Space & Security segment in Huntington Beach, Calif., and Hydroid Inc. in Pocasset, Mass.

Boeing has developed the Echo Voyager, a 51-foot large UUV that can reach depths of 11,000 feet and can operate independently for months underwater. Boeing unveiled the Echo Voyager one year ago and began sea trials of the unmanned undersea craft last summer.

Hydroid, meanwhile, offers a family of UUVs called the Remote

Environmental Measuring Units (REMUS). The largest of these is the REMUS 6000. Although not nearly the size of the Boeing Echo Voyager, the REMUS 6000 is 13 feet long and 28 inches in diameter. It can reach depths of nearly 20,000 feet.

Hydroid engineers developed the REMUS 6000 together with the Naval Oceanographic Office, the Office of Naval Research, and the Woods Hole Oceanographic Institution. Hydroid is a subsidiary of Kongsberg Maritime in Kongsberg, Norway.

Separately from the DARPA Hydra program, the Office of Naval Research is working on the Large Displacement Unmanned Undersea Vehicle (LDUUV) for a wide variety of applications like long-range surveillance.

The LDUUV is to operate in the open ocean and in coastal waters and harbors on missions lasting more than 70 days. The large unmanned submersible is to be a pier-launched and recovered. The project's primary goals are to develop enabling technologies in machine autonomy and long-endurance propulsion.

Companies involved in the LDUUV program include: Metron Inc. in Reston, Va., which is working machine intelligence; Hydroid, which is developing an autonomy testing system; Fuelcell Energy Inc. in Danbury, Conn.; Sierra Lobo Inc. in Fremont, Ohio; the Hamilton Sundstrand Corp. Sea Systems segment in Windsor Locks, Conn.; General Atomics in San Diego; Lynntech Inc. in College Station, Texas; and NexTech Materials Ltd. in Lewis Center, Ohio.

With machine intelligence, long-endurance propulsion, and other crucial UUV technologies under development in the Hydra and LDUUV programs, the DARPA Hunter payload delivery system could be just the technology to provide real intelligence and reconnaissance capabilities for future large unmanned submarines. ←

Naval Research Laboratory to test swarming palm-sized drones

Imagine a fleet of drones, each the size of your palm blooming from a package dropped from an airplane. That's what the U.S. Naval Research Laboratory's tiny CICADA drone can do through upcoming swarm flight testing.

The Close-In Covert Autonomous Disposable Aircraft (CICADA) has pressure, temperature, and humidity sensors on board, and consists basically of a circuit board with tiny wings and autopilot controls built-in. It weighs less than three ounces, and drops at around 1,000 feet per minute according to the official specs.

One of the launch tubes that carry the CICADAs holds 32 individual drones, and the tube is designed to be dropped from a U.S. Navy P-3 Orion airplane. The CICADAs deploy from the tube once it's released from the aircraft, and fly on to their target, where they can land with accuracy of around 50 square feet. ←

well against a variety of surrogate targets and we are confident we will refine its performance to support the planned schedule in 2017," says Jon Rucker, program manager of the Navy Unmanned Maritime Systems Program Office (PMS406). The comprehensive assessment showed the capability of the UUV to detect and classify potential mines at various depths and on the sea floor.

Air Force demonstrates F-16 drone that can take out targets autonomously

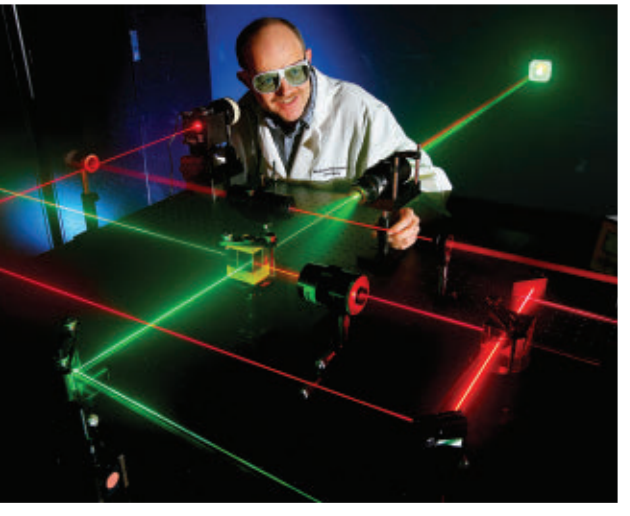
The U.S. Air Force has developed an unmanned F-16 jet fighter that not only can fly autonomously, but also engage in battle with intelligent strategies that it conceives on its own. The Air Force had already been using F-16 drones as practice targets for the F-35 to destroy in training. Now the Air Force has announced fully autonomous air-to-air and ground strike capabilities that it developed with Lockheed Martin Skunk Works. During the demonstration, an experimental unmanned F-16 aircraft showed how it can react to a dynamic threat environment during an air-to-ground strike mission. It planned and executed the mission on its own, deciding the best route and strategies based on mission priorities and available assets. The aircraft was also able to react to changing threats and adjust its course of action accordingly. ←

ELECTRO OPTICS watch

Engility to find cutting-edge optical warfare uses for light and lasers

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio – Laser protection experts at Engility Corp. in Andover, Mass., are finding new ways to use infrared, ultraviolet, visible light, and lasers for offensive and defensive purposes in the emerging discipline of optical warfare.



The U.S. Air Force is asking Engility Corp. to find new ways of using infrared, ultraviolet, visible light, and lasers for offensive and defensive optical warfare.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have announced an $8.5 million order to Engility for additional work in the Optical Radiation Bioeffects and Safety (ORBS) program. Engility experts seek to understand, mitigate, and exploit the effects of ultraviolet, visible, and infrared optical radiation devices and their countermeasures on U.S. military personnel and aerospace missions.

Engility will continue looking for new ways to diagnose and treat combat injuries due to optical radiation; improved methods of combat casualty care, including triage, diagnosis, and treatment; and simulating laser injury to assess mission performance.

The notion of optical warfare involves the use of light for weapons, communications, sensors, defensive measures, surveillance, and other instruments of warfare. Optical warfare is one component of an emerging military discipline called spectrum warfare, which also includes electronic warfare (EW) and cyber warfare.

The ORBS program seeks to identify, develop, and perfect new technologies for using lasers and other kinds of light emitters as weapons, as well as for protecting military personnel from the effects of lasers.

Engility experts will try to develop new technologies to diagnose and treat optical warfare combat injuries; find economical and efficient ways to care for optical warfare combat casualties; and simulate laser injuries to help develop laser weapons and laser protective technologies. Engility will do the work at Joint Base San Antonio-Fort Sam Houston, Texas, and should be finished by April 2020.

FOR MORE INFORMATION visit **Engility Corp**. online at *www.engilitycorp.com*.

Elbit to provide helmet-mounted displays for Navy helicopters

Elbit Systems of America in Fort Worth, Texas, will provide the U.S. Navy with helmet-mounted displays for pilots of MH-60R anti-submarine warfare helicopters and MH-60S multimission helicopters under terms of a $49.9 million contract. Officials of the U.S. Naval Surface Warfare Center Crane Division in Crane, Ind., are asking Elbit to provide 126 helmet display tracker systems (HDTS) for MH-60R and MH-60S helicopter pilots. The HDTS provides MH-60 situational awareness and targeting enhancements via pilot/copilot line-of-sight capability; continuously computed impact point for the 20-millimeter automatic gun helicopter armament subsystem; LAU-61C/A 2.75-inch unguided rockets; and LAU-61G/A precision guided digital rocket launcher.

Raytheon to establish software team for UAV multi-spectral sensors

Raytheon is establishing a dedicated software team to support multi-spectral targeting sensors on the MQ-1 Predator and MQ-9 Reaper medium-range attack unmanned aerial vehicles (UAVs). Officials of the U.S. Air Force Lifecycle Management Center at Wright-Patterson Air Force Base, Ohio, announced a $12.6 million contract to Raytheon Space and Airborne Systems in McKinney, Texas, to develop, field, and sustain Medium Altitude Long Endurance Tactical Multi-Spectral Targeting Systems software.

IARPA seeks to image geosynchronous objects for space situational awareness

BY **John Keller**

WASHINGTON — U.S. intelligence experts are launching an initiative to develop space situational awareness precision imaging technology sufficient to gather high-resolution images of objects orbiting in geosynchronous orbit from installations on the ground.

Officials of the U.S. Intelligence Advanced Research Projects Agency (IARPA) in Washington are briefing industry on the upcoming Amon-Hen program to produce images of objects in geosynchronous orbit, which is 22,236 miles above the Earth's surface. IARPA's Amon-Hen program seeks to develop ground-based GEO imaging that enables rapid collection of data for inteferometric image reconstruction of geosynchronous objects at low cost.

One potential technology approach to the Amon-Hen project is to use a large number of small apertures. In addition to reducing costs, small aperture could enable simultaneous measurements at a large number of baselines, reducing acquisition timelines and increasing the number of geosynchronous objects imaged in one night.

The goal of the Amon-Hen program is to develop a low-cost, passive, ground-based, optical interferometer that from the ground can resolve images in geosynchronous orbit to 12.5 nanoradian angular resolution, and then convert one night's imaging data to a final image.

Imaging data from one geosynchronous object must be completed in less than one hour. Image interpretability must be equivalent to Space Object Rating Scale (SORS) Level 6 or better.

Geosynchronous orbit is of particular interest to U.S. intelligence experts because it is the altitude at which orbiting remote-sensing satellites maintain the same position above the Earth's surface; the Earth does not rotate underneath the spacecraft as it does with satellites orbiting at lower altitudes.

As more nations become active in space, U.S. intelligence agencies have an increasing need for space situational awareness, particularly timely information about systems and activities in geosynchronous Earth orbit.

The U.S. Senate Armed Services Committee has identified the need to develop ground-based capabilities for passive imagery of geosynchronous objects to provide a credible layer of accountability for behavior in space.

Since objects in geosynchronous orbit are 22,236 miles above the Earth's surface, these objects appear from the ground to be so small and dim that telescopic observation cannot provide imagery of sufficient resolution for the space situational awareness needs of the military and intelligence community. The altitude of geosynchronous orbit is nearly three times the diameter of Earth.

Different ground-based approaches to image geosynchronous objects have focused on interferometers, such as the Naval Precision Optical Interferometer (NPOI) and the Magdalena Ridge Optical Interferometer (MROI), both of which have active research programs in geosynchronous imaging. Because geosynchronous objects are dim, however, finding and measuring the interference fringes developed between any two apertures in the interferometer is challenging.

Intelligence experts are developing the ability to take high-resolution images of objects in geosynchronous orbit.

The complex shape of geosynchronous objects also reduces inherent signal strength in the fringes resulting in a fringe tracking and fringe measurement problem that rapidly becomes more difficult at longer interferometer baselines necessary for high-resolution image reconstruction.

Previous attempts have involved several design approaches using relatively large apertures of one to two meters in diameter. Even with such large apertures, taking enough baseline measurements for image reconstruction in a reasonably short period of time leads to prohibitively high system costs. The upcoming Amon-Hen project will try to overcome many of these challenges.

E-mail questions or concerns to IARPA's Merrick DeWitt at dni-iarpa-baa-17-02@iarpa.gov.

MORE INFORMATION IS
online at *https://www.fbo.gov/notices/5327a4fdba9bf3b451594850c8861422.*

PRODUCT applications

COMMERCIAL AVIONICS

Lufthansa chooses wireless routers from Kontron for test and measurement flights

Aviation IT specialist Lufthansa Systems in Kelsterbach, Germany, needed rugged wireless routers for the company's test bed on Lufthansa´s FlyingLab test and measurement flights. They found their solution from embedded computing specialist Kontron in Augsburg, Germany.

Lufthansa Systems is using the Kontron Cab-n-Connect A100 cabin wireless access point (CWAP) to deliver simultaneous access of HD video streaming in dense multi-client applications on Lufthansa FlyingLab flights.

Lufthansa started its FlyingLab flights to help passengers test and familiarize themselves with technologies and services being developed for use on airlines as well as to showcase stimulating types of live content and digital trends.

FlyingLab enables Lufthansa to introduce technology and collect feedback in a real-world commercial aircraft environment. The IT subsidiary Lufthansa Systems is responsible for the technical infrastructure enabling the Wi-Fi connection onboard.

The Wi-Fi network is based on the technology of the Lufthansa Systems digital platform Board Connect.

Kontron's Cab-n-Connect A100 wireless access point with 802.11ac Wi-Fi substantially increases bandwidth efficiency for HD video on the aircraft. The A100 helps the client device and access point work together to provide an optimized communication path for strong and fast data transmission.

Lufthansa Systems chose Kontron for the job based on Lufthansa's history with previous Kontron equipment where these certified open platform solutions gave them the most cost-and shortest route to deployment, Kontron officials say.

FOR MORE DETAILED INFORMATION visit **Kontron** online at *www.kontron.com/industries/avionics.*

DISPLAYS

BAE Systems to provide new head-up display for F-22 jet fighter avionics

Military avionics designers at Lockheed Martin Corp. needed upgraded head-up display (HUD) technology for the U.S. Air Force F-22 Raptor jet fighter. They found their solution from the BAE Systems Electronic Systems segment in Rochester, England.

Officials of the Lockheed Martin Aeronautics segment in Fort Worth, Texas, have chosen BAE Systems to modernize the F-22's HUD by replacing it with a completely digital version, BAE Systems officials say.

BAE Systems engineers will use the company's advanced Digital Light Engine (DLE) technology to implement a form, fit, and function HUD solution that integrates seamlessly into the F-22's existing HUD space, BAE Systems experts say.

BAE Systems officials say they expect to receive a follow-on production contract from Lockheed Martin to retrofit the current HUDs in the Air Force F-22 fleet with the modern DLE solution, company officials say.

The DLE package is compatible with any existing aircraft interface. The upgrade removes the conventional cathode ray tube (CRT) image source and introduces a more advanced digital display, which offers increased reliability, eliminates high-maintenance and obsolete items, and provides a constant luminance performance.

DLE technology provides enhanced situational awareness for the military aviator, and allows some freedom of head movement, which can reduce reducing pilot. DLE HUD technology is backward-compatible with existing aircraft interface, and offers minimal impact on display performance, company officials say.

FOR MORE INFORMATION visit **BAE Systems Electronic Systems** online at *www.baesystems.com*, and **Lockheed Martin Aeronautics** at *www.lockheedmartin.com/us/aeronautics.html*.

ELECTRONIC WARFARE

Harris to provide electronic warfare systems for Morocco's F-16 jet fighter fleet

Military aviation experts of the Royal Moroccan Air Force (RMAF) in Rabat, Morocco, needed airborne electronic warfare (EW) systems to help protect the RMAF F-16 jet fighter aircraft fleet from enemy radar-guided missiles. They found their solution from the Harris Corp. Electronic Systems segment in Palm Bay, Fla.

Harris won a $91 million contract from the U.S. Air Force Warner Robins Air Logistics Center at Robins Air Force Base, Ga., to provide AN/ALQ-211 Advanced Integrated Defensive Electronic Warfare Suite (AIDEWS) systems to the Moroccan air force.

Harris will supply AIDEWS systems, spares and support equipment and services to Morocco. The combat-ready ALQ-211(V)4 integrated radar warning and RF countermeasures to alert pilots to missile launches, and then spoof and jam the missiles' electronic guidance systems.

AIDEWS provides fighter pilots with situational awareness and protection against radar-based surface-to-air and air-to-air missiles. The Harris ALQ-211 AIDEWS and its RF and microwave components can be internally integrated or pod-mounted. Either configuration offers integrated radar warning and electronic countermeasures capability.

AIDEWS is built on the ALQ-211 family of electronic warfare systems that support U.S. and allied military helicopters and jet fighters, including the NH-90, V-22, MH-47, MH-60, F-16, and several commercial aircraft.

FOR MORE INFORMATION visit **Harris Corp.** online at *www.harris.com*.

ELECTRO-OPTICS

Malin Space Science to provide rad-hard cameras for geosynchronous satellites

U.S. Navy electro-optics researchers needed radiation-hardened cameras for space operations in geosynchronous orbits. They found their solution from Malin Space Science Systems Inc. in San Diego.

Officials of the Naval Research Laboratory (NRL) in Washington announced an $11 million contract to Malin Space Science for the Space Qualified Visible Cameras for Geosynchronous Operations project. Malin will develop visible-light cameras with modified housings to meet the radiation environment of geosynchronous altitude, where solar winds and space radiation produce an extremely harsh environment for electro-optics and electronics.

The Space Qualified Visible Cameras project calls for Malin Space Science to design four different cameras for the Naval Research lab.

On this contract, Malin Space Science Systems will increase the thickness and material of the camera housing case, while leaving the interior components of the camera unchanged. The company designed the Camera Monitoring Assembly (CMA), which originally was for a NASA science mission, but later went into space on a classified Earth orbiter mission to image near-field objects from the spacecraft.

FOR MORE INFORMATION visit **Malin Space Science Systems** online at *www.msss.com*.

new PRODUCTS

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

RUGGED COMPUTERS

Safety-critical embedded computing for avionics and mission computing introduced by Mercury

Mercury Systems Inc. in Chelmsford, Mass., is introducing the Mercury Mission Systems (MMS) safety-qualified embedded computing product line for safety-critical solutions for

mission computers, avionics, and platform management in defense and commercial aerospace applications. MMS products feature design assurance and supporting software designed to reduce integration time and effort. The product line includes solutions from the former Creative Electronic Systems (CES) in Geneva, acquired by Mercury last November. MMS products are designed to the DAL-A, DO-254, and DO-178 safety-critical standards and are for primary flight control units, flight test computers, mission computers, command and control processors, graphics and video processing, and avionics-certified Ethernet and I/O.

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

CONNECTORS

Rugged ARINC 600 receptacle military connectors introduced by TE Connectivity

TE Connectivity in Harrisburg, Pa., is introducing size 20, 16, and 12 power contacts for the company's rugged ARINC 600 receptacle connectors for military, avionics, and marine applications. TE also is offering press fit quadrax contacts to safe space and weight, and reduce the need for gold plating. These connectors are in addition to TE's existing size 22 press fit contacts. The new contacts complement TE's Next Generation ARINC

600 receptacle connector, which combines stamped and formed contacts with a one-piece insert to reduce cost, size, and weight of connectors for a variety of applications including in-flight entertainment systems, air-to-ground communications, collision avoidance, and many other avionics systems.

FOR MORE INFORMATION visit **TE Connectivity** online at *www.te.com/arinc600*.

RF AND MICROWAVE

Millimeter wave transmitter for wireless communications introduced by Pasternack

RF and microwave components specialist Pasternack Enterprises Inc. in Irvine, Calif., is introducing the PEM010 millimeter wave transmitter module for developing multi-gigabit, high-speed, point-to-point wireless communications links. These communication links provide low-cost, gigabit wireless throughput for a variety of applications involving

telecommunications last-kilometer distribution, telecommunications cellular backhaul, millimeter wave wireless gigabit Ethernet data communications, building-to-building high-speed networks, and mesh-based LAN infrastructures. The PEM010 operates in the global unlicensed frequency spectrum from 57 to 64.8 GHz. It also supports IEEE 802.11ad and 802.11aj Wi-Fi protocols for wireless multi-gigabit, high-speed networking. This module's design incorporates a silicon germanium MMIC-based frequency synthesizer and power amplifier.

FOR MORE INFORMATION visit **Pasternack** online *at www.pasternack.com*.

EMBEDDED COMPUTING

Curtiss-Wright introduces Gen 4 PCI Express with MultiGig RT2 VPX connectors

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the ability to meet the increased bandwidth requirements of Gen 4 PCI Express embedded computing with standard MultiGig RT2 VPX connectors. This uses a new optimized design approach, extends the ability of the VPX and OpenVPX (VITA 65) standards to support the full bandwidth and signal integrity required when transferring 16-gigabaud PCI Express 4.0 data communications signals over the backplane. Curtiss-Wright plans to support Gen

4 PCI Express using standard VPX connectors on its Fabric64 family of modules and systems. "The ability to support next generation Gen 4 PCI Express data rates over VPX without having to abandon the current OpenVPX architecture, today's

de facto bus and board standard for aerospace and defense systems, will enable our customers to protect and preserve their investment in current VPX hardware," says Lynn Bamford, senior vice president and general manager of Curtiss-Wright Defense Solutions.

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

DATA CONVERTERS

XMC high-speed data converter for SATCOM, UAVs, and radar introduced by Pentek

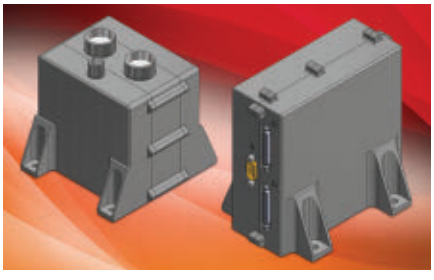
Pentek Inc. in Upper Saddle River, N.J., is introducing the model 71851 data converter switched mezzanine card (XMC) for high-speed data acquisition, waveform generation, communications, satellite communications (SATCOM), unmanned aerial vehicle (UAV), and radar applications. The 71851 is based on the Xilinx Kintex Ultrascale field-programmable gate array (FPGA) and has two 500 MHz, 12-bit analog-to-digital (A/D) converter with multiband digital down converters (DDCs), one digital upconverter (DUC), and two 800 MHz 16-bit D/As. The front end accepts two analog HF or IF inputs on front panel SSMC connectors with transformer-coupling into two Texas Instruments ADS5463 500 MHz, 12-bit A/D converters. Optionally, a Texas Instruments ADS5474 400 MHz, 14-bit A/D may be factory-installed instead of the ADS5463 for those that need better resolution.

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

SPACE COMPUTING

Rugged space-qualified remote I/O interface introduced by Aitech

Aitech Defense Systems Inc. in Chatsworth, Calif., is introducing the rugged space-qualified Ai-RIO remote I/O interface unit that uses



expansion modules, or "slices" for application-specific remote I/O management in a variety of aerospace, defense, and military applications. The Ai-RIO is a high-density, low-power rugged subsystem that provides user-specific functionality. It is suited for vehicle platform flight control, attitude and navigation controls, servo-valve and thrust vector control (TVC), robotic motor control, video and image processing and storage, data telemetry, platform stabilization, communications and telematics, high-speed data recorders, booster and launch propulsion and thruster control, remote sensor, and effector monitoring. The Ai-RIO is expandable with as many as eight units networked together. Added capabilities include I/O, power switching, and mass/SD FLASH memory.

FOR MORE INFORMATION visit **Aitech** online at *www.rugged.com*.

SINGLE-BOARD COMPUTERS

3U OpenVPX single-board computer for harsh environments introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing the SBC329 rugged 3U OpenVPX single board computer as a drop-in replacement for existing users of Abaco's mission-ready embedded computing systems for demanding applications to be deployed in harsh constrained environments. The SBC329 offers a 10 percent performance improvement over its predecessors. It is based on the latest 7th generation Intel Core technology (codenamed "Kaby Lake"). The SBC329 is available in two variants that are pin-compatible with previous versions. For applications prioritizing throughput and performance, the SBC329 is configurable with the Intel Xeon E3-1505M V6 processor operating at 3 GHz. The SBC329 provides advanced security capabilities such as anti-tamper and information assurance, including an inherently secure field-programmable gate array (FPGA), and support for Intel's Trusted Execution Technology.

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

POWER ELECTRONICS

DC-DC converters for COTS military applications introduced by TDK Lambda

TDK-Lambda Americas Inc. in San Diego is introducing the HQA85 isolated DC-DC converters for commercial off-the-shelf (COTS) military and harsh-environment industrial power electronics applications. Rated at 85 watts, the HQA85 has been qualified with methods consistent with MIL-STD-883 and MIL-STD-202. Initially available with 12-, 24-, and 28-volt outputs, the encapsulated quarter bricks accept DC inputs of 9 to 40 volts, withstanding a 50-volt surge for 10 seconds. With typical efficiencies to 90 percent, internal heating is minimized allowing the HQA85 converters to operate in high ambient temperatures to 115 degrees Celsius and a minimum of -40 C. No opto-couplers are used in the design for enhanced reliability at high temperatures and the switching frequency is fixed at 270 kHz for simplified noise filtering.

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

ADVERTISERS INDEX

Military & Aerospace Electronics

GROUP PUBLISHER Alan Bergstein
603 891-9447 / alanb@pennwell.com

EDITOR-IN-CHIEF John Keller
603 891-9117 / jkeller@pennwell.com

EXECUTIVE EDITOR Courtney E. Howard
509 413-1522 / courtney@pennwell.com

CONTRIBUTING EDITOR WESTERN BUREAU J. R. Wilson
702 434-3903 / jrwilson@pennwell.com

ART DIRECTOR Meg Fuschetti

PRODUCTION MANAGER Sheila Ward

SENIOR ILLUSTRATOR Chris Hipp

AUDIENCE DEVELOPMENT MANAGER Stephanie O'Shea
603 891-9119 / stephanieo@pennwell.com

AD SERVICES MANAGER Glenda Van Duyne
918 831-9473 / glendav@pennwell.com

MARKETING MANAGER Gillian Hinkle
603 891-9126 / gillianh@pennwell.com

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EDITORIAL OFFICES
PennWell Corporation,
Military & Aerospace Electronics
61 Spit Brook Road, Suite 401, Nashua, NH 03060
603 891-0123 • FAX 603 891-0514 • www.milaero.com

SALES OFFICES

EASTERN US & EASTERN CANADA & UK
Bob Collopy, Sales Manager
603 891-9398 / Cell 603 233-7698
FAX 603 686-7580 / bobc@pennwell.com

WESTERN CANADA & WEST OF MISSISSIPPI
Jay Mendelson, Sales Manager
4957 Chiles Drive, San Jose, CA 95136
408 221-2828 / jaym@pennwell.com

REPRINTS Jessica Stremmel
717 505-9701 x2205 / Jessica.stremmel@theygsgroup.com

DIRECTOR LIST RENTAL Kelli Berry
918 831-9782 / kellib@pennwell.com

For assistance with marketing strategy or ad creation, please contact PennWell Marketing Solutions
Paul Andrews, Vice President
240 595-2352 / pandrews@pennwell.com

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