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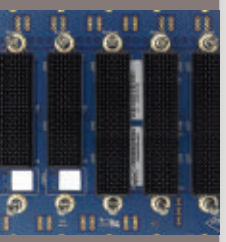





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BY **JOHN KELLER**, EDITOR IN CHIEF

# Military open-systems electronics standards: this time it's going to work

Open-systems industry standards for embedded computing are making another run at the aerospace and defense market, and this time it looks like they're for real.

This latest set of standards like the Sensor Open Systems Architecture (SOSA) is steadily gaining traction in the Pentagon and in the defense business because everybody's on board — the government as well as industry.

The potential benefits of standard electronic architectures seem like a no-brainer: component interoperability, rapid innovation, quick technology insertion, reduced costs to the taxpayer, and the ability for defense systems to keep up with the cutting edge of commercial computer technology.

Still, attempts to formulate open-systems electronics over the past three decades typically have fallen short. The reason is they have been pushed by just one side or the other — government or industry. This time everyone's working together, and this time it looks like it's going to happen.

The linchpin is SOSA, the newest in the latest crop of open-systems electronics standards, and one that borrows heavily from the OpenVPX embedded computing standard of the VITA Open Systems and Open Markets trade group in Oklahoma City. SOSA has gained industry appeal by winnowing-down the large number of standards outlined in OpenVPX to a relatively small number manageable to the military.

What sealed it for SOSA is the so-called Tri-Service Memo, signed one year ago by the secretaries of the U.S. Navy, Army, and Air Force. The memo mandates SOSA and several other standards for all future military requirements in weapon system modification and new-start development programs to the maximum extent possible.

In addition to SOSA, the Tri-Service Memo mentions the Future Airborne Capability Environment (FACE); Hardware Open Systems Technologies (HOST); Vehicular Integration for C4ISR/EW Interoperability (VICTORY); and Open Mission Systems/Universal Command and Control Interface (OMS/UCI). Other new or emerging open-systems standards of influence to the military include Command, Control, Communications, Computers, Intelligence, surveillance and Reconnaissance (C4ISR) / Electronic Warfare (EW) Modular Open Suite of Standards (CMOSS); and Modular Open RF Architecture (MORA).

Not only have the military services voiced their support for SOSA, but each service sends representatives to SOSA standards-formation committees.

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

HOST, for example, saw its beginnings and initial support at U.S. Naval Air Systems Command. VICTORY comes from the Army combat electronics community, FACE primarily is a military avionics project, OMS/UCI is an Air Force project, and MORA came out of the Army Communications-Electronics Research, Development and Engineering Center (CERDEC) at Aberdeen Proving Ground, Md.

Although SOSA seems to have the most influence, it's doubtful that SOSA will evolve into a multi-service, multi-platform, one-size-fits-all standard that will absorb all the others.

The goal, ultimately, is to craft SOSA, FACE, HOST, CMOSS, VICTORY, OMS/UCI, MORA so that these standards are at least 80 percent common. That way, a company that has invested in aligning its products to one standard.

In other words, it's no longer necessary to jump onto one standards bandwagon to the exclusion of all the others. Companies should be able to choose any of these standards for their technology and product development, knowing that they will be at least 80 percent aligned with all the others.

With this kind of top- and mid-level support, government and industry are marching forward together — finally — to craft the high-performance electronic systems of the future.

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Military researchers are trying to enhance the performance of radar and signals intelligence with a new set of advanced computational neural network computing kernels that embed mathematical digital signal processing (DSP) models.

# Researchers to infuse DSP with neural network kernels to enhance radar performance

BY **John Keller**

**ARLINGTON, Va.** — U.S. military researchers are asking industry to develop a new set of advanced computational neural network computing kernels that embed established physics-based mathematical digital signal processing (DSP) models in military applications.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a presolicitation (DARPA-PA-19-03-04) for the Signal Processing in Neural Networks (SPiNN) program.

The SPiNN project seeks to apply neural network signal processing to military communications and radar and make substantial improvements to these applications over what conventional DSP technology could offer.

Accurately communicating multi-dimensional complex modulated signals through non-ideal dynamic communication channels is critical to many U.S. military radar and radio communications applications, DARPA researchers point out.

Conventional DSP techniques recover distorted signals by executing dedicated processing physics models to mitigate impairments sequentially. They assume stationary channel models with Gaussian noise, and therefore have limited capability to process temporal dispersion, non-linear distortions, or interference.

These error-prone cascaded operations are incapable of discovering and mitigating unknown impairments beyond established simple channel models. Such approaches also are computationally intensive, with long latency and poor size, weight, power, and cost (SWaP-C).

Emerging machine-learning techniques promise a new generation of computational approaches with reduced compute complexity and latency. For example, recent advances in Deep Neuromorphic Network (DNN) demonstrate fast feed-forward inference for good accuracy once it is trained with high-quality data sets. Currently, DNNs are trained by data sets and do not use physics-based mathematical models.

Yet missing corner cases and other unseen events beyond the collected data sets often leads to insufficient or misinterpreted representations to cause critical mission failures.

To establish a reliable and accurate DNN model, remote cloud computing facilities are necessary to support a vast computational workload on a large volume of training data. This practice makes DNNs impractical for many U.S. Department of Defense (DOD) machine-learning models.

The Signal Processing in Neural Networks (SPiNN) program will develop a new set of neural network computing kernels that embed established physics-based mathematical DSP models.

The SPiNN program will capitalize on established physics-based signal processing algorithms and mathematical tool kits to establish a set of trained, verifiable, accurate ,and efficient neural network kernels.

SPiNN seeks to transpose important linear and non-linear DSP function blocks such as Fast-Fourier Transform (FFT/iFFT), Multi-Input Multi-Output (MIMO), Matched Filter (MF), Kalman Filter (KF), trellis/Viterbi decoders, and error-correction codes with verifiable outcome and accuracy into pretrained and low latency neural network kernel representations.

These pretrained neural network kernels will be fine-tuned to real-world data, and should outperform traditional DSP models, which lack the inherent capability to capture and process events that are difficult to model.

SPiNN kernels first will build on these verified DSP model sets to establish pre-trained neural network discriminators to process the incoming data with known accuracy, and then will then combine the trained neural network discriminator block with a generative neural network block and adaptive learning transform layer to form a generative-adversarial network kernel.

This kernel will capture corner cases and extract additional hidden structures beyond the known DSP models. The resulting SPiNN adaptive neural network kernels will provide accurate signal processing in real time when facing a dynamic real world environment.

The SPiNN project will depend on the open exchange of data sets and common interface of emulator suites among performers. Once selected for SPiNN, performers must share data set and common interface to the emulation suites.

The first phase of the SPiNN program will develop and demonstrate signal processing kernels based on physics models and adapt the models with a transformer layer.

Each proposal should propose either a communications or a radar applications for these DSP kernels. Communications applications could involve mobile phones, internet of things (IoT), point-to-point link, or cognitive radios.

Radar sensing applications, meanwhile, could involve surveillance radar, moving target indicator radar, synthetic aperture radar, or automotive radars.

*Companies interested were asked to submit proposals by 31 Jan. 2020 to the DARPA BAA Website at https://baa.darpa.mil. The project should begin on 1 April 2020. Email questions or concerns to Young-Kai Chen, the DARPA SPiNN program manager, at SPiNN@darpa.mil. More information is online at https://beta.sam.gov/opp/a09982b4ddc54349a4845f106752ff50/view.*

### Hypersonic weapons are among the nation's highest priorities

Hypersonic weapons have grabbed the attention of the defense industry, with Pentagon Under Secretary of Defense for Research and Engineering Michael Griffin calling hypersonic capabilities "the highest technical priority." With Russia recently announcing its Avangard hypersonic glide vehicle operational, we understand the challenge as the U.S. races to field these advanced hypersonic missile systems. Russia claims Avangard can travel at 27 times the speed of sound and strike "like a fireball," while China contends its Starry Sky-2 hypersonic glide vehicle can evade existing U.S. missile defense systems. And it's not just Russia and China. Technology can proliferate.

### Researchers eye $5 million program for new technologies in detecting deepfakes

Members of Congress say they hope a $5 million prize competition will unlock the secret to automatically detecting deepfakes. The annual defense policy bill, which the president signed into law Dec. 20, called on the U.S. Intelligence Advanced Research Projects Activity (IARPA) to start the competition as a way to stimulate the research, development, or commercialization of technologies that can detect deepfakes automatically. Deepfakes are machine-manipulated media that depict events that never happened. For example, many deep-

# Navy orders 32 TH-73A training helicopters to replace TH-57B/C rotorcraft

**The U.S. is buying the TH-73A helicopter from AgustaWestland, shown above, to replace the service's fleet of Bell TH-57B/C Sea Ranger training helicopters.**

BY **John Keller**

**PATUXENT RIVER NAS, Md.** — U.S. Navy helicopter pilot training experts are ordering 32 TH-73A trainer helicopters from AgustaWestland Philadelphia Corp. in Philadelphia under terms of a $176.5 million contract announced in January.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking AgustaWestland Philadelphia, a wholly owned subsidiary of Leonardo S.p.A. in Rome to provide the TH-73A helicopters to replace the Navy's Bell TH-57B/C Sea Ranger training helicopters, which have been in service since the 1980s.

The TH-73A is based on the AgustaWestland AW119 Koala single-engine jet-powered multi-role helicopter, which accommodates a crew of one or two, and can carry as many as six or seven passengers.

The AW119 has Garmin G1000H glass avionics, with a cockpit design to enhance situational awareness reduce pilot workload.

The helicopter can carry internal loads as heavy as 6,283 pounds, or external loads as heavy as 6,945 pounds. It can fly as fast as 131 knots, at distance to 515 nautical miles, and for as long as five hours and 20 minutes.

The aircraft is 42 feet, 5 inches long; 11 feet, 10 inches high; and has a rotor diameter of 35 feet, 6 inches.

*On this contract AgustaWestland will do the work in Philadelphia; Mineral Wells, Texas; and other U.S. locations, and should be finished by October 2021. For more information contact AgustaWestland Philadelphia online at www.leonardocompany.com, or Naval Air Systems Command at www.navair.navy.mil.*

fakes commonly superimpose one individual's face onto another's person's head as a way to deceive viewers into thinking the first individual said or did things that he or she never did. With the technology becoming more advanced and widespread, the Pentagon now views machine-manipulated media to be a national security issue. Military leaders imagine a digitally altered video that shows a national security leader giving orders they never gave or behaving unprofessionally could cause significant problems and confusion.

### Air Force to craft 5G-powered smart base of the future with big data streaming

As Tyndall Air Force Base in Florida's panhandle continues to rebuild after taking a direct hit from Hurricane Michael in 2018, it's getting not only a makeover, but a 5G modernization, too. The Air Force is working with AT&T to create a "smart base of the future," including reconstructing and transforming the Tyndall 's communications infrastructure with 5G-powered capabilities. Although the base buildout is expected to take three to five years, AT&T will light up 5G in mid-2020, enabling Tyndall to start taking advantage of benefits such as support for augmented and virtual reality. One potential use case he pointed to is supporting flight-line operations massive amounts of data streaming to warfighters using data platforms, sensors and aircraft' onboard systems so that crews on the ground and in the sky can more easily communicate.

### Lockheed Martin to build four MMSC surface warships for Saudi navy

Naval experts at Lockheed Martin Corp. will build four corvette-sized Multi Mission Surface Combatant (MMSC) small surface warships for the government of Saudi Arabia, under terms of an order worth nearly two billion dollars. The MMSC is a variant of the Lockheed Martin Freedom-class littoral combat ship (LCS) that can be configured with a variety of sensors and weapons that help enable interoperability among U.S. naval forces and those of allied navies during joint operations. The MMSC will feature Lockheed Martin COMBATSS-21 combat management system (CMS) to integrate the ship's sensors, communications, and armament. Sensors will include a TRS-4D surveillance and target acquisition radar, a modern fire

# Lockheed Martin to develop hypersonic weapon to attack time-sensitive targets

BY **John Keller**

**ARLINGTON, Va.** — U.S. military researchers are asking Lockheed Martin Corp. to find a way to attack enemy relocatable time-sensitive targets like mobile ballistic missiles with hypersonic ground-launched rocket-propelled smart munitions that can penetrate modern air defense systems.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a $31.9 million contract in January to the Lockheed Martin Missiles and Fire Control segment in Grand Prairie, Texas, for the Operational Fires (OpFires) Integrated Weapon System phase 3 program.

The DARPA OpFires project seeks to enable capabilities for a mobile, ground-launched tactical weapon-delivery system able to carry a variety of payloads to a variety of ranges. This project is asking Lockheed Martin to develop a hypersonic mobile ground-launched tactical weapon able to deliver a variety of payloads to several different ranges.

The project is a three-phase effort that consists of weapon system preliminary design, critical design, and flight testing. In October 2018 DARPA awarded a $9.5 million contract to Sierra Nevada Corp. in Sparks, Nev., to develop an OpFires hypersonic propulsion system.

DARPA officials are pursuing the OpFires project to compensate for limitations of U.S. ground forces in the effective range of surface-to-surface precision fires. OpFires seeks to provide theater level commanders with the ability to strike time-sensitive targets while providing persistent stand-off from enemy counter-fire.

Lockheed Martin will focus on a hypersonic mobile, ground-launched system design, and flight test, including mobile ground launcher and all-up round. The company also will integrate the Sierra Nevada propulsion system into the final design. Flight demonstrations should be in 2022.

The OpFires prototype is not expected to meet all potential operational requirements, but will demonstrate critical system attributes, technologies, and functionality.

Lockheed Martin engineers also will identify and develop critical enabling technologies and components such as weapon command and control; booster thermal management; component technologies; launcher simulations; missile guidance, navigation and control simulations; and system safety.

**Hypersonic weapons will generate tremendous amounts of heat as they fly through the atmosphere at speeds in excess of Mach 5, so electronics ruggedization is essential.**

*On this contract Lockheed Martin will do the work in Grand Prairie, Texas; Huntsville, Ala.; Toledo, Ohio; Elkton, W.Va.; Kirkland, Wash.; and Camden, Ark., and should be finished by January 2021. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com, or DARPA at www.darpa.mil.*

control radar, a multi-function phased array radar, an identification friend or foe (IFF) system, towed hull-mounted and dipping sonars.

### Israeli defense companies developing laser weapons to defeat UAVs, rockets, artillery, mortars and missiles

The Israeli military is developing laser weapons to defeat drones, rockets, artillery, mortars and anti-tank guided missiles, calling the effort a major research breakthrough by its Directorate of Defense Research and Development. Lasers are seen as a major new frontier in combating munitions and unmanned aerial vehicles (UAVs). The U.S. Air Force has used a Raytheon-made high-energy laser to destroy "dozens of small drones," according to the company. Rafael Advanced Defense Systems' Drone Dome can also use lasers to address drone threats. Rheinmetall's high-energy laser has also been used against small drone swarms. Israel has faced an array of threats in recent years, including an armed drone launched from Syria in February 2018, drones that a team attempted to launch from Syria in August 2019, as well as 2,600 rockets fired by militants based in Gaza. Israel's multilayered air defense architecture successfully confronted these threats thus far.

### U.S. military authorities face replacing compromised chips in military computers

Revelations about vulnerabilities in computer chips ubiquitous in U.S. government and military computers — and just how poorly their manufacturer responded to these revelations — show that business as usual leaves our military open to truly staggering attacks. Experts say the U.S. must act with the greatest urgency to ensure that all available security patches are applied to weapons, intelligence systems, and other critical infrastructure. And in some cases, should replace the chips: an expensive, but necessary step. In 2018, researchers discovered security vulnerabilities, known as Spectre and Meltdown, that took advantage of design flaws inside processors that date back to the mid-1990s. The trusted-computing flaws, which primarily (though not exclusively) affect chips manufactured by Intel, persisted through several design generations.

# BAE Systems to build 160 AMPV armored combat vehicles with networked vetronics

BY **John Keller**

**WARREN, Mich.** — Armored combat vehicle experts at BAE Systems will build 160 new U.S. Army Armored Multi-Purpose Vehicles (AMPVs) with vetronics and battlefield networking capability under terms of a $400.9 million order announced in January.

Officials of the Army Contracting Command's Tank and Automotive segment in Warren, Mich., are asking the BAE Systems Platforms & Services segment in Sterling Heights, Mich., to produce 160 full-rate production AMPVs.

This networked combat vehicle is a replacement for the Army's Vietnam-era M113 family of combat vehicles, and will function on the battlefield as an armored ambulance, mortar carrier, engineer vehicle, and command vehicle, as well as a backup to the BAE Systems M2A3 Bradley Fighting Vehicle.

The Army's AMPV program consists of five vehicle variants: general purpose, mission command, mortar carrier, medical evaluation, and medical treatment vehicles.

The AMPV program calls for vetronics and software that adhere to the U.S. military's Vehicle Integration for C4ISR/EW Interoperability (VICTORY) standards, which use an adopt-adapt-author approach independent of specific hardware or software.

The program aims to provide the Army with a survivable and mobile fleet of vehicles to replace the M113. The AMPV capitalizes on the Bradley Fighting Vehicle and M109A7 advanced Paladin self-propelled artillery designs to enable the AMPV to maneuver with other modern combat vehicles in the Army's armored brigade combat team (ABCT).

This order is a modification to a potential $1.2 billion contract awarded to BAE Systems in late 2014 to develop and build the AMPV. BAE Systems engineers are designing the new vehicle to accommodate periodic technology upgrades.

The original 52-month contract called for BAE Systems to build 29 AMPVs across each of the variants. The award also provided an option to begin the low-rate initial production (LRIP) phase.

In 2017 BAE Systems won a $15.2 million order to upgrade the vetronics architecture of the AMPV with battlefield networking capability to enable the AMPV to be part of secure wireless networks to coordinate communications and tactics among other combat vehicles and command echelons, as well as provide networking among the vehicle's on-board systems.

**BAE Systems will build 160 new Armored Multi-Purpose Vehicles (AMPVs), shown above, with digitally networked vetronics.**

*On the latest AMPV manufacturing order, BAE Systems will do the work in York, Pa., and should be finished by February 2023. For more information contact BAE Systems Platforms & Services online at www.baesystems.com, or the Army Contracting Command's Tank and Automotive segment at www.tacom.army.mil.*

# Air Force set to kick-off Unicorn Blue project for digital signal processing and geolocation in SIGINT

BY **John Keller**

**ROME, N.Y.** — U.S. Air Force researchers are ready to kick-off a potential $50 million project to develop digital signal processing (DSP) capabilities that scan through the RF spectrum quickly to detect high priority emissions.

Officials of the Air Force Research Laboratory's Information Directorate in Rome, N.Y., have issued a presolicitation (FA8750-20-R-1001) for the Unicorn Blue project for signals intelligence (SIGINT) and RF geolocation.

The project also will develop technologies to collect, detect, and geo-locate emerging signals of interest to various SIGINT collection systems. The work will include real-time processing to extract the contents of RF transmissions automatically, and provide time-critical alerts and information on the signals collected.

Companies selected will develop prototypes that quickly can be fielded, upgraded, and adapted to emerging requirements. Participants must have top-secret security clearances at the prime level.

A draft request for proposal for the Unicorn Blue project is expected this month, and a formal solicitation should follow in March. Email technical questions or concerns to the Air Force's Daniel Robbins, the Unicorn Blue program manager, at Daniel.Robbins.8@us.af.mil.

*Email contracting questions to Contract Specialist Andrey Selyuzhitskiy at andrey.selyuzhitskiy@us.af.mil, or Contracting Officer Andrew Clark at andrew.clark.25@us.af.mil. More information is online at https://beta.sam.gov/opp/9973adcdfeda4790997d6bec81276ac1/view.*

The Silent CROW system can be configured for a variety of airborne and ground platforms, including a wing-mounted pod for the MQ-1C Gray Eagle UAV.

# Enabling technologies for airborne electronic warfare

High-performance embedded computing, improvements in SWaP, and distributing capability over many different aircraft is helping the military fight in the electromagnetic spectrum.

BY **J.R. Wilson**

Airborne electronic warfare (EW) is heading in different directions as the U.S. Air Force, Navy, Army, and Marine Corps each stake out their own approaches, equipment requirements, tactics, techniques and procedures, and concepts of operation to deal with the rapidly evolving technologies flooding the 21st century world.

The Air Force has abandoned large-scale dedicated manned EW aircraft, the Navy is betting heavily on the Boeing EA-18G Growler, the Marines have eschewed the Growler in favor of equipping aircraft with cyber electronic warfare capabilities, and the Army is building a Multi-Function Electronic Warfare (MFEW) family of systems.

What all four have in common is a broader view of this growing arena, that includes EW, cyber warfare, and

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signals intelligence (SIGINT). Slowly for some, rapidly for others, it all now falls under the umbrella of electromagnetic spectrum warfare.

"Being able to maneuver in the electromagnetic spectrum is a fundamental tenant of all operations and has been for some time," says Air Force Lt. Col. Dan Javorsek, program manager for the Mosaic Warfare Execution Portfolio at the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va. "You can't imagine any modern nation having a program without some expertise in the electromagnetic spectrum. Communications and EW all fit in the same part of the spectrum and you need to be able to manipulate that space.

"The transition to the digital world gives us a lot of new capabilities, but also a lot more things we need to manage," Javorsek continues. "Most of the time there is an opportunity for the system user to modulate and control that, to use EW in an offensive and a defensive sense. If the user has maximum flexibility, which digital systems give us, that emphasis will move around a lot. The more we can control, manipulate and exploit the electromagnetic spectrum, the technology is really agnostic in terms of offense or defense."

**The AN/APR-52(V)1 electronic warfare system increases aircraft survivability and provides threat awareness in complex and dense electronic battlefield environments.**

### Electromagnetic spectrum as a domain

Many now see the electromagnetic spectrum as a major battle domain, to be managed and dominated, with EW a part of that.

"Twenty years ago, we were looking at the world through stovepipes, and EW was mildly interesting, but radar was the system of choice," notes Joe Ottaviano, director of advanced product solutions at the Lockheed Martin Corp. Rotary and Mission Systems segment in Syracuse, N.Y. "As we have moved to digital, multifunction and EW systems have taken the forefront in how the warrior looks at the battlespace. So there has been a maturing of EW from an analog to digital multifunction capability."

Airborne EW also is expanding as technological advances enable unmanned aerial vehicles (UAVs) to take on a growing role. Previously used primarily for intelligence, surveillance and reconnaissance (ISR) and hunter/killer missions, UAVs of all sizes are being considered to be EW platforms.

"With unmanned you do have the ability to do things you couldn't or wouldn't with a manned aircraft, such as projecting farther. There also are opportunities to use those in concert, which comes down to processing, storage, between platform networking, just a lot of computing infrastructure," says David Jedynak, chief technology officer at the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va.

"As we are able to provide more and more capability in a smaller and smaller size, the capability that can go on an unmanned vehicle (UV) can continue to climb — or you can put equivalent capability on a smaller platform," Jedynak says. "That means you can proliferate more EW, by degrees, to more different platforms, including smaller aircraft that couldn't carry the old, heavy equipment."

The main thrust in developing EW UAVs is some level of machine learning and autonomy, he adds.

"There are things that can be done with manned aircraft that are easier than unmanned because the entire loop is within the aircraft and you don't have to worry about latencies or other issues with bandwidth. With a UAV, you're sending a lot of stuff off-platform and the pipes you're using

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**The Advanced Off-Board Electronic Warfare (AOEW) program will deliver persistent electronic surveillance and attack capability against naval threats like anti-ship missiles.**

limit how much you can send," he says.

"Just good data analytics means you may not have to send as much out, then lightweight machine learning can do more, such as recognizing things, and eventually move that out to generate or select techniques to apply to EW. It goes by degrees, from a minimum of making the data more manageable all the way to closing the reaction loop on the UAV, making it much more on its own. At that point, it also applies to manned aircraft."

### Embedded computing for EW

Standardization also is of significant importance in making EW ubiquitous on manned and unmanned aircraft, as is the growing use of data processors like field-programmable gate arrays (FPGAs).

"Open standards, whether you call it a technology or a policy, have made the growth of airborne EW possible. The continued advancement in performance of A/D and D/A converters helps us significantly in what we're doing. The higher the performance of things like FPGAs have continued to enable doing more," Jedynak says.

"Part of that, with FPGA-plus or coupling them with specific processors, is the use of more general-purpose processors, a drive to more heterogeneous computing, where you see an FPGA with onboard processing and a general-purpose processor all setting on the same silicon. Those are good enablers to do more and it can scale up or down."

At the same time, the increasing emphasis on open-systems standards has been called one of the single biggest changes enabling EW. In the past, EW often was more of an add-on, where now it is an upfront, integral part of the requirement. The tri-service importance of continuing to employ open standards was emphasized at the beginning of 2019 when the secretaries of the Air Force, Navy and Army penned a joint memo — which Jedynak termed "quite rare" — calling for adherence to open standards.

John Thompson, director of EW campaigns at the Northrop Grumman Corp. Mission System's Airborne C4ISR Systems division in Falls Church, Va., says EW underpins modern military operations.

"We're watching a drive to be as quiet as possible and when you do emit, do so in a very singular area. It's all tied to survivability. If I'm surveilling, I want it to be very difficult for the other side to locate me — low probability of intercept, because he who emits first, dies," he says. "When you think about EW, you have to look at electromagnetic warfare. I need to control all emissions from my radars and other surveillance systems. Emission control is the name of the game."

### Open-systems architectures

Another change in the advancement of open-systems new technologies is the recognition of adjacent markets — commercial development areas seemingly completely removed from the military, especially an area as militarily-specific as EW, but where close attention by defense contractors can reveal similar design patterns. Such a new view enables different markets to move together, from growth to solutions, taking a solution from one market and putting it into another.

"We're seeing a lot of advances in commercial technology making its way into the DOD marketplace. That is feeding the ability to reduce the volume of our systems — weight and power as well as price — putting added capability into the hands of the warfighter," says Max Pelifian, senior program manager for airborne EW at the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y.

The resulting resonance from a strong adjacent market is good for the defense industry on several levels, from finding solutions that might not have been obvious to pursue from a strictly military perspective to saving DoD research and development money through answers provided by non-defense applications.

"The defense market needs to find the right technologies and vendors who are not necessarily focused only on very-high-volume markets, but are attempting to spread out into many different markets. From a business standpoint, it's a pyramid. At the bottom, you have commodity parts and at the top of the pyramid you have incredibly small markets. In the middle, you have those looking for high-end, strong markets, such as defense and medical, where the demand is not anywhere near consumer markets," says Curtiss-Wright's Jedynak.

"When talking about increasing the pace of change, what you are trying to get into are open standards," Jedynak continues. "You need to make sure you are appropriately looking around the market and not starting down a path that says 'this is used on cell phones, I'll just use that'. Those people don't even want to talk to you because your market is not large enough to allow you to interfere with their development and delivery of the next generation of cell phones, for example."

Open standards and a closer partnership with industry also have dramatically reduced the development time for upgrades. Lockheed Martin's Ottaviano says what was up to a 24-month cycle as little as five years ago has now been shortened to 30 days.

Each service has laid out its own path for the future of airborne EW — approaches that will make open standards, interoperability and commonality even more important.

### U.S. Air Force

The Air Force retired its last dedicated EW aircraft equivalent to the Navy's EA-18G Growler — the IF-111 Raven — in 1998. It still maintains a small fleet of about a dozen EC-130H Compass Call aircraft, which entered service in 1983 and have been in constant use in Southwest Asia and Syria — longer than any other Air Force asset in Afghanistan. That aircraft is now slowly being replaced by the EC-37B Compass Call Re-Host aircraft, the first two scheduled to achieve initial operational capability (IOC) in 2023.

About 70 percent of the EC-37B's prime mission equipment will be rehosted from retiring EC-130H aircraft without modification; the remaining 30 percent will be new or modified. The Air Force projects the new Com-

**The AN/ALQ-217 system functions as the highly sophisticated ears of advanced tactical aircraft and is currently installed on the U.S. and international E- 2C and E-2D Advanced Hawkeye and P-3C type aircraft. [Photo by Northrop Grumman]**

pass Call aircraft will have increased range, speed, endurance and operating altitude for better stand-off range and survivability, better enabling the Air Force to conduct electronic attack in anti-access/area denial.

Although not intended for purely EW missions, the Air Force's new F-35A Raptor joint strike fighter is touted by its prime contractor, Lockheed Martin, as having sufficient organic EW capability that it will not need the support of dedicated EW aircraft.

The F35's AN/ASQ-239 EW system serves as a signals collector system, provides radar warning, identifies the geolocation of electronic emitters, simultaneously tracks multiple aircraft, provides high-gain (i.e., highly focused radio antenna), high gain counter measures and high gain electronic attack through the radar. Lockheed says these EW capabilities will provide wide-frequency coverage, quick reaction time, high sensitivity and probability of intercept, accurate direction finding, multiple aircraft tracking, self-protection countermeasures and jamming.

Those capabilities also will be available on the Marine Corps short take-off/vertical landing (STOVL) F-35B and the Navy's carrier-based F-35C.

"A lot of the things we are doing today at DARPA play a critical role in integrating future EW technologies and aircraft. We want more software-defined systems, which give us more flexibility overall. It allows us to break the vendor lock and bring in third party developers, which is the path we need to go down to preserve our technical advantage in the future," DARPA's Javorsek says.

"Concerto [one of his programs] looks at the more advanced arrays and sensors and systems that produce a tremendous number of options," Javorsek continues. "In the future, as we increase the diversity of the assets we have out there and the number of options within a platform and multi-function capabilities, how do we manage the high level of complexity we are imposing on ourselves so we cause the maximum number of challenges for our adversary without causing the same level of challenges for ourselves?"

### Information and cyber warfare

In 2019, the Air Force created a new information warfare organization to pursue its renewed emphasis on airborne EW and cyber warfare.

"Without question, EW is critical to the operations we conduct. The advancement of technology in the world and the software centric world we operate in today isn't the same as decades ago," says Brig. Gen. David M. Gaedecke, director of the new electromagnetic spectrum superiority office.

"The electromagnetic spectrum as a whole has become much more contested and congested, not just from bad actors, but from cell phones and wireless routers, and commercial security systems," he says.

"Considering the traditional definition of EW — electronic protection, attack, and support — and looking at current Air Force aircraft, there isn't just a single platform or service responsible for EW," Gaedecke goes on. "As we look to the future and the force structure of the Air Force, it's clear on some of our more advanced platforms and our legacy fleet of F-15s, F-16s, B-52s and others, we are always looking for ways for them to operate in this contested and congested electromagnetic environment and at new ways to maintain our competitive advantage."

Adapting UAVs to EW operations "gets to the heart of our future force structure", he adds.

"Remotely piloted aircraft have become a big part of our operations," Gaedecke says. "Electromagnetic spectrum operations are more than just EW, which is a subset of it. We're just operating at different ranges than in the past.

"The new 5G is an example of that, operating across multiple bands and

frequencies as we move toward the software-centric battlespace," Gaedecke continues. "Smartphones are an example, not having a huge programmatic requirement for new capabilities by updating the software. That's what I see in taking some of the individual technologies available to us and maneuvering those into the electromagnetic spectrum at a time of our choosing."

The key for the Air Force is adding capability to existing platforms and enabling existing weapons systems to be survivable and highly capable in the operating environment.

"One of my roles is, as we build the strategy, requirements and design of the Air Force moving forward, is ensuring the EW we're aware of is built into the architecture of new platforms. It's part of transitioning from inflexible hardware solutions to more agile software-defined systems, where we can adapt as fast as software can change," Gaedecke says.

The Air Force commitment to airborne EW and dominating the electromagnetic spectrum also is closely linked to its relationship to the new Space Force, Gaedecke adds.

### U.S. Navy

Dr. Dino Mensa, senior scientist-technology manager for EW technologies at U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md.(NAVAIR), says the Navy also is committed to electromagnetic spectrum dominance and airborne EW provides "reach and agility and the ability to go out and come back without putting boots on the ground".

Which is why the Navy, in addition to the dedicated EA-18G Growler EW aircraft, is looking to equip all its combat aircraft with some level of EW capability, which he says already is greater than most people believe.

"The platforms that have not traditionally been thought of as EW platforms need that to protect themselves," Mensa says. "You also have the traditional players, such as the Growler. It's a rising tide as all platforms look to how they can achieve spectrum dominance and maintain it," he says.

"You have to be able to scale to the power of the aircraft and its mission. That drives what the package is going to be, using the technologies available now and the proliferation of what we can do based on commercially derived

technology," Mensa says. "We also talk about rotary wing aircraft that have less space and power and are already crammed with gear. For unmanned, we have to work around things like interference with data and control links as well as the scalability of EW packages."

As commercial technology has had an ever greater impact on the advances made by potential adversaries, the Navy has recognized the need to abandon decades old military development and procurement cycles.

"In the last three or four years, while the technology has kept advancing, we've had a cultural shift to focus on what technology we can speed to the fleet, to be ready to fight tonight. For the past 10-to-20 years, we were looking at what we could do 10 years down the road. Now we are accepting more risk, looking at what we can do today. We really need to respond fast," Mensa says.

"We still maintain a five-year plan and our program office road maps and science and technology advisors whose job is to think ahead. Develop tonight and deliver tomorrow really focuses on what we can do and I don't see those [and long-range efforts] as competing priorities. But the need to keep pace with our adversaries has been heightened in the last few years.

"In that, I look at the industry more as a partner than a recipient of requirements," Mensa continues. "It's much more productive to have a collaborative exploration of the options and look at requirements as the spirit rather than as a checklist."

Even so, the basic enablers for developments in airborne EW have not changed since the turn of the century, although advancing technology has brought new enablers, as well.

"Miniaturization continues its march, the ability to put more computing power in a smaller space and deal with heat disposition. One of the more recent attention getters is the power of automation and the potential of artificial intelligence deliver autonomous behavior, which is an exciting new field we're exploring and trying to understand how it can make a difference," Mensa says.

"We're a lot more mature now about bolt-on capabilities and what the ripple effects are to other systems. We have more understanding of how complicated the electromagnetic spectrum is and how hard integration is. So we are looking at integration earlier in the development cycle. A pillar of our product output is interoperability and EW is part of that. In the coming decade, we're really going to see leaps and bounds in the synergy of systems."

Northrop Grumman's Thompson says there is an increasing interest in multifunction capabilities by all the services, with the Navy in particular talking about electromagnetic warfare.

"Where previously all systems were built by different companies, then provided to a prime, that can no longer happen; now we have shared apertures, shared processors. Crew is no longer 'in the loop', but 'on the loop'," he says. "In the loop meaning the airframe has a specific target and I agree with that. On the loop means the machine has identified a threat or something that needs to be surveilled and the operator is made aware of that and can change it, but is no longer part of the work. With that comes a lot of issues."

### U.S. Marine Corps

While Air Force and Navy airborne EW concerns tend to be long-range, the Marine Corps is more concerned about the immediate battlespace — although they, too, have long-range needs with respect to their F-35B Raptors.

Having retired the last of their EA-6B Prowler radar-jamming planes in March 2019 and deciding not to acquire its Navy replacement in the EA-18G Growler, the Marines are looking to incorporate the EW mission into nearly all of its aircraft, especially the F-35B and UAVs.

"The Marine aviation approach to electromagnetic spectrum operations is a distributed, platform-agnostic strategy. Marine aviation is integrating EW systems and Intrepid Tiger II payloads across aviation platforms to provide commanders with an organic and persistent airborne EW capability," according to the Corps' 2018 aviation plan.

"The F-35 brings a powerful combination of [EW], weapons, sensors and reduced signature to the [Marine Air-Ground Task Force]. F-35 EW capabilities include emitter geolocation, identification and parametric data sharing via Link 16."

The Intrepid Tiger II is a radio- and radar-jamming pod compatible with most helicopters and fixed-wing aircraft. The Corps is developing it for integration on Marine AV-8B jump jets, UH-1Y transport helicopters, KC-130J aerial tankers and MV-22B tiltrotors, providing communications EW support and electronic attack capabilities. They also plan to add IT II to the current RQ-21 and the future Marine Unmanned Expeditionary (MUX) UAVs, which the aviation plan says will "provide a long-range, persistent, penetrating, responsive, airborne (EW) capability."

BAE Systems, manufacturer of the Raptor's AN/ASQ-239 EW suite, says the system "provides the pilot with maximum situational awareness, helping to identify, monitor, analyze and respond to potential threats. Advanced avion-

ics and sensors provide a real-time, 360-degree view of the battlespace, helping to maximize detection ranges and provide the pilot with options to evade, engage, counter or jam threats."

The Corps also has called on Boeing to upgrade nine MV-22 Osprey Block B aircraft to Block C, which includes enhanced EW capabilities for the tiltrotor platform.


**The Navy Boeing EA-18G Growler electronic warfare jet, shown above, will carry the Raytheon Next-Generation Jammer (NGJ) into future aerial combat.**

### U.S. Army

While not normally considered to be part of airborne operations, the U.S. Army is one of the world's largest rotorcraft and UAV operators.

In 2019, Lockheed Martin was contracted to design, develop and test a cyber/electronic warfare podded system for the "Air Large" component of the Army's MFEW family of systems. The open architecture Silent CROW system is designed to be easily configured for a variety of airborne and ground platforms, including a wing-mounted pod for MQ-1C Gray Eagle UAVs. According to Lockheed Martin, Silent CROW would enable U.S. soldiers to disrupt, deny, degrade, deceive and destroy adversaries' electronic systems through electronic support, electronic attack and cyber techniques.

The Army's new EW strategy calls for enhancing EW and cyber warfare capabilities at the tactical edge and restoring EW at all echelons in response to capabilities exhibited by Russia. Those capabilities are deemed critical as the Army prepares to face new battlefields in which EW will be ubiquitous.

"UAVs have a different problem set than manned aircraft — they can be smaller, longer endurance, different SWaP restrictions. Transitioning into a world where EW is more software defined than in the past opens the door for smaller systems to bring capabilities that did not exist in the past," DARPA's Javorsek says.

"In mosaic warfare, we try to get away from monolithic, high value systems to more distributed systems. UAVs fit into that framework — when needed, they can do EW, ISR or whatever. Today, each of those is a separate federated system and, in the UAV space, you don't have the real estate to work with all those different systems. You need a collaborative system."

New technologies and new applications of those have led to major changes in how the military looks at the modern battlespace.

"From a doctrine standpoint, the overall view of the electromagnetic spectrum as a battlespace as opposed to just an element of a different battlespace is a major change of context, how we think about it and use it. It's not just in support of the airborne battlespace any longer, but is a battlespace in itself," Curtiss-Wright's Jedynak says.

"When you start viewing it in that context, some of the technical thinking changes. It's not just how to put capability 'X' on one aircraft and capability 'Y' on another. With the COTS, open standards architecture view of the world, it means we're no longer making an EW widget for a particular aircraft, but one other aircraft can use as well."

Dominating the electro-magnetic spectrum is integral to 21st Century warfare, with airborne EW playing an especially vital role.

"In the future, you will need to sense your environment, understand what is out there, understand the layout of the battlespace," says John Wojnar, Director-Cyber/EW Convergence Strategies at Lockheed Martin. "Big picture-wise, you will see more airborne data collection, handing off to ground or shipboard systems that are not as SWaP-constrained. It is really customer dependent."

## WHO'S WHO

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**Northrop Grumman Corp. Mission Systemis Airborne C4ISR Systems**
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*https://www.northropgrumman.com/*

# The brave new world of embedded computing backplanes and chassis

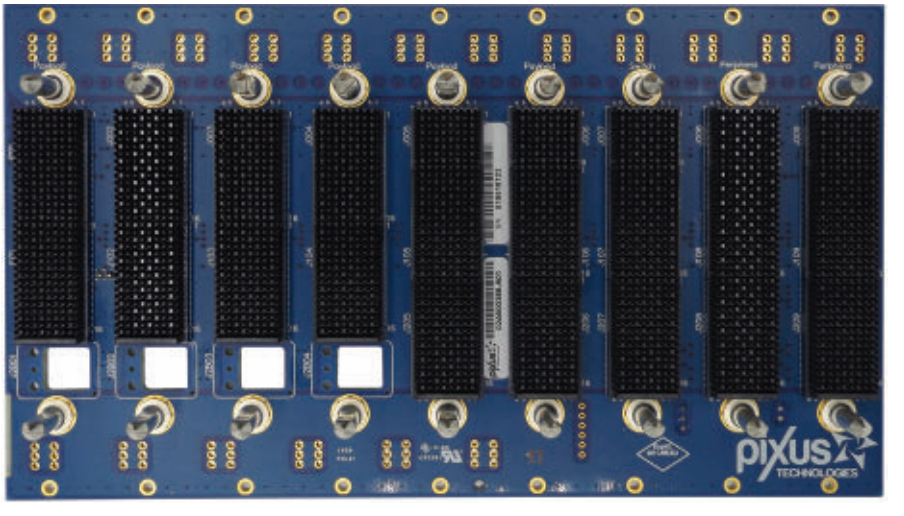
Today's powerful server-grade microprocessors are pushing systems designers toward ever-faster data throughput, innovative power control and thermal management, industry standards like SOSA, CMOSS, and HOST.

BY **John Keller**

Military embedded computing systems based on bus-and-board architectures are advancing quickly on three fronts: data throughput; thermal management; and standards-based designs. These three technology trends promise to bring the latest advances in high-performance computer processors to demanding applications like electronic warfare (EW), signals intelligence (SIGINT), and radar signal processing.

Ruggedized embedded systems enclosures certainly are important, but do not represent the latest trends in embedded systems chassis and databuses, which increasingly reflect new open-systems standards, blended optical and copper interconnects, and electronics cooling approaches to deal with computer boxes that can generate in excess of 2,000 Watts.

It's all part of the latest trends in databuses and enclosures that will produce some of the most powerful embedded computing systems ever developed, which will be designed to accept rapid upgrades, accommodate rapid changes in technologies, and bring server-grade computing to ruggedized digital signal processing systems aboard aircraft, on ships and submarines, and on the latest armored combat vehicles.




**Market trends are generating interest for Gen5 and 100 Gigabit Ethernet for backplanes in the near future, like those made by Pixus Technologies, shown above.**

## Data throughput

Many military embedded computing systems are developed today using the OpenVPX standard of the VITA Open Systems and Open Markets trade group in Oklahoma City, and that means increasingly rapid data throughput. "We really finished out last year with pushing the VPX architecture from 10 gigabits per second per lane to some of the first demonstrations of 25 gigabits per second per lane," explains Michael Munroe, principal backplane architect at Elma Electronic Inc. in Fremont, Calif.

"What's really been driving the last part of last year is moving data rates on three fronts — in VPX itself, in COM Express, and FMC [FPGA Mezzanine Card] — all up into much higher speeds," Munroe says.

"Bandwidth is going up, and it can be networked," says Ken Grob, director of embedded technology at Elma. "From a payload standpoint, there are applications where you need to send lots of data between boxes, or between

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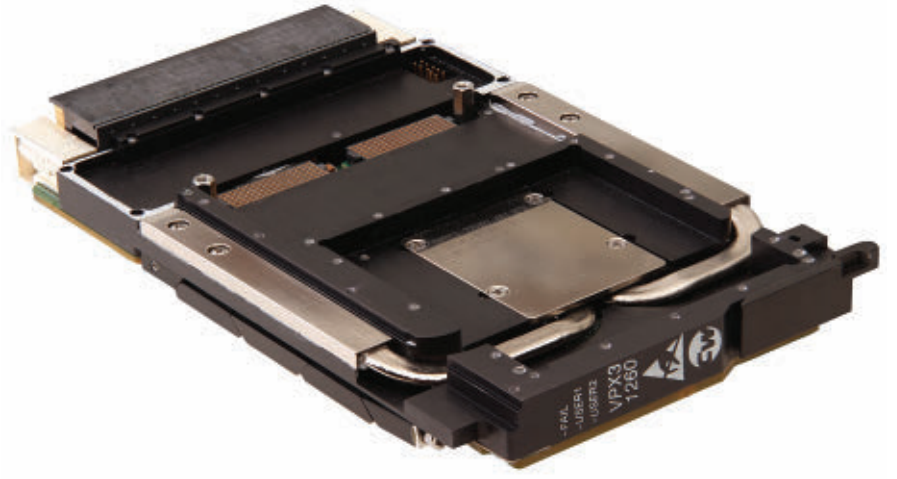


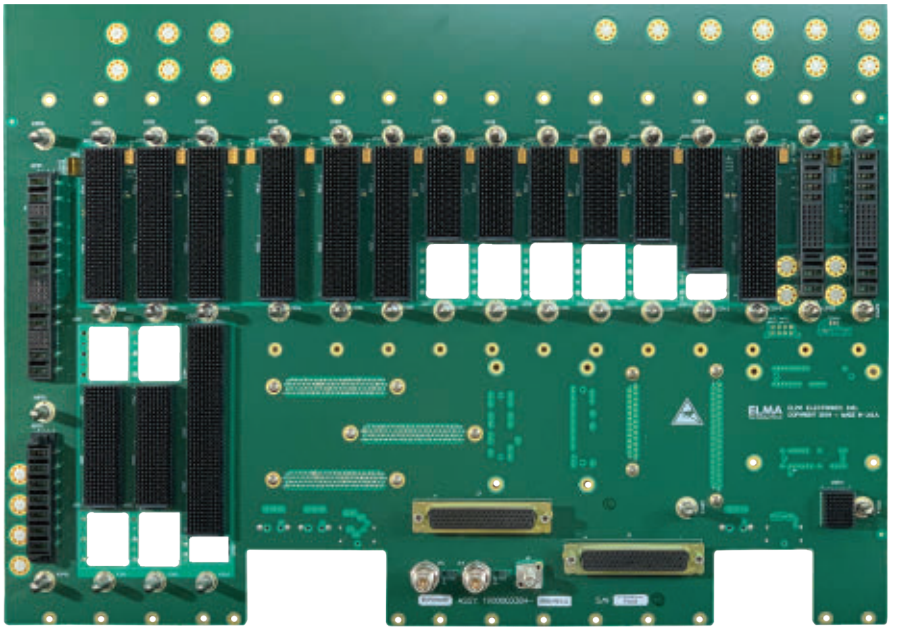

**The VPX3-1260 from Curtiss-Wright is a rugged 3U OpenVPX single board computer featuring the latest 8th Gen Intel Xeon processor with integrated graphics.**

a collection point in the front-end, and distribute it to payload cards."

FMC module interconnects to carrier cards are being pushed to 57 gigabits per second to accommodate blazingly fast microprocessors. FMC modules come in two sizes: 69 millimeters wide — not much bigger than a credit card — and double-width 139 millimeters wide. These modules pack a substantial amount of computing power in relatively small spaces.

"We are seeing higher-speed backplanes; that is certainly a trend," says Justin Moll, vice president of sales and marketing at embedded computing specialist Pixus Technologies in Waterloo, Ontario. "There also is interest in hundred-gigabit speeds."

Moving to that kind of data throughput can require use of the RT 3 connector on the backplane — a high-performance iteration of the VPX backplane databus connector, Moll says. "It has the pin paths that are smaller, and that helps with signal integrity."



**Manufacturers like Elma Electronic are designing backplanes and chassis able to move data as fast as 25 gigabits per second. Faster speeds are expected in the future.**

### Optical interconnects

Such speeds may be approaching the limits of copper interconnects, and in some cases will require use of optical fiber. "Over the last year we saw a big change in fiber-optic development for next-generation processors," Elma's Grob says.

"As data rates get faster and faster, we are outpacing our ability to run over copper, so we are looking at optical fiber," echoes Chris Ciufo, chief technology officer and chief commercial officer at General Micro Systems (GMS) Inc. in Rancho Cucamonga, Calif.

Among the enabling technologies facilitating a move to optical fiber interconnects is the notion of apertures in electronics enclosure designs, says Elma's Munroe. Apertures are cutouts that accommodate coaxial and fiber optic connectors.

"Apertures is a new concept in VPX, where we have some standard cutouts on the backplanes," Munroe says. "The acceptance of apertures helps move data through a Eurocard backplane, and to move cables off the front of the card, and move rugged applications of RF and optical cables onto the rear of the cards."

Use of apertures is described in the ANSI VITA 67.3 standard, Munroe explains. There are about five different apertures, and the three most important are the half-size D aperture, the C full-size aperture, and the E full-plus-half-size aperture. "Industry has moved to at least one-inch slot width, and the larger apertures allow more coaxial and fiber optic contacts."

"The range of connectors in an aperture-type architecture can vary," Mun-

roe says. "It allows a lot of flexibility. The connectors can accommodate a mixture of optical and RF, and the user will find it easy to change these modules. The apertures are only held by a couple of screws and alignment pins."

The spirit of this design approach blends standard and custom design, Munroe points out. "The standard tells you the size of the aperture in the backplane, and where the mating is, but the number of contacts can be done to suit the equipment, and can be changed easily in the backplane," Munroe says. "We can have optical signals going slot-to-slot; it does not require backplanes for these high-speed lanes. They are for optical or RF point-to-point interconnects, to connect to cards or antennas."

Primary applications for aperture-type designs are EW, radar, jamming, different types of frequency hopping, and software-defined radio. The signals go out through the rear of the backplane," Munroe says.

These speed increases didn't just happen overnight; it's been taking place over about the last four to five years, experts say. "We are starting to see the modules actually implemented, with the ability to make a system that is interoperable, and make it quickly," says Elma's Grob. "The technology is becoming real, can be adopted, and can demonstrate interoperability that can be reused and stood-up into different systems. There is momentum building."

## Thermal management

All of these increasing speeds, however, mean generating a growing amount of system heat, which puts pressure on design engineers to devise innovative means of electronics cooling. "The power consumption in these systems is getting much higher — to the point where the P-zero connector at these lower voltages can only handle so much," points out Pixus's Moll. "Power limitation right now is an issue that is coming up, and sometimes we have to put in a special connector to get enough power on the backplane."

GMS's Ciufo characterizes the thermal management challenges that today's embedded computing designers face. "Processors are consuming more and more power, and generating more and more heat. We have been introducing rackmount servers, starting with the Intel Xeon E5, and upgraded to the new Intel Xeon Scalable processor and second-generation

Scalable processors."

Yet the heat continues to rise, he says. "Intel's latest and greatest middle-of-the-road 20- and 24-core Scalable processors consume 150 Watts per processor," Ciufo continues. "Our systems have two to four processors, so easily it can get to 300 Watts for only two processors and 600 Watts for four processors."

Still, today's leading-edge embedded computing systems rely on more than just processors. "Add two artificial intelligence cards from nVidia is another 500 Watts — 250 Watts per processor. These systems easily are consuming in excess of 2,000 Watts and more. No longer is it trivial to air-cool rackmount servers, so we have stepped-up or game."

It's not just GMS that must step-up its game, but also every other high-performance embedded computing designer who seeks to serve this market. "Cooling is kind of the tool kit," says David Jedynak, chief technology officer at the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va. "There are no new physics to magically cool things. At the chassis level, the thermal design can be very focused for the type of platform, but on the board there are only a few ways we can cool them."

For GMS air-cooled chassis and enclosures "we have taken a page out of the VITA 48 playbook, to make sure we are doing managed air flow — essentially to make certain we can cool systems that in excess of 2,000 Watts," Ciufo says. "We are doing computational fluid dynamics to make sure the air moves where it needs to, and moves the heat out of the back of the chassis."

GMS designers are experimenting with different kinds of heat sinks that blend conduction and forced-air cooling. "We have developed more exotic materials for heat sinks," Ciufo says. "We used a combination of active cooling in our heat sinks themselves to make sure they are as efficient as possible. We also hired new engineers to use not just metallic alloy, but also other elements to improve the amount of heat flux you can use to get out the heat. Many of our ATR chassis are conductively cooled from the card to the chassis wall, and then convection cooled along the edge of the chassis."

## Industry standards

Perhaps the most important trend in embedded computing backplanes and chassis involves new and emerging industry standards that seek to promote interoperability, easy upgrades, winnowing-down cumbersome OpenVPX standards into a useful subset, and economical designs for aerospace and defense applications.

One year ago the U.S. secretaries of the Navy, Army, and Air Force issued the so-called "Tri-Service Memo" directing the Pentagon's service acquisition executives and program executive officers to use open-systems standards that fall

**This photo shows an aperture design approach for backplanes and chassis that enables designers to blend optical and copper point-to-point interconnects in the same system.**

under the umbrella of the Modular Open Systems Approach (MOSA) project.

The memo mentions the Sensor Open Systems Architecture (SOSA); Future Airborne Capability Environment (FACE); Vehicular Integration for C4ISR/EW Interoperability (VICTORY); and Open Mission Systems/Universal Command and Control Interface (OMS/UCI).

SOSA, which revolves around the VITA OpenVPX embedded computing standard, focuses on single-board computers and how they can be integrated into sensor platforms. It involves a standardized approach on how embedded systems interrogate sensor data to distill actionable information.

The Pentagon-backed FACE open avionics standard is to enable developers to create and deploy applications across military aviation systems through a common operating environment. It seeks to increase capability, security, safety, and agility while also reducing costs.

VICTORY aims at military vehicle electronics (vetronics) components, subsystems, and platforms interoperability. It is for multi-vendor implementation, and is considered a critical enabler for the Assured Position, Navigation and Time (APNT) program; several programs of record require VICTORY standards. VICTORY focuses on three core areas: tactical systems capabilities; host and network system capabilities; and vehicle system and logistics capabilities.

The OMS/UCI standard concerns a common message set that enables interoperability across several different manned and unmanned weapon systems. It focuses on interoperable plug-and-play software applications that run on a wide variety of systems, and enable designers to integrate new capabilities quickly in much the same way that smart phone users download applications.

Other new and emerging standards that influence today's chassis and backplane designs include Hardware Open Systems Technologies (HOST); Command, Control, Communications, Computers, Intelligence, surveillance and Reconnaissance (C4ISR) / Electronic Warfare (EW) Modular Open Suite of Standards (CMOSS); and Modular Open RF Architecture (MORA).

HOST seeks to decompose military embedded systems into functional blocks to ease system design and reuse of embedded computing hardware and software. It's intended to open systems for several different vendors and avoid locking single vendors into large system designs. Navy leaders are starting to push HOST standards on Navy programs, as well as on Navy vendors. HOST saw its beginnings and initial support at Naval Air Systems Command.

CMOSS is intended to move the embedded industry away from costly, complex, proprietary solutions and

**The Elma small portable OpenVPX development platform is designed to help engineers build next-generation high-throughput embedded computing systems.**

## WHO'S WHO

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**Curtiss-Wright Defense Solutions**
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**Elma Electronic Inc.**
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**ECS Case**
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**FiberQA**
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*www.mrcy.com*

**Pentek Inc.**
Upper Saddle River, N.J.
*www.pentek.com*

**Pixus Technologies**
Waterloo, Ontario
*www.pixustechnologies.com*

**Reflex Photonics**
Kirkland, Quebec
*https://reflexphotonics.com*

**Systel Inc.**
Sugar Land, Texas
*www.systelusa.com*

**TE Connectivity**
Harrisburg, Va.
*www.te.com/usa-en/home.html*
Ultra Communications Inc.
Vista, Calif.
www.ultracomm-inc.com

**VadaTech Inc.**
Henderson, Nev.
*www.vadatech.com*

**ZMicro**
San Diego
*https://zmicro.com*

**This OpenVPX embedded computing system from Elma enables systems designers to blend 6U and 3U cards in the same chassis.**

toward readily available, cost-effective, and open-architecture commercial off-the-shelf (COTS) technologies. It was started at the Army Communications-Electronics Research, Development and Engineering Center (CERDEC) at Aberdeen Proving Ground, Md.

The MORA initiative seeks to create standard RF and microwave systems modules like the embedded computing industry has standardized on circuit card form factors, electronic interconnects, backplane connectors, and electronic chassis. Like CMOSS, it also comes from Army CERDEC. MORA recognizes the embedded computing industry's OpenVPX standards initiative as a potential model for creating open-systems RF and microwave systems standards.

With these kinds of standards, "there is a much higher chance of saying we want to upgrade a system's capability using an open standard interface, and a higher chance you could go to the same or different vendors and have an improved card in that area," says Curtiss-Wright's Jedynak.

"The idea is to consolidate boxes onto cards," says Jason Dechiaro, system architect at Curtiss-Wright. "You can virtualize in a lot of ways, such as no longer needing a SINCGARS box, but have a SINCGARS card in a box." SINCGARS is a legacy anti-jam communications system called the Single Channel Ground and Airborne Radio System.

Industry experts, at least for now, are optimistic that standards like MOSA, SOSA, and CMOSS can enforce vendor interoperability at the bus, board, slot, and chassis level. "We see a lot of positive movement in SOSA, and its influence on various working groups in VPX," says GMS's Ciufo. "We want to get it right this time to have real interoperability among vendors."


# Raytheon to build hundreds of radar-guided air-to-air missiles

**Raytheon is building hundreds of the AIM-120 Advanced Medium Range Air to Air Missile (AMRAAM) for the U.S. and foreign militaries.**

BY **John Keller**

**EGLIN AIR FORCE BASE, Fla.** — U.S. military airborne weapons experts are ordering several hundred of the nation's most sophisticated radar-guided air-to-air missiles for the U.S. Air Force, Navy, and military allies under terms of a multi-million-dollar contract.

Officials of the Air Force Life Cycle Manager Center at Eglin Air Force Base, Fla., are awarding a $768.3 million contract to the Raytheon Co. Missile Systems segment in Tucson, Ariz., for Lot 33 production of the AIM-120 Advanced Medium Range Air to Air Missile (AMRAAM) for the U.S. and foreign militaries.

AMRAAM is one of the world's most advanced all-weather, all-environment medium range air-to-air missiles. The system is an active radar-guided intercept missile with inherent electronic protection capabilities for air-to-air applications against massed penetration aircraft.

This contract involves foreign military sales (FMS) to Australia, Belgium, Canada, Denmark, Indonesia, Japan, Kuwait, Morocco, Netherlands, Norway, Oman, Poland, Qatar, Romania, Saudi Arabia, Singapore, Slovakia, South Korea, Spain, Thailand, Turkey, and the United Kingdom.

The contract includes captive air training missiles, guidance sections, AMRAAM telemetry systems, spare parts, and other production engineering support hardware.

Each AMRAAM lot typically contains between 400 and 500 missiles. The latest version of the missile, the AIM-120D, has improved accuracy via Global Positioning System aided navigation, improved network compatibility, and enhanced aircrew survivability via a two-way data link capability.

The AMRAAM missile has air-to-air and surface-launch versions. In the air-to-air role, the weapon's advanced active guidance section provides the aircrew find targets quickly in challenging environments, Raytheon officials say.

AMRAAM has scored combat victories in Iraq, Bosnia, and Kosovo, Raytheon says. It uses digital technology, micro-miniaturized solid-state electronics, and active radar guidance for air combat and air defense.

Raytheon also is developing the AMRAAM Extended Range missile for ground-based air defense, AMRAAM-ER will enable intercepts at longer distances and higher altitudes.

Procured by 36 countries, the AMRAAM has been integrated onto the F-16, F-15, F/A-18, F-22, Typhoon, Gripen, Tornado, and Harrier combat jets.

*On this contract Raytheon will do the work in Tucson, Ariz., and should be finished by February 2023. For more information contact Raytheon Missile Systems online at www.raytheon.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.*

# Air Force pursues path-agnostic communications using space internet for high-speed decision-making

BY **John Keller**

**WRIGHT-PATTERSON AFB, Ohio** — U.S. Air Force researchers are asking communications and networking experts at two U.S. defense contractors to find new ways to distribute information among land, sea, and air forces quickly to support high-speed decision-making.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, awarded contracts in December to L3Harris Technologies and to Northrop Grumman Corp. for the Defense Experimentation Using the Commercial Space Internet (DEUCSI) program.

This project seeks the ability to move and share data seamlessly among a wide variety of fixed and mobile operating locations using constantly available, high-bandwidth, beyond-line-of-sight communications.

This new capability will be called path-agnostic communications because its users will be able to communicate reliably to any location in the world without explicitly specifying which nodes of a communication network to use.

Air Force researchers awarded a $17.9 million contract to L3Harris Technologies Communication Systems-West in Salt Lake City; and a $9.9 million contract to the Northrop Grumman Technology Services segment in Herndon, Va., for the DEUCSI Call 002 vendor flexibility effort.

The contracts to L3Harris and Northrop Grumman seek to establish the ability to communicate with Air Force and other military platforms via several different commercial space internet constellations using common user terminal hardware elements.

In October the Air Force awarded a $3.6 million contract Lockheed Martin Corp. in Bethesda, Md., and a $2.3 million contract to Ball Aerospace & Technologies Corp. in Boulder, Colo., for the DEUCSI program.

The vision for path-agnostic communications is becoming possible due to the burgeoning commercial space internet, Air Force officials say. Several commercial companies plan to establish space internet constellations consisting of hundreds to thousands of satellites, each to create global internet services.

The Defense Experimentation Using the Commercial Space Internet program seeks to establish resilient, high-bandwidth, high-availability Air Force communications and data sharing capabilities by leveraging developing commercial space internet networks.

This approach differs radically from traditional military satellite communications programs in which the government typically specifies and funds every aspect of the program, Air Force researchers point out.

Instead, taking advantage of the commercial space internet will concentrate government efforts on the few areas that are unique to Air Force applications.

The project has three phases: establish connectivity between several Air Force sites using commercial demonstration satellites and terminals; expand connectivity to many Air Force assets by proliferating user terminals to several locations and vehicle types; and special experiments to address military-unique requirements not otherwise met by commercial space internet vendors.

**The DEUCSI project seeks to move and share data seamlessly among a wide variety of fixed and mobile operating locations using high-bandwidth beyond-line-of-sight communications.**

*For more information contact L3Harris Communications Systems-West online at www2.l3t.com/csw, Northrop Grumman Technology Services at www.northropgrumman.com, or the Air Force Research Laboratory at www.wpafb.af.mil/afrl.*

Northrop Grumman will upgrade the surface-search radar system aboard the company's MQ-8C Fire Scout shipboard unmanned helicopters.

# Northrop Grumman to upgrade radar aboard Navy MQ-8C unmanned helicopters

BY **John Keller**

**PATUXENT RIVER NAS, Md.** — Military unmanned aerial vehicle (UAV) experts at Northrop Grumman Corp. will upgrade a sophisticated surface-search radar system on eight of the U.S. Navy's MQ-8C Fire Scout shipboard unmanned helicopters.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $9.1 million order to the Northrop Grumman Aerospace Systems segment in San Diego to provide eight AN/ZPY-8 radar modification kits for MQ-8C UAVs.

The order includes eight forward-access panel modification kits, non-recurring engineering, and qualification as part of the MQ-8C mission processor unit upgrade. The AN/ZPY-8 Osprey MM radar aboard the Navy MQ-8C fleet is from Leonardo MW Ltd. in Edinburgh, Scotland.

Northrop Grumman is the designer and systems integrator of the MQ-8C Fire Scout, an unmanned version of the Bell 407 helicopter from Bell Helicopter Textron Inc. in Fort Worth, Texas. The manned version of the Bell 407 seats seven, can carry a useful load of 2,347 pounds, flies as fast as 140 knots, and has a range of 324 nautical miles.

The long-range MQ-8C is designed to fly from the decks of destroyers and other naval surface warships to extend the surveillance and reconnaissance range of the Navy's surface ships that are operating away from aircraft carriers and land-based aircraft.

The Navy chose Leonardo MW Ltd. to provide the MQ-8C radar in 2016. Leonardo MW is an arm of the Leonardo-Finmeccania corporation in Rome, which oversees the company's aerospace, defense and security operations in the United Kingdom.

The Leonardo Osprey MM is a multimode surveillance radar for helicopters and fixed-wing aircraft that provides second-generation active electronically scanned array (AESA) surveillance capability. It brings together

wide-azimuth and -elevation electronically scanned fixed antennas with a compact radar signal processor and multi-channel receiver.

Employing high-frequency radio waves, an Osprey-equipped MQ-8C Fire Scout can detect targets at long ranges, at night, and in poor visibility to detect distant threats.

The small-size Osprey MM provides high-performance sea surveillance against difficult targets, as well as land surveillance with wide-swath high-resolution ground mapping, small and low-speed ground target indication, air-to-air surveillance, tracking, and intercept. Osprey MM comes with a variety of antenna sizes, depending on the azimuth coverage to facilitate the MQ-8C's operation to and from unprepared surfaces. It offers persistent surveillance and target detection from high altitudes to enhance MQ-8C fuel efficiency.

Osprey MM's flexible configuration, with antenna size and installation options, its low SWaP, air cooled line replaceable units (LRU), and its open standard interfaces all simplify its integration. On this order Northrop Grumman will do the work in Santa Clarita and San Diego, Calif.; Fort Worth, Texas; and Lititz, Pa., and should be finished by April 2021.

*For more information contact Northrop Grumman Aerospace Systems online at www.northropgrumman.com, Leonardo MW Ltd. at www.uk.leonardocompany.com/en/home, or Naval Air Systems Command at www.navair.navy.mil.*

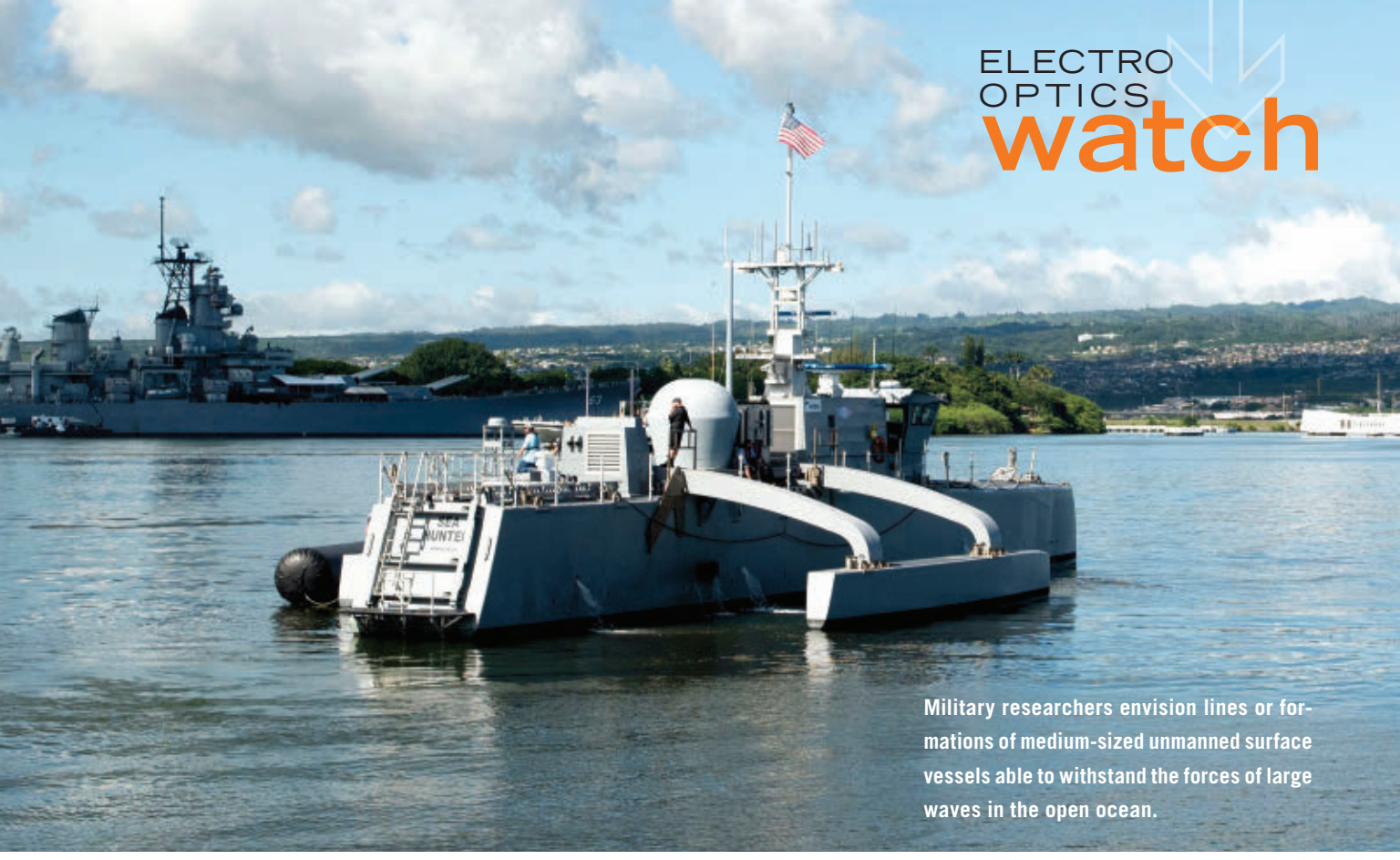


### Plans take shape for bomber aircraft that functions as an arsenal plane

U.S. Department of Defense (DOD) officials may select a bomber aircraft already in the Air Force's inventory to become its munitions-packed arsenal plane, says Will Roper, assistant secretary of the Air Force for acquisition, technology and logistics. The Air Force in June flew its first test flight of the AGM-183A Air Launched Rapid Response Weapon, a hypersonic weapon known as ARRW (pronounced "Arrow").

### Army researchers developing technology to enable unmanned ground vehicles to take-on off-road navigation

While the private sector struggles to perfect self-driving cars for well-mapped and maintained roads, the U.S. Army Ground Vehicle Systems Center (GVSC) in Warren, Mich., has developed a standard set of software and sensors that can turn wheeled and tracked vehicles into off-road unmanned ground vehicles (UGVs). Self-driving civilian vehicles can rely on marked lanes, paving, curbs, and access to GPS and mapping applications. One of the big attractions of 5G networks is how their much greater bandwidth might make self-driving cars safe on the open road. By contrast, an unmanned military vehicle might not even have a map to rely on.



Military researchers envision lines or formations of medium-sized unmanned surface vessels able to withstand the forces of large waves in the open ocean.

# Researchers eye trains of wave-resistant unmanned ships for the open ocean

BY **John Keller**

**ARLINGTON, Va.** — U.S. military researchers are trying to make it easier for military forces to cross the world's oceans by using a system of connected unmanned surface vessels (USVs) that would act as trains across the seas.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a broad agency announcement (HR001120S0010) for the Sea Train project.

This program seeks to enable extended transoceanic transit and long-range naval operations by capitalizing on the efficiencies of a system of wave-resistant connected vessels using a distributed fleet of tactical unmanned ships.

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

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

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

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

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

The first technical area of the Sea Train project involves developing an integrated design composed of a hull form, hull connector, propulsion, and gap mitigation between the vessels.

### Japan wants avionics, radar, and electronic warfare (EW) upgrades for its powerful F-15J jet fighter

The U.S. State Department in late October 2019 cleared the Japanese government to spend up to $4.5 billion upgrading 98 Boeing F-15J jet fighters to a new and greatly-improved standard it calls the Japanese Super Interceptor (JSI). The JSI upgrade includes a wide array of new avionics systems, including Raytheon's AN/APG-82(V)1 active electronically scanned array (AESA) radar and the BAE Systems AN/ALQ-239 digital electronic warfare system — in essence, a powerful radar-jammer. The JSI also could carry new missiles. The JSIs with avionics upgrades could fly alongside the Japanese air force's growing fleet of stealthy Lockheed Martin F-35 Joint Strike Fighters, each type complementing the other. The U.S. Air Force meanwhile is pursuing its own, mixed force of F-15s and F-35s. Stealth fighters are better than conventional planes at avoiding detection owing in part to their ability to carry their weapons internally. But weapons bays displace fuel, resulting in stealth fighters lacking range and payload compared to non-stealthy fighters.

### NRO lets two important remote sensing contracts to improve satellite surveillance

The National Reconnaissance Office (NRO) awarded two first-of-a-kind contracts to study new kinds of commercial satellite surveillance, the spy agency announced. One award goes to Capella Space for commercial synthetic aperture radar (SAR), which can see through cloud cover. The other goes to Hawkeye 360 for remote sensing of radio frequency (RF) transmissions, which include communications and radar. This is not just about sucking up more data: the studies also look at how to check accuracy and incorporate the new information into the NRO's existing databases, able to combine SAR, RF, and visual perspectives on the same target. The agency especially wants to add the rapidly growing capabilities of commercial satellites with its own (expensive) purpose-built birds, creating what the announcement calls an integrated overhead architecture consisting of both national and commercial capabilities.

The second technical area involves developing a control architecture to monitor environmental conditions; handle multi-vessel alignment, spacing, and structural loads.

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

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

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

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

DARPA researchers discourage the use of drag-reduction technologies, such as polymer injection; energy creation, harvesting, or storage technologies; systems that require fuels other than marine diesel systems that require human intervention during connecting and disconnecting; nuclear power and propulsion; and systems that experiment using live animals.

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

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

Sea Train sensors should include techniques that perceive sea conditions for path planning and route optimization identify vessel spacing and orientation identify structural loads; handle vessel autonomy; and decision algorithms for propulsion and fuel consumption.

*Companies interested were asked to submit proposals no later than 20 Feb. 2020 to the DARPA BAA Website at https://baa.darpa.mil. Email questions or concerns to DARPA at HR00112OS0010@darpa.mil. More information is online at https://beta.sam.gov/opp/cc8157fcd8e845f3b5d883fd517172c0/view.*

NIGHT VISION

## Air Force chooses image-intensifier tubes from L3Harris for urgent night-vision upgrades to HH-60 helicopter

U.S. Air Force night-vision experts needed efficient, high-performance image-intensifier tubes for urgently needed upgrades to night-vision goggles for the Air Force HH-60 Pave Hawk special operations helicopter. They found their solution from the L3Harris Integrated Land Systems segment in Tempe, Ariz.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, announced a $93 million contract to L3Harris for high-figure-of-merit green and white image intensifier tubes.

This contract is for image-intensifier tubes for fielding to the Air Force following a combat Air Force urgent operational need for the HH-60 night-vision goggles update for combat search and rescue crews. The Air Force needs 15,424 image-intensifier tubes over the next five years.

The contract also accommodates requests for the high-field-of-merit tubes from other U.S. Department of Defense customers.

An image-intensifier tube is a vacuum tube that increases the intensity of available light in optical systems like night-vision goggles for use in low-light conditions. They convert light photons into electrons, amplify the electrons, and convert them back into photons for viewing.

High figure of merit means high performance and efficiency of a given device, material, or procedure.

The company provides capabilities and technologies to aim and illuminate devices; image intensifier tubes and systems; thermal imaging systems and detectors; high-performance night-vision and fusion goggles; and precision targeting and wireless connectivity.

On this contract L3Harris will do the work in Tempe, Ariz., and should be finished by December 2025. For more information contact L3Harris Integrated Land Systems online at www.l3harris.com.

EMBEDDED COMPUTING

## Abaco to provide U.S. Navy with high-performance embedded computing for training in electronic warfare (EW)

Abaco Systems Inc. in Huntsville, Ala., will provide U.S. Navy researchers with high-performance embedded computing systems for electronic warfare (EW) under terms of a $24 million contract.

Officials of the Naval Research Laboratory in Washington are asking Abaco to build specially developed embedded computing systems known as Multiple False Targets Box Phase two (MFTBOX2) and MFTBOX3 flight units, and spare parts for fleet readiness training exercises in EW jamming.

The flights units are partially-integrated high performance embedded computing systems able to generate advanced EW jamming techniques. NRL will integrate the Abaco computer units with NRL-owned software to enable their EW capabilities.

The Navy will use the MFTBOX2 and MFTBOX3 flight units in fleet training exercises to train Navy radar operators in modern jamming techniques.

The Navy will use these flight units during pre-deployment qualification trials in air-to-air and air-to-surface scenarios. On this contract Abaco will do the work in Huntsville, Ala., and should be finished by March 2020.

For more information contact Abaco Systems online at www.abaco.com, or the Naval Research Laboratory at www.nrl.navy.mil.

SENSORS

## Raytheon to build radar fire-control for Navy Flight III Burke-class destroyers

Shipboard electronics experts at the Raytheon Co. are building additional MK 99 fire-control systems for the Aegis weapon systems on future Flight III Arleigh Burke-class guided-missile destroyers under terms of a $123.5 million order.

Officials of the Naval Sea Systems Command in Washington are asking the Raytheon Integrated Defense Systems segment in Marlborough, Mass., for fiscal 2020 options on MK 99 Aegis fire-control systems equipment.

The MK 99 fire-control system functions as the interface between the Aegis AN/SPY-1 radar and the ship-launched SM-2 family of anti-air missiles. The MK 99 fire-control system communicates with the missile-control station, notifying it of the air threat, and then illuminates the missile's target.

Flight III Burke-class destroyers are the latest versions of the Aegis warship that are scheduled to go to sea beginning in 2023.

The MK 99 also controls the loading and arming of shipboard missiles aboard Burke-class

destroyers and Ticonderoga-class cruisers. The MK 99 launches and provides terminal guidance for the ship's missiles, and controls the continuous-wave illuminating radar to provide a high probability of kill.

This order also covers building Aegis ballistic missile defense kill assessment ordnance alteration kits and solid-state switch assembly test equipment to help enhance Flight III Burke-class destroyer anti-air warfare and ballistic missile defense capabilities.

On this order Raytheon will do the work in Andover, Marlborough, and Burlington Mass; Chesapeake, Va.; Portsmouth, R.I.; and San Diego, and should be finished by April 2023.

For more information contact Raytheon Integrated Defense Systems online at www.raytheon.com, or Naval Sea Systems Command at www.navsea.navy.mil.

RADAR

## Northrop Grumman to provide fire-control radar systems for F-16 upgrades in potential billion-dollar order

U.S. Air Force aerial radar experts are ordering hundreds of modern active electronically scanned array (AESA) radar for F-16 jet fighter aircraft under terms of a seven-year order worth more than a billion dollars.

Officials of the Air Force Life Cycle Management Center, Fighter Bomber Directorate, F-16 Division, at Wright Patterson Air Force Base, Ohio, announced a $1 billion order on 19 Dec. to the Northrop Grumman Corp. Mission Systems segment in Linthicum Heights, Md., for as many as 372 AN/APG-83 AESA radar systems for the F-16.

This order is a modification to a $243.9 million Air Force contract to Northrop Grumman in May 2017 for 72 APG-83 radars, spare parts, and support services.

The bandwidth, speed, and agility of AESA radars enable legacy fighter aircraft like the F-16 to detect, track, and identify many targets quickly and at long ranges, and to operate in hostile electronic warfare (EW) environments.

Northrop Grumman is building APG-83 radar systems for global F-16 upgrades and new aircraft production, as well as for the U.S. Air National Guard. Northrop Grumman also has installed a production APG-83 SABR on a U.S. Marine Corps F/A-18C Hornet jet fighter-bomber, company officials say.

On this order Northrop Grumman will do the work in Linthicum Heights, Md., and should be finished by May 2027. For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

SENSORS

## Arete to provide multispectral unmanned vehicle sensors that help Marines find mines in the beach zone

Electro-optics experts at Arete Associates in Northridge, Calif., are building multispectral unmanned aircraft sensor payloads to help unmanned helicopters detect and pinpoint enemy mines and obstacles in beach surf zones to help keep Marines safe during amphibious attacks.

Officials of the Naval Surface Warfare Center Panama City Division in Panama City, Fla., announced a $17.6 million order to build AN/DVS-1 Coastal Battlefield Reconnaissance and Analysis (COBRA) Block I systems.

Carried on the Navy Northrop Grumman MQ-8 Fire Scout unmanned helicopter, the sensor system has limited detection capability in the surf zone. It enables operators and personnel to remain at safe distances for mine detection. COBRA will be deployed from the littoral combat ship and is an integral part of the ship's mine countermeasures mission package.

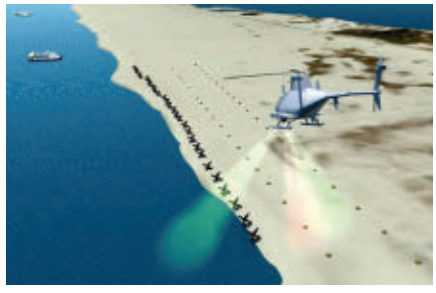
COBRA uses multispectral sensors to conduct unmanned aerial tactical reconnaissance to detect and localize mine fields and obstacles in the surf zone and beach zone prior to amphibious assault.

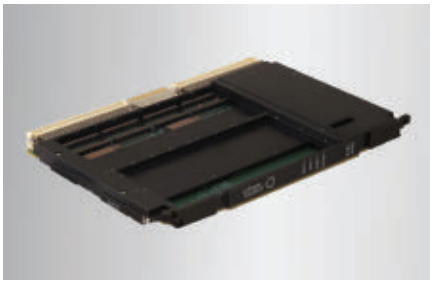
A multispectral image contains data within specific wavelength ranges to extract information the human eye fails to capture with its receptors for red, green and blue.

The AN/DVS-1 COBRA passive multispectral sensor system is for unmanned helicopters to perform daytime surface-laid mine line and obstacle detection in the beach zone, and has off-board processing, Arete experts say.

The COBRA payload includes stabilized step stare digital gimbal, high-resolution multispectral imaging digital camera with spinning six-color filter wheel, a processing unit, and a solid-state data storage unit.

On this order Arete Associates will do the work in Tucson, Ariz.; Destin, Fla.; and Santa Rosa, Calif., and should be finished by July 2022. For more information contact Arete Associates online at http://arete.com, or the Naval Surface Warfare Center Panama City Division at www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Panama-City.





EMBEDDED COMPUTING

## VME board for systems upgrades introduced by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the VME-1910 VME single board computer for system integrators seeking to modernize legacy VME systems. The VME-1910 delivers high-performance multi-core computing and advanced trusted computing capabilities in a board that's pin-compatible with many older generations of VME computer boards without increasing power consumption. The VME-1910 is for use in systems consolidating the functionality of many separate computer board modules into a single board, satisfying demanding storage, data logging, and sensor processing requirements for a wide range of embedded applications and systems upgrades. The VME-1910 features Intel's powerful six-core hyper-threading Intel 8th Gen E-2176M Xeon processor with integrated graphics, support for software security, and delivers 60 percent more processing power than previous four-core designs. The board has as much as 32 gigabytes of DDR4 memory; as much as 256 gigabytes of high-performance NVMe onboard data storage; support for two PMC/XMC expansion mezzanines; and software support for Linux, Wind River VxWorks, Green Hills Software INTEGRITY, Microsoft Windows, and Lynx Software Technologies LynxOS. The board also comes in air- and conduction-cooled versions. For more information contact Curtiss-Wright Defense Solutions online at www.curtisswrightds.com.


INTEGRATED CIRCUITS

## Communications transceiver introduced by Analog Devices

Analog Devices Inc. in Norwood, Mass., is introducing the ADRV9026 wideband transceiver for communications base station applications including single and multi-standard 3G/4G/5G macrocell base stations, massive MIMO (M-MIMO), and small cell systems. The ADRV9026 offers quad-channel integration with low power and small size. The software defined transceiver supports frequency division duplex (FDD) and time division duplex (TDD) standards, simplifying design and reducing system power, size, weight, and costs for 3G/4G/5G applications. The RadioVerse design and technology ecosystem offers a one-stop radio design environment focused on simplifying radio development for a wide range of applications. The RadioVerse RF and microwave ecosystem includes rapid prototyping platforms, chip-level evaluation systems, simulation tools and development kits as well as a global partnership network that provides multiple levels of design support. For more information contact Analog Devices online at www.analog.com.

TEST EQUIPMENT

## Test system for software-defined radio waveforms introduced by Astronics

Astronics Corp. in East Aurora, N.Y., is introducing the ATS-3100 vector signal transceiver-based radio solution (VRS), a turnkey, consolidated radio test platform for field testing of military tactical, land mobile, and avionics radios. The ATS-3100 VRS is the fifth-generation of radio test solutions from Astronics, capable of testing emerging software-defined radio (SDR) waveforms, modern multi-band radios and legacy radios (e.g. SINCGARS) from any original equipment manufacturer (OEM). Leveraging the PXI Vector Signal Transceiver (VST) from National Instruments (NI), the platform delivers the fastest test times and widest bandwidth (to 1 GHz) in a radio test solution, enabling high throughput, reduced mean time to repair (MTTR) and maximum uptime of critical radios in the field. The new ATS-3100 VRS from Astronics Test Systems is an integrated, bench top, software-defined radio test solution addressing radio test needs for legacy, current and next generation technology. The modular architecture eases future upgrades, extends the life of the military radio test system, and allows for flexibility as maintenance needs change. For more information contact Astronics online at www.astronics.com.

POWER ELECTRONICS

## Rugged TDK Lambda DC-DC converter offered by Sager

Electronics distributor Sager Electronics in Middleborough, Mass., is offering the TDK-Lambda i6A4W non-isolated DC-DC converter series of power electronics modules for communications, industrial, test and measurement, and medi-

cal equipment. Capable of operating from an input voltage of as much as 9 to 53 volts, TDK's i6A4W step-down converters deliver an output voltage that can be adjustable from 3.3 to 15 volts or 3.3 to 40 volts. The i6A4W series can operate from existing 12-, 24-, 36-, or 48-volt system voltages to generate additional high-power voltages. It uses less than 0.47 square inches of board area, representing a 60 percent saving compared to 1/16 brick format converters. With efficiencies to 97.5 percent, the power electronics device minimizes power losses to enable the products to operate in harsh ambient temperatures of -40 to 125 degrees Celsius even with low airflow requirements. For more information contact Sager Electronics online at www.sager.com.

CHASSIS AND ENCLOSURES

## Chassis-management module for 3U VPX introduced by Pixus Technologies

Pixus Technologies in Waterloo, Ontario, is introducing the SHM200 chassis-management module for OpenVPX embedded computing systems that complies with the VITA 46.11 specification for system management. The SHM200 comes in 0.8- or 1-inch pitch sizes, and can plug into a standard 3U VPX backplane slot, with versions with just the P-zero connector or the P-zero and P-one connectors for access to extended I/O. Users also can connect a 6U panel to plug into a 6U slot. The standard panel interface has RS-232, RJ-45, USB, and LEDs. Monitoring of at least six temperature sensors and 10 fans is available on the SHM200 with custom options available. There is fan PWM/Tach control, along with 16 digital inputs and outputs. A Level-2 unmanaged 3- port Ethernet hub also is

## PRODUCT & LITERATURE SHOWCASE

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an option. The Pixus SHM200 embedded computing solution also includes a web interface to remotely query the system. Users can import images of their boards. By clicking on the image for each slot, the user can drill down to the monitored status of the module. For more information contact Pixus Technologies online at www.pixustechnologies.com.

INTEGRATED CIRCUITS

## Rad-hard microcontroller for space applications introduced by Vorago

Vorago Technologies in Austin, Texas, is introducing the VA416X0 radiation-hardened ARM Cortex-M4 microcontroller for manned and unmanned spacecraft applications. The VA416X0 comes with and without integrated 256-kilobyte non-volatile memory, incorporates the Vorago Technologies HARDSIL technology, and presents a space-saving semiconductor technology that can shorten the design process, improve reliability, and reduce footprint for the design of mission-critical systems. VA416X0 microcontroller includes industry-standard ARM Cortex-M4 with floating point unit that works as fast as 100 MHz; direct memory access controller; 256 kilobytes of on-chip non-volatile memory; integrated multichannel analog-to-digital converter and digital-to-analog converter; and a range of communication interfaces such as I2C, UART, CAN, SPI, Ethernet, and Spacewire. The part for space applications comes with development kit, with support and service offerings available from Vorago. For more information contact Vorago Technologies online at www.voragotech.com.


SENSORS

## Analog output displacement sensor for high-repeatability introduced by Kaman

The Measuring Division of Kaman Precision Products Inc. in Middletown, Conn., is introducing the SC-2440 off-the-shelf, self-contained analog output displacement sensor for high-precision, and high-repeatability applications. The low-cost SC-2440 requires no calibration and continually monitors the temperature of the sensor. the circuit provides a voltage output of 0.5 to 1.2 volts DC in temperatures from 0 to 70 degrees Celsius. This temperature-proportional voltage can be monitored by a microprocessor or PLC for active correction of the displacement output with changing temperature conditions. Additional features of the SC-2440 system include self-contained electronics, submersible IP-67 rugged housing, a compact build, built-in temperature sensor, fixed gain output, reverse polarity, and short circuit protection. For more information contact Kaman Precision Products online at www.kamansensors.com.

CABLING

## Rugged angled Ethernet cables introduced by ShowMeCables

ShowMeCables, an Infinite Electronics-brand electronics distributor in Irvine, Calif., is offering patented L-com brand Category 6-rated, angled patch cables for Tight-fit and dense-connectivity applications like data centers. These category 6-rated, angled Ethernet cables facilitate cable management, while protecting the connection

within the cable. Non-angled patch cables risk being damaged when they are bent near the boot, breaking the wires inside the cord and severing the connection. These L-com cables are fastened at a specific bend, which does not place stress on any internal wires. ShowMeCables carries 14 angle variations. For more information contact ShowMeCables online at www.showmecables.com.

CONNECTORS

## 2.92-millimeter circuit board connectors for testing introduced by Cinch

Cinch Connectivity Solutions, a Bel group company in Waseca, Minn., is introducing Johnson 2.92-millimeter vertical launch circuit board compression-mount connectors for test and measurement, PC board characterization, and networking applications. The connectors come with and without a side groove, and are designed to provide low return loss values for frequencies to 40 GHz. The side groove connectors enable microstrip or grounded coplanar waveguide (GCPW) designs that are suitable for various board materials and thicknesses. Both are available in two-hole flange mount and the vertical launch design reduces footprint requirements without sacrificing performance. For more information contact Cinch Connectivity Solutions online at https://belfuse.com/cinch.

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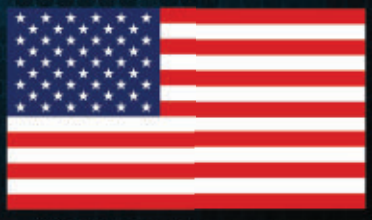

"Server hardware exploits, banned Chinese electronics and a trade war are a wake-up call." *Ben Sharfi, GMS CEO*

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