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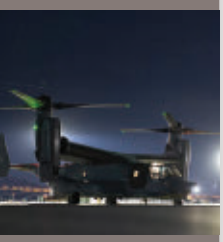

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BY **JOHN KELLER**, EDITOR IN CHIEF

Defense budgets likely to remain healthy during new Biden Administration

We have a new presidential administration, so what does that mean for a defense industry that has gotten used to robust Pentagon budgets over the past four years with plenty of money for technology research and development?

The short answer: it's probably too early to tell. We won't have many hints probably until March — perhaps even as late as May. President Trump did not submit his administration's detailed defense budget proposals to Congress until May 2017, which was about four months after he took office. Most likely we should expect the same from President Joe Biden.

Long term, should we expect drastic defense budget cuts from the new administration? Probably not. We've seen different administrations come and go over the past four decades, with few drastic changes in military spending. The defense budget historically changes slowly, and in a gentle way. It doesn't mirror the sharp highs and lows we see typically in private industry.

There's a lot of money in the U.S. defense budget — many hundreds of billions of dollars every year — and there's no reason we shouldn't expect that to continue in the foreseeable future. There are many military programs and technology-development projects in progress that simply wouldn't make sense to stop now, or even slow down in a big way.

Many defense jobs are at stake, to say nothing about long-established corporate interests in continuing defense spending at healthy levels. We saw some relatively low military budgets during the Clinton years of the 1990s, but that had to do more with a perceived defense dividend at the end of the Cold War than it did with political differences.

After the two Bill Clinton administrations, defense spending increased in a moderate and controlled way during the George W. Bush administrations. There was concern in the defense industry of drastic budget cuts during the administrations of Barack Obama, but much of that fear was overblown. We did have the so-called "fiscal cliff" military budget drawdowns of 2012, but those were relatively short-lived and in many ways had compensation from a variety of budget resolutions to soften the blow.

If the Pentagon budget didn't exactly flourish during the Obama years, there wasn't an historic fiscal disaster, either. Spending remained relatively strong, there was little programmatic upheaval at the Pentagon, and most projects remained intact. Despite one's political biases, there is little chance to expect anything different during the Biden Administration.

It's not as though the defense industry hadn't been preparing for some kind of downslope in defense spending. For at least a couple of years now, many believed that the Trump budgets couldn't continue their upward trend sustainably, and the defense industry planned accordingly.

Less than two years ago Raytheon Co. and the defense division of United Technologies Corp. merged to form Raytheon Technologies Corp. Since Donald Trump took office in 2017, United Technologies bought Rockwell Collins; Harris Corp. and L3 Technologies merged to form L3Harris; and Northrop Grumman bought rocket-maker Orbital ATK. Not long before that, United Technologies sold its Sikorsky helicopter unit to Lockheed Martin — and all this happened during the so-called Trump Bump in defense spending.

During these same heady days, military leaders in the Pentagon also were preparing for a downturn, and discontinued or cut back expensive programs like the B-1 bomber and the Navy's Zumwalt-class land-attack destroyer. If there is to be a noticeable downturn in military spending under the Biden Administration, the Pentagon and defense industry are ready for it.

So what would a defense budget downturn of any size mean for the defense electronics industry? Probably nothing drastic. Spending cutbacks mean keeping existing platforms in the field for longer than anticipated. That translates into systems upgrades that involve advanced electronic technologies.

So should the defense industry fear Pentagon budgets under the Biden Administration? Not likely. Defense budgets will continue to have a lot of money, and it's likely there will be plenty to go round.

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Navy eyes multi-aperture antennas for electronic warfare (EW) on surface warships

BY **John Keller**

SAN DIEGO — U.S. Navy electronic warfare (EW) experts are surveying industry to find companies able to perform communications, electronic support, and electronic attack from the same antenna array aboard naval surface warships.

Officials of the Naval Information Warfare Center-Pacific in San Diego issued a request for information (NIWC_Pacific_MKTSVY_1754EE) on Tuesday for the Active Electronically Steered Array (AESA) and Phased Array Fed Reflector (PAFR) project.

Navy experts want to identify companies able to determine if active electronically steered array (AESA) and phased-array fed reflector antennas can provide wideband high UHF thru SHF transmit and receive capability at very high effective isotropic radiated power and gain over temperature.

These capabilities must come in small size, weight, power consumption, cooling, and cost package. The transmit and receive aperture must be no larger than 73 inches high, 73 inches in diameter, have a deck-mounted support pedestal no higher than 24 inches, and weigh no more than 1,000 pounds.

Navy experts say they need the ability conduct communications, electronic support, and electronic attack operations aboard surface warships from one small aperture to face current and future threats. A wideband high effective isotropic radiated power transmit and receive array across at least S- though X-band, as well as a lower effective isotropic radiated power transmit capacity and receive capacity in L- through Ku-bands is necessary to do this.

Photo (above): Navy experts want to conduct communications, electronic support, and electronic attack operations aboard surface warships from one small aperture.

Given the limits of available shipboard topside space, the Navy wants to make electronic support and electronic attack functions available from the same aperture.

Each proposed solution must be a modular design that can be configured to several different missions, and use technology mature enough to validate in a simulated environment (TRL-6).

Companies interested were asked to submit white papers by 29 Jan. 2021. More information is online at https://beta.sam.gov/opp/74d3976717f24ba7afde06318b48a96c/view.

Lockheed Martin prepares to build another 133 F-35 combat aircraft

Combat aircraft designers at Lockheed Martin Corp. are preparing to build 133 new F-35 jet fighter-bombers for the U.S. Navy, Marine Corps, Air Force, allies, and others under terms of a $903.6 million order. Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md. — the organization handling F-35 aviation technology procurement for all military forces — are asking the Lockheed Martin Aeronautics segment in Fort Worth, Texas, to provide long lead materials, parts, components, and support necessary to maintain on-time production and delivery of 133 Lot 16 F-35 aircraft. The F-35 with its advanced avionics is a fifth-generation single-seat, single-engine, all-weather stealth multirole jet fighter-bomber designed to perform ground attack, aerial reconnaissance, and air defense missions. It is one of the most advanced combat jets in the world. Long-lead items either are difficult and time-consuming to obtain, and are funded early in the aircraft design process to keep overall production on schedule. Contracts to build the actual aircraft will come later. The F-35 is to replace U.S. F-16, A-10, F/A-18, and AV-8B tactical fighter and attack aircraft. Lockheed Martin has been developing the F-35 since 2001. Lot 16 consists of 101 F-35A conventional-takeoff and -landing aircraft, 32 F-35B short-takeoff and -landing aircraft, and 24 F-35C carrier-based aircraft.

Hypersonic weapons soon could fire from surface warships

Hypersonic weapons soon could fire from U.S. Navy destroyers and take off from surface warships at five times the speed of sound from deck-mounted Vertical Launch Systems, fire from bomber aircraft, and shoot up from the ground near the boundaries of space. One in particular is the Tactical Boost Glide (TBG) program of the U.S. Air Force and Defense Advanced Research Projects Agency (DARPA). This project consists of a high-speed rocket that separates from the hypersonic payload, which then glides unpowered to its destination. What would it mean for a Navy ship to have this kind of range and strategic attack envelope? Surely sit would enable surface warships to destroy

Boeing moves to production on electronic warfare (EW) avionics for Air Force F-15 fleet

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio — Electronic warfare (EW) avionics experts at the Boeing Co. are moving from development to production of EW avionics for the U.S. Air Force F-15 jet fighter fleet that will help protect the combat aircraft from radar-guided missiles.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, announced a $79.6 million contract in December to Boeing Defense, Space & Security segment in St. Louis for the F-15's Eagle Passive Active Warning and Survivability System (EPAWSS) low rate initial production.

The EPAWSS provides the Air Force F-15 jet fighter fleet with EW technology to make the most of mission effectiveness and survivability, BAE Systems officials say. It provides offensive and defensive EW options for the pilot.

Low-rate initial production happens after full-scale development and before full-scale production. This state is to produce a small quantity of EPAWSS systems and set a technology baseline for initial operational test and evaluation (IOT&E).

Boeing is the original manufacturer of the 1970s-vintage F-15 Eagle jet fighter, and the BAE Systems Electronic Systems segment in Nashua, N.H., designs and builds the EPAWSS. McDonnell Douglas Corp. designed the aircraft and manufactured it from 1976 to 1996. Boeing bought McDonnell Douglas in 1996 and continued F-15 production through 2019.

EPAWSS also will be part of the avionics suite of the next-generation F-15EX, which is based on the F-15 Advanced Eagle that Boeing is building for the air forces of Qatar and Saudi Arabia, which has a fly-by-wire flight control system, digital electronic warfare (EW) suite, an infrared search and track (IRST) system, and the Raytheon APG-63(v)3 active electronically scanned array (AESA) radar.

The U.S. Air Force F-15EX jet fighter, shown above, will be among the recipients for the Eagle Passive Active Warning and Survivability System (EPAWSS), which has entered production.

Boeing provides planning, design development, integration, testing, and risk reduction activities for the F-15 EPAWSS program, while partner BAE Systems provides EPAWSS design and production.

EPAWSS offers integrated radar warning, geo-location, situational awareness, and self-protection to detect and defeat enemy aircraft, air-to-air missiles, as well as surface-to-air missiles amid dense electronic signals in contested airspace. Its electronic countermeasures enable the F-15 to penetrate enemy air defenses.

The all-digital EPAWSS is smaller than previous F-15 EW systems, and offers improved reliability and maintainability. The Air Force and Boeing chose BAE Systems to design and build the EPAWSS last year to replace the F-15's ALQ-135 EW suite.

Delays in building and deploying the Lockheed Martin F-35 have encouraged Air Force leaders to extend the service life of the F-15 fleet beyond 2040, with upgrades involving new active electronically scanned array (AESA) radars, new EW sensors and processors, and new cockpit displays.

The F-15EX carries more weapons than similar fighter aircraft, and will be able to launch hypersonic weapons that are as large as 22 feet long and weigh as much as 7,000 pounds, Boeing officials say. The F-15EX also is following the U.S. Department of Defense (DOD) DevSecOps initiative to develop secure, flexible, and agile

software and an open-systems avionics architecture.

The F-15EX will be a large, powerful, non-stealthy, twin-engine jet fighter able to carry a large air-superiority weapons payload. The plane will be able to carry as many as 22 AIM-9X Sidewinder and AMRAAM medium range air-to-air missiles.

It also will have a substantially more powerful mission computer than all existing versions of the F-15, new cockpit displays, a digital backbone, infrared search and track (IRST) system, the Raytheon APG-63(v)3 active electronically scanned array (AESA) radar, and the Eagle Passive Active Warning Survivability System (EPAWSS) — an electronic warfare and threat identification system.

The F-15EX also will have terrain-following radar to enable the pilot to fly at a very low altitude following cues displayed on a heads up display. The targeting pod contains a laser designator and a tracking system with a 10-mile range. The plane also will have as many as 11 underwing weapons stations and digital Joint Helmet-Mounted Cueing Systems. The original F-15 jet fighter began development in 1967, and entered service with the U.S. Air Force in 1976.

On this EPAWSS contract Boeing will do the work in San Antonio, Texas, and should be finished by December 2026. For more information contact Boeing Defense, Space & Security online at www.boeing.com, BAE Systems Electronic Systems at www.baesystems.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

enemy land, sea, and air targets operating at otherwise unreachable distances or traveling at speed quite difficult to track. A hypersonic weapon not only could destroy land targets, but also hit fighter jets flying faster than the speed of sound. This expands the operational scope of Navy ships and favors coordinated networked offensive weapons fired from standoff distances safe from enemy fire.

Teledyne Technologies to acquire FLIR Systems electro-optical sensor specialist

Teledyne Technologies Inc. in Thousand Oaks, Calif., has agreed to buy FLIR Systems in Wilsonville, Ore., in an $8 billion cash-and-stock acquisition to expand its electro-optical sensor offerings for the defense industry. “At the core of both our companies is proprietary sensor technologies,” says Teledyne Chairman Robert Mehrabian. “Our business models are also similar: we each provide sensors, cameras and sensor systems to our customers.” Teledyne is a provider of instrumentation, digital imaging products and software, aerospace and defense electronics, and engineered systems. FLIR focuses on intelligent sensing for defense and industrial applications. Teledyne electro-optical products are used in the Boeing Space Launch System for NASA. FLIR and Teledyne provide components for the Lockheed Martin F-35 joint strike fighter.

Boeing to install EPAWSS electronic warfare on F-15 jet fighter fleet

Electronic warfare (EW) avionics experts at the Boeing Co. have won their second large contract within a month to produce EW avionics for the U.S. Air Force F-15 jet fighter fleet that will help protect the combat aircraft from radar-guided missiles. Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, announced a $189.3 million six-year order in January to Boeing Defense, Space & Security segment in St. Louis for the F-15’s Eagle Passive Active Warning and Survivability System (EPAWSS) low rate initial production. The EPAWSS provides the Air Force F-15 jet fighter fleet with EW technology to make the most of mission effectiveness and survivability, BAE Systems officials say. It provides offensive and defensive EW options for the pilot. Boeing is the original manufacturer of the 1970s-vintage F-15 Eagle jet fighter, and the BAE Systems Electronic Systems segment in Nashua, N.H., designs and builds the EPAWSS. McDonnell Douglas Corp. designed the aircraft and manufactured it from 1976 to 1996. Boeing bought McDonnell Douglas in 1996 and continued F-15 production through 2019. EPAWSS also will be part of the avionics suite of the next-generation F-15EX, which is based on the F-15 Advanced Eagle that Boeing is building for the air forces of Qatar and Saudi Arabia, which has a fly-by-wire flight control system, digital electronic warfare (EW) suite, an infrared search and track (IRST) system, and the Raytheon APG-63(v)3 active electronically scanned array (AESA) radar.

Navy orders 35 eCASS test systems to troubleshoot and repair avionics at sea or ashore

BY **John Keller**

LAKEHURST, N.J. — Test and measurement experts at Lockheed Martin Corp. will provide 35 eCASS advanced combat avionics test instruments under terms of a $89.2 million order announced n December.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., are asking engineers at the Lockheed Martin Rotary and Mission Systems segment in Orlando, Fla., to build 35 electronic Consolidated Automated Support Systems (eCASS).

The eCASS equipment is designed to help sailors and Marines to troubleshoot and repair aircraft assemblies and return the avionics to service quickly. The test and measurement systems are for aircraft carriers, amphibious assault ships, or at aviation land bases.

This contract also provides for four self-maintenance and test/calibration operational test program sets, five calibration equipment suites and kits, 36 rack rail kits, 44 shore installation kits, and 28 ship installation kits.

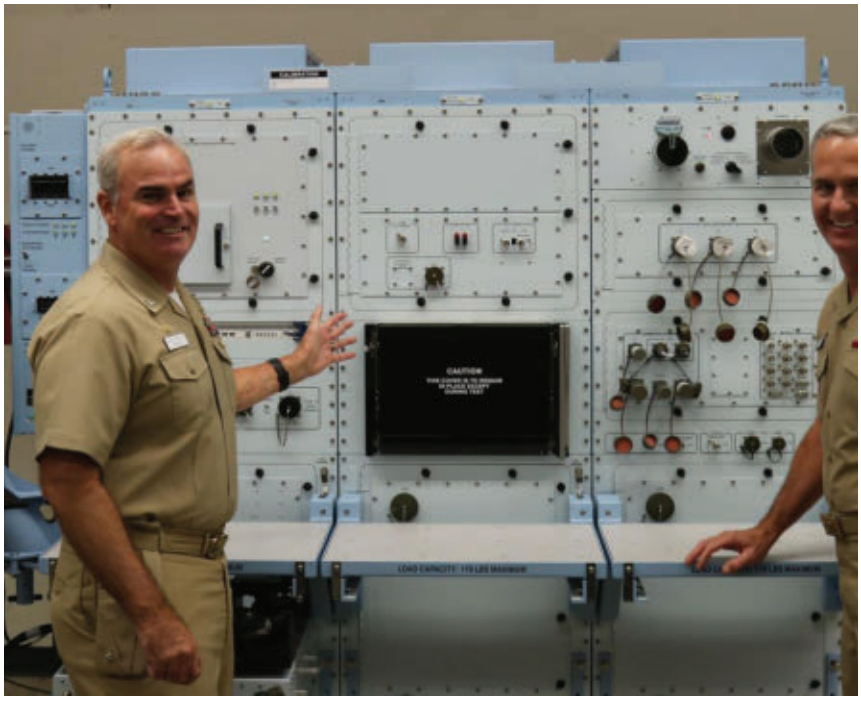
The eCASS test equipment is replacing the Navy's legacy CASS test equipment originally fielded in the early 1990s. CASS is the Navy's standard automatic test equipment family supporting electronics on naval aircraft.

The first eCASS station went to the Navy in February 2014 to support all the aircraft in the Navy's fleet, extending to new weapons systems such as the F-35 Lightning II joint strike fighter. Lockheed Martin won a $103 million low-rate initial production (LRIP) contract in January 2014 for the first 36 eCASS test and measurement stations.

The eCASS station is the workhorse for avionics repair across the naval aviation enterprise, Lockheed Martin officials say. The test gear helps aircraft maintenance technicians return equipment to readiness status quickly and efficiently. Compatibility with legacy CASS stations preserves the Navy's investment in more than 550 test program sets supporting 750 avionics components.

The eCASS architecture is based on the Lockheed Martin LM-STAR commercial automated testing system that is designed to facilitate technology insertion and long-term supportability.

LM-STAR serves as the cornerstone of the F-35 Lightning II harmonization plan, which helps enable several different avionics manufacturers to develop tests to help electronics move from the factory floor to fleet maintenance depots, Lockheed Martin officials say.



The Consolidated Automated Support System (eCASS) helps sailors and Marines troubleshoot and repair aircraft assemblies aboard aircraft carriers and at land bases.

On this contract Lockheed Martin will do the work in Orlando, Fla., and should be finished by December 2023. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or the Naval Air Warfare Center Aircraft Division-Lakehurst at www.navair.navy.mil/lakehurst.

Lockheed Martin to develop hypersonic smart munitions to counter relocatable targets

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking Lockheed Martin Corp. to develop an integrated system 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 $58.9 million order last month 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 contract calls for Lockheed Martin to develop the integrated OpFires system. Last July Lockheed Martin won a $7.4 million contract to develop the OpFires propulsion components.

The DARPA OpFires project seeks to enable capabilities for a mobile, ground-launched tactical weapon system able to carry a variety of smart munitions payloads to several different ranges to attack relocatable targets.

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 standoff 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.

Lockheed Martin will build hypersonic weapon prototypes to attack enemy relocatable time-sensitive targets like mobile ballistic missiles.

On this contract Lockheed Martin will do the work in Grand Prairie, Texas; Huntsville, Ala.; and Elkton, W.Va., and should be finished by January 2022. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com, or DARPA at www.darpa.mil.

Military re-learns the importance of electronic warfare (EW)

Top commanders seek to embed EW capability at virtually all echelons as warfighters seek to make up for years of lost time.

Photo (above): The Menlo Micro MM5130 'Ideal Switch' operates from DC to 26 GHz.

BY **Jamie Whitney**

The need to dominate the electromagnetic spectrum never has been higher for the U.S. military since the end of the Cold War. By using electronic warfare (EW), branches under the Department of Defense (DOD) umbrella can go on the attack and protect American warfighters and military resources.

This fall, the DOD unveiled its Electromagnetic Spectrum Superiority Strategy, which outlines how the U.S. military aims to dominate the electromagnetic spectrum when it is challenged by peer and near-peer adversaries.

"The Department is transitioning from the traditional consideration of EW as separable from spectrum management to a unified treatment of these activities as Electromagnetic Spectrum Operations (EMSO)," Secretary of Defense Mark Esper wrote in the foreword to the publication released in October 2020. "Consequently, this 2020 Department of Defense EMS Superiority Strategy builds on essential objectives from the 2013 DOD EMS Strategy and the 2017 DOD EW Strategy, and takes the Department another critical step forward in implement-

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ing the 2018 National Defense Strategy. This Strategy seeks to align EMS resources, capabilities, and activities across the DOD to support our core national security objectives while remaining mindful of the importance of U.S. economic prosperity. Additionally, this Strategy lays the foundation for a robust EMS enterprise, prepares EMS professionals to leverage new technologies, and focuses on strengthening alliances to achieve the Department's vision of Freedom of Action in the Electromagnetic Spectrum."

The EMS Superiority Strategy includes five goals: develop superior EMS capabilities; evolve to an agile integrated EMS infrastructure; pursue total force EMS readiness; secure enduring partnerships for EMS advantage; and establish effective EMS governance.

The AN/ALQ-217 ESM system functions as the sophisticated ears of advanced tactical aircraft and is installed on the U.S. and international E-2C and E-2D Advanced Hawkeye and P-3C type aircraft.

"U.S. military operations are rarely conducted unilaterally and are increasingly reliant on contributions from our allies and partners," DOD experts write in the strategy. "DOD must ensure EMS enterprise development efforts are interoperable and aligned with our allies and partners and should remove barriers limiting collaboration. This requires interoperable data sources and architectures. The Department will help develop military-to-military agreements, host nation agreements, agreements with the North Atlantic Treaty Organization (NATO), and other allies and partners focused on enabling coalitions the use of their full portfolio of EMS capabilities."

The report continues, "This requires the means (software, data standards, transport channels, etc.) to move and process data at machine speeds with allies and partners. DOD must encourage our allies and partners to adopt, build, or enhance EMS capabilities that will increase our combined coalition EMS capability and capacity with particular focus on near-peer threats. This cooperation includes the need to expand opportunities for coalition EMS testing, training, and education in the United States and abroad."

Jonathan Leitner, the radio frequency (RF) product marketing engineer for Menlo Microsystems Inc. in Irvine Calif., notes that "Battlespace dominance requires the upper hand in tactical and strategic troop and asset capabilities, and superiority with C6ISR — command, control, communications, computers, cyber-defense and combat systems and intelligence, surveillance, and reconnaissance. All of these are inter-

connected in a fabric that is reliant on the electromagnetic spectrum, particularly radio frequencies from HF to millimeter-wave. The U.S. will need to maintain a level of supremacy in the core RF technologies, from the component to the systems level. This will require that domestic companies stay far ahead of adversaries in core research in semiconductors, materials sciences, architectures, software tools, and manufacturing."

Menlo Micro's Leitner notes that the company is making a concerted effort into the aerospace and military sector, including EW, RF front ends, radar, and tactical and military communications systems.

"Menlo Micro has introduced the MM5130, which is currently in production and operates from DC to 26 GHz," Leitner says. "We've coined the term, 'Ideal Switch' as the MM5130 combines the attributes and advantages of mechanical relays with those of solid-state switch technology. We've incorporated the MM5130 Ideal Switch into a new high power MM6000 series reconfigurable filter product. The key advantage of a filter designed using the Ideal Switch are the ultra-low losses of the RF paths, fast switching speeds, and very high-power handling and linearity levels. What is also unique are the extreme levels of ruggedness that the switch and therefore filter can handle. The core MEMS technology of the switch's contact and beam structure have ultra-low mass and thus can withstand very high levels of shock and vibration. Much higher levels than what is capable with traditional RF relays and switches."

Last summer, Liteye Systems Inc. announced the Trailer Anti-UAS Defense System (T-AUDS), with an On-the-Move and Fixed-Site Counter Unmanned Aircraft Systems (C-UAS) solution.

Unmanned EW

Electronic warfare capabilities increasingly are being added to unmanned platforms, whether they

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are in the sky, on the ground, and even underwater.

"Unmanned EW platforms can take humans out of direct conflict, which saves lives, but will limit the ability to discern nuances that only well-trained personnel can detect," says Menlo Micro's Leitner. "This is why EW platforms will still be required for command, control, and communications. Unmanned systems will grow more important as a complementary platform but not as a replacement to piloted ones."

Jeff Bateman, line manager of field-programmable gate array (FPGA) products at Curtiss-Wright Defense Solutions in Santa Clarita, Calif., says that using unmanned vehicles for EW will enable the swarming of large numbers of drones.

"For example, increased sensor bandwidth could be accommodated by upgrading the RF and data converter boards, while upgrading to newer DSP or GPGPU boards satisfies increased processing requirements," Bateman says. DSP stands for digital signal processing, while GPGPU stands for general-purpose graphics processing unit.

Electronic warfare platforms also are following military and aerospace industry trends in embracing open-systems standards.

"Open standards make it easier to build highly integrated, scalable EW systems that can keep up with changing application requirements," says Curtiss-Wright's Bateman. "For example, increased sensor bandwidth could be accommodated by upgrading the RF and data converter board(s), while upgrading to newer DSP or GPGPU boards satisfies increased processing requirements.

"The use of open standards eases integration between different pieces of the EW system technology chain," Bateman continues. "So, you can have a tuner outputting data in a standardized form, such as VITA 49 (VITA Radio Transport) to an FPGA-based device or SBC. The receiving device can then ingest that data in a standardized way then process that data. So, integration of components from different parts of Curtiss-Wright or even different companies is eased by that standardization."

Bateman says that Sensor Open Systems Architecture (SOSA) standards help build upon existing VITA VPX standards.

"SOSA also eases the integration of different types of processing in an EW system, so that you can leverage a wide variety of processing types, for example, FPGA, SBC or GPU processing," says Bateman. "Different types of hardware can be easily and more readily applied in the same physical environment thanks to standard-

Navy Capt. Sacarra Pusey, foreground, an electronic warfare officer, participates in a cyber event at Aberdeen Proving Ground, Md.

ized and defined pin-outs, etc. That means, too, that you can more easily change the system configuration in the future if needed, if, for example, a new higher-performance FPGA or DSP becomes available. Upgrades are simplified because of standardization.

"EW by its very nature is a protean challenge that is continually evolving as adversaries develop new techniques and technologies. To keep up with these ever-changing requirements you need a smooth path for upgradeability, which is why open standards are so attractive," concludes Bateman.

General Atomics' MQ-1C Gray Eagle drone received an EW upgrade via Lockheed Martin's Air Large pod.

Army aerial EW

U.S. Army officials announced last year that they would move forward with an EW pod made by Lockheed Martin to be put on the MQ-1C Gray Eagle unmanned aerial system (UAS). The pod, dubbed "Air Large" by Lockheed Martin, provides the Army with capabilities to jam equipment as well as provide electronics support and sense the EMS.

"Our internal research & development programs have resulted in first-of-its-kind converged technologies that are at the forefront of realizing our customers' urgent need and vision for combined cyber and EW capability and dominance," says Deon Viergutz, vice president of Lockheed Martin's Spectrum Convergence division.

Lockheed Martin has been testing the pod as part of the Army's Cyber Blitz exercise. Army officials plan to have the capability deployed to combat aviation brigades in 2022.

Last year, the Army announced a plan to defeat swarms of EW-enabled air-launched drones with its Air Launched Effects (ALE) family of systems. The Army says that its air-launched multipurpose UAS will be able to act as scouts or decoys, go on the offensive with electronic attacks, and even act as a "suicide drone." The military branch says that the ALEs will be integrated into existing and future unmanned (and manned) platforms.

"ALE is a crucial piece of the Future Armed Reconnaissance Aircraft Ecosystem advanced team concept synergistically enhancing survivability, threat identification, targeting, and lethality of Army aviation brigades and ground force commanders' assets," Army officials say. "The ALE FoS extends tactical and operational reach and lethality of manned assets, allowing them to remain outside of the range of enemy sensors and weapon systems while delivering kinetic and non-kinetic, lethal and non-lethal mission effects against multiple threats, as well as, providing battle damage assessment data. They will provide scalable effects to detect, locate, disrupt, decoy, and/or deliver lethal effects against threats."

Terrestrial counter-UAS

On the ground, U.S. forces and allies must counter UAS armed with EW capabilities alongside traditional munitions.

Last summer, Liteye Systems Inc. in Centennial, Colo., announced its Trailer Anti-UAS Defense System (T-AUDS), with an On-the-Move and Fixed-Site Counter Unmanned Aircraft Systems (C-UAS) solution. T-AUDS, is a Multi-Domain Awareness and Protection package, capable of detecting and defeating RF controlled and silent flight drones while mobile, then transiting from on-the-move to static in less than two minutes, with full capabilities being brought to bear in defense of a location.

The combined system provides an on-the-move 360-degree defensive capability, while several layers of detection, classification and positive identification provide situational awareness and protection. The combination of electronic attack options for the operator provides both a sophisticated machine learning high fidelity

An Area-I Air-Launched, Tube-Integrated, Unmanned System, or ALTIUS, is launched from a UH-60 Black Hawk at Yuma Proving Ground, Ariz., where the Army led a demonstration that highlighted the forward air launch of the ALTIUS.

frequency defeat and a robust directional broad-band defeat to ensure protection from the most serious threats.

Late last year, the U.S. Air Force announced a contract to Black Sage of Boise, Idaho to take down enemy drones with its Tactical High Power Microwave Operational Responder (THOR).

The Air Force Research Laboratory (AFRL) aims to use the CUAS radar system to provide precise targeting data to down enemy drones.

To provide the precise targeting data required by the THOR system, Black Sage utilized its proprietary DefenseOS software to receive and process data from the CUAS radars and export the data to the US military's Forward Area Air Defense Command and Control (FAAD C2). During a successful evaluation, the integrated CUAS radar system, FAAD C2 and THOR weapon targeted and defeated drones.

THOR is a counter-swarm electromagnetic weapon supervised by AFRL for defense of air bases. The system provides non-kinetic defeat of multiple targets. It operates from a wall plug and uses energy to disable drones. The system uses High Power Microwaves (HPM) to cause a counter electronic effect. Targets are identified, the silent weapon discharges in a nanosecond, and the impact is instantaneous.

Naval EW

Last year Dino Mensa, a senior scientist-technology manager for EW technologies at Naval Air Systems Command at Patuxent River Naval Air Station, Md., said 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."

The Navy aims to equip all its combat aircraft with at least some level of EW capability, going beyond the well-equipped EW-ready EA-18G Growler.

"You have to be able to scale to the power of the aircraft and its mission, Mensa told Military & Aerospace Electronics in 2020. "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. 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.

He continues, "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. 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. 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," Mensa concludes.

Collaboration is key

DOD officials also cite collaboration as a key part of its fourth goal listed in the EMS Superiority Strategy: securing enduring partnerships for an EMS advantage.

"Strong international alliances and partnerships are foundational to the Department's ability to execute its complex global missions and conduct effective operations in the EMS

as referenced in the NDS," says the DOD in its strategy.

"The Department must rely on strong international alliances and partnerships to ensure EMS access policies support the U.S. military in conducting its full range of global operations. Successful engagement in the International Telecommunication Union (ITU) treaty processes, including the World Radio-communication Conference (WRC), will help to maximize DOD EMS access where and when needed to meet wartime and peacetime national security objectives. Of note, this successful international engagement begins with effective Department participation in domestic processes."

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Curtiss-Wright Corp. Defense Solutions Division
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General Dynamics Corp. Mission Systems segment
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Leidos
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www.leidos.com

Lockheed Martin Corp. Rotary and Mission Systems segment
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www.lockheedmartin.com

Menlo Microsystems Inc.,
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https://menlomicro.com/

Mercury Defense Systems
Cypress, Calif.
www.mrcy.com/markets/electronic-warfare

Northrop Grumman Corp. Mission Systems segment
Baltimore
www.northropgrumman.com

Raytheon Space and Airborne Systems
El Segundo, Calif.
www.raytheon.com/capabilities/ew

U.S. Army Cyber Center of Excellence
Fort Gordon, Ga.
https://cybercoe.army.mil/home.html

Likewise, the DOD notes that U.S. military operations are infrequently conducted unilaterally, and that must hold true in the world of electronic warfare.

"DOD must ensure EMS enterprise development efforts are interoperable and aligned with our allies and partners and should remove barriers limiting collaboration," says the DOD. "This requires interoperable data sources and architectures. The Department will help develop military-to-military agreements, host nation agreements, agreements with the North Atlantic Treaty Organization (NATO), and other allies and partners focused on enabling coalitions the use of their full portfolio of EMS capabilities. This requires the means (software, data standards, transport channels, etc.) to move and process data at machine speeds with allies and partners. DOD must encourage our allies and partners to adopt, build, or enhance EMS capabilities that will increase our combined coalition EMS capability and capacity with particular focus on near-peer threats. This cooperation includes the need to expand opportunities for coalition EMS testing, training, and education in the United States and abroad."

On the ground

EW systems go beyond shipboard, UAS, and airborne platforms. Last month, the U.S. Army announced that it would be ensure every brigade combat team will have an EW platoon and a separate signals intelligence (SIGINT) network support team.

This gels with the preface penned by Maj. Gen. Robert M. Dyes Jr. for the U.S. Army Concept for Cyberspace and Electronic Warfare Operations 2025-2040.

"Defeating future enemies that possess advanced capabilities calls for land forces operating as part of integrated joint teams that conduct simultaneous and sequential operations across multiple domains," Dyes wrote in 2018. "In multi-domain battle, future Army forces will fight and win across all contested spaces to create windows of advantage across multiple domains that enable Joint Force freedom of action to seize, retain and exploit the initiative.

"The Army will operate in and through cyberspace and the electromagnetic spectrum and will fully integrate cyberspace, EW, and electromagnetic spectrum operations as part of joint combined arms operations to meet future operational environment challenges," Dyes continued. "These operations provide commanders the ability to conduct simultaneous, linked maneuver in and through multiple domains and to engage adversaries and populations where they live and operate. They also provide commanders a full range of physical and virtual, as well as kinetic and non-kinetic, capabilities tailored into combinations that enhance the combat power of maneuver elements conducting joint combined operations."

The evolution of embedded computing chassis, backplanes, and enclosures

High data throughput and innovative thermal management may lead to a revolution in systems design that places the burden of electronics cooling on the enclosure more than on the card.

BY **John Keller**

The traditional embedded computing backplane and design is subject to many pressures these days, such as increasing demands for thermal management, open-systems standards such as the Sensor Open Systems Architecture (SOSA), demands for increased data throughput, steady demands for customization within accepted industry standards, and demands for increased data input/output (I/O).

These pressures are leading to innovations that taken together may be altering embedded chassis and enclosure design in a fundamental way, as systems integrators seek to accommodate rapid upgrades on the chip and board level on the one hand, while maintaining fundamental chassis and backplane design approaches on the other.

The Elma VITA 48.4 liquid flow-through ATR box with a 6U OpenVPX backplane can accommodate as many as eight boards and two VITA 62 plug-in power supplies

Suffice it to say that today's embedded computing chassis and backplanes are far from your father's VME architectures. Pressure to deal with ever-growing amounts of heat, ever-shrinking electronic components and board architectures, and the need to produce ruggedized computing subsystems in ever-smaller form factors will ensure a rapid pace of change for embedded computing backplanes and enclosures.

Thermal management

It's clear that computer components that get too hot do not perform to their designed specifications. The objective, then, is to cool these hot components sufficiently so they can operate at top performance. The problem, however, involves size, weight, and power consumption — better-known as SWaP. Systems designers want high performance in small packages, but the smaller the package, the more heat it generates.

"Thermals and cooling are more and more key," says Ram Rajan, senior vice president of engineering and research at chassis and electronics enclosure specialist Elma Electronic Inc. in Fremont, Calif. A decade or more ago the electronics cooling and thermal management challenge was relatively uncomplicated. Ruggedized systems for avionics or land vehicles featured convection cooling where fans blew heat way from hot components, or conduction cooling where processor heat flowed to card wedge locks and out through the walls of the chassis. For all but the most demanding applications, these approaches were sufficient for many years.

It's different today, however, as embedded computing

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systems are higher performance, yet run far hotter, than ever before. "The trend is going away from air-cooled, and to conduction cooling and liquid cooling," says Elma's Rajan. Driving demands on thermal management are advanced applications such as signals intelligence (SIGINT) and electronic warfare (EW), and ever-more tight packaging for SWaP.

This is leading to new innovations in thermal management within chassis and enclosures. Elma designers, for example, rely on a hybrid cooling approach that combines convection and conduction cooling called Air Flow Through (AFT), which is outlined in the ANSI-VITA 48.8 open-systems standard. Elma's Rajan says these approaches historically have been for niche aerospace and defense applications, or for test-and-development chassis products.

"Compared even to five years ago, the cooling requirements have jumped up significantly because of the higher-Wattage boards," explains Justin Moll, vice president of sales and marketing at Pixus Technologies in Waterloo, Ontario. "Now we need to cool in an air-cooled chassis maybe 2,000 to 2,500 Watts — and in some cases our customers want these to be in rugged deployable chassis."

The Pixus open frame development chassis for OpenVPX/SOSA applications features four VPX power and ground-only slots, four VITA 67.3c cutouts, and SOSA clocking.

There was a time not long ago when this kind of cooling capability came only in chassis intended for benign environments, but not so today. "One thing that is changing is people want that kind of performance in the rugged chassis, as well," Moll says.

While conduction cooling dominated rugged embedded computing systems just a few years ago, the trend today is shifting to approaches that blend-in air cooling like VITA 48.8 designs, he says. "We are seeing more air cooling today over conduction cooling," Moll says.

A similar hybrid electronics cooling approach similar to VITA 48.8 is called Air Flow By, as illustrated in VITA 48.7. Both approaches blend conduction and forced-air cooling to wring the most performance possible out of embedded computing systems.

"We have to have card guides for wedge locks, but there is air going through or passing over the boards," Moll says. "There is definitely much more of a push to flow air over the conduction-cooled boards to supplement the cooling. We are seeing more of that over typical conduction cooling for VPX type of systems."

Because modern embedded computing architectures can generate so much heat, designers are seeing a spike in demand for liquid-cooled chassis and modules. "In the last year we have done more liquid-cooling designs than we had in the previous 20 years," points out Elma's Rajan.

Demand is increasing for extremely high-performance OpenVPX and customized systems, including this Pixus chassis with backplane speeds in excess of 100 Gigabit Ethernet and cooling to 2500 Watts.

Similarly, Pixus experts plan to announce a an electronics enclosure later this year that cools hot components by running liquid through the chassis walls.

Design transformation

The challenges of hybrid and liquid cooling for embedded computing systems are encouraging systems designers to question some of the fundamental chassis and enclosure design issues as seek to find the most efficient solutions for cooling superheated systems, as well as to accommodate rapid systems upgrades and technology insertion.

Modern embedded computing design typically calls for thermal management at the card level. Circuit boards are designed specially to conduction cooling, convection cooling, hybrid cooling, and liquid cooling. Today some experts are starting to question if thermal management should move primarily to the enclosure level, rather than remain at the card level.

"We have watched power density increase year-over-year for the past handful of years, and what's hap-

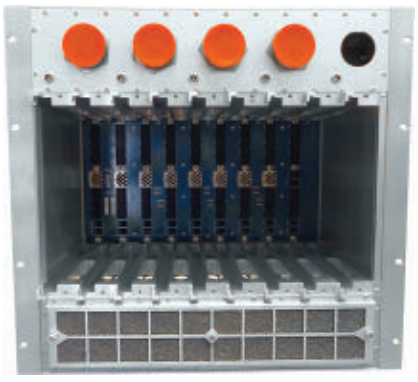
pened is the approach of conduction cooled cards in enclosed chassis has solved the vast majority of the needs for deployed military electronics," explains Jacob Sealander, chief architect for C5ISR Systems at Curtiss-Wright Defense Solutions in Ashburn, Va.

Traditional conduction cooling simply cannot keep up with today's rapid evolution in processor cards. As state-of-the-art processor solutions move from boards to systems-on-chip, the heat generation increases rapidly with the decrease in size of general-purpose processors (GPUs), field-programmable gate arrays (FPGAs), and general-purpose graphics processing units (GPGPUs).

In this situation "you are removing components that are 50 or 60 Watts apiece to components that are 120 Watts apiece, Curtiss-Wright's Sealander says. "Cooling technology is bumping into the same thing as the high-end processors out there, which have employed non-standard cooling technologies. They are not defacto solutions, but are exotic solutions that are becoming more of a mainstay."

While the old VME design approach several years ago resulted in stable and predictable architectures, the rise of OpenVPX has resulted in a fragmenting of industry standards, which can confound systems integrators.

"Cards are all very different designs for liquid and Air-Flow-Through," Sealander says. "One of the things industry is pushing for is not to have such wildly different designs for cooling, because the costs are too great. So we need to ask how can I accommodate these different methods of dealing with heat without dealing with wildly different card form factors."



This Pixus enclosure meets MIL 810 for shock, vibration, and other environmental considerations. It provides supplemental air cooling to dissipate high-power boards.

standards that can deal with high power density. "There will be a continued push for a standardized card that can deal with all the different cooling methodologies," he says.

Despite this, The SOSA and C5ISR/EW Modular Open Suite of Standards (CMOSS) standards still are attempting to standardize at the card-level interfaces, rather than at the box level. That may be in the process of changing.

"People are talking more about solutions these days rather than on hardware like chips and boards," Sealander says. "CMOSS and SOSA are embracing that by standardizing on the hardware to get that pool-of-resources approach that you see in cloud and IT world ... what is the hardware layer we need to get to the desired functionality? CMOSS and SOSA are helping the military electronics market embrace the cloud computing and virtualized space methodology. That's where we need to go because rather than having a computer hardware dedicated to a function, you can have a pool of resources that can achieve that functionality."

This ATR chassis is an example of the high amount of I/O that one box had to accommodate. The unit is about the size of a half-ATR box.

Sealander says Curtiss-Wright is in the initial stages of devising a single-card design that accommodates a wide variety of cooling methodologies, and places the difficult burden of thermal management into the chassis and enclosure. "Rather than designing how the card is cooled, we could put the complexity into the enclosure itself," Sealander says. "The cooling fluid itself could be air, or liquid — both are viable for pulling heat off cards."

This approach could enable embedded computing designers to change card designs quickly to meet customer demands, while using enclosure and chassis designs that could change slowly and accommodate new card designs rapidly. "The enclosure part of the infrastructure could change slowly: the metal box and the cabling. That is where the need is. The electronics is changing quickly, and if we don't want to keep fighting against it, we want to adapt at the speed of technology. With natural conduction or forced-air convection, the cards all have to be different. We are working toward a single card design to take advantage of advanced cooling."

SOSA and standards

SOSA, CMOSS, and related emerging standards seek to take the proliferating OpenVPX standards into a manageable set of guidelines for aerospace and defense electronics designs, which is a driving trend in electronic chassis and enclosures. "The desire for systems to support what were previously multiple, physically separated functions on one converged system is driving the need for more cores and support for virtualization," says Peter Thompson, vice president of product management at Abaco Systems Inc. in Huntsville, Ala.

The U.S. military services also are increasing their support for SOSA, CMOSS, and a variety of other related open-systems standards. The U.S. secretaries of the Navy, Army, and Air Force have 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 under the umbrella of the Modular Open Systems Approach (MOSA) project, of which SOSA is a part.

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.

CMOSS is intended to move the embedded industry away from costly, complex, and proprietary solutions and 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 SOSA effort is an area where there is significant activity," says Pixus's Moll. "It is using backplanes that employ some variation of VITA 66 for optical and VITA 67 for RF interfaces over the backplane.

Backplane speeds

Systems designers also are demanding increasing data throughput from backplane and enclosure manufacturers. "The speeds of the backplane are increasing from the PCI Express Gen 3 type of speed of eight gigabaud. Now 40 gigabit Ethernet is becoming common, but in the future we are seeing PCI Express Gen 4, and eventually 100 Gigabit Ethernet," Moll says. "Together with these faster boards, the drive is more speed in less space."

Abaco's Thompson also identifies 100 Gigabit Ethernet interconnects and switches as a major trend in what Abaco's customers are looking for. Echoes Elma's Rajan, "We are getting more and demands for 25-gigabit backplanes. For that you would need PCI Gen 4 for any of the high signaling."

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TE Connectivity
Harrisburg, Va.
www.te.com/usa-en/home.html

Ultra Communications Inc.
Vista, Calif.
www.ultracomm-inc.com

VadaTech Inc.
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Raytheon to start full production of covert Silent Knight aircraft radar

BY **John Keller**

MacDILL AIR FORCE BASE, Fla. — Aircraft radar experts at Raytheon Technologies Corp. will start full production of covert terrain-following radar to enable military aircraft to infiltrate enemy territory by hiding in mountain passes, valleys, and in bad weather under terms of a $235.6 million five-year order.

Officials of U.S. Special Operations Command at MacDill Air Force Base, Fla., are asking the Raytheon Intelligence & Space segment in McKinney, Texas, to build and deliver the Silent Knight radar system.

Silent Knight is an above-K-band multi-aircraft terrain-following and terrain-avoidance radar designed to enable Special Forces aircraft to infiltrate dangerous areas undetected and at night with reduced risks of crashing while flying at low altitudes.

The radar is designed for the Lockheed Martin MC-130J four-engine turboprop; Boeing MH-47G heavy-lift helicopter; Sikorsky MH-60M medium-lift helicopter; and the Bell Boeing CV-22 block 30 tiltrotor aircraft.

Special Operations commanders need aircraft capable of flying at low altitudes covertly at night to insert and remove commando forces for operations behind enemy lines.

The system also provides navigation support, ground mapping, and weather information to air crews. The radar has advanced terrain-following and -avoidance capabilities and will be lighter and require less power than its predecessors. Raytheon's principal partners on the Silent Knight radar include DRS Technologies in St. Louis, and Collins Aerospace in Cedar Rapids, Iowa.

The Silent Knight radar operates at low-power levels to reduce its chances of being detected by enemy passive RF receivers. The system also has color weather tactical data displays to enhance pilot situational awareness.

Essentially the Silent Knight radar system enables MC-130J and other Special Forces aircraft to fly close to the ground — hugging low spots in mountain passes, valleys, and other terrain features — even when darkness and bad weather cause zero-visibility.

The system's sophisticated weather radar also enables the aircraft to hide in clouds, fog, dust, rain storms, and total darkness at very low altitudes. Its radar can pick out key details like electrical towers and high-tension power lines while providing pilots with enough warning to avoid them.

The covert Silent Knight radar system from Raytheon helps Special Operations aircraft infiltrate enemy territory at night and in bad weather.

On this contract Raytheon will do the work in McKinney, Texas, and Forest, Miss., and should be finished by July 2025. For more information contact Raytheon Intelligence & Space online at www.rtx.com, or U.S. Special Operations Command at www.socom.mil.

Army to add EW and SIGINT systems on brigade combat team armored combat vehicles

The U.S. Army has worked furiously to develop new electronic warfare (EW) capabilities by rebuilding what it divested after the Cold War, and is building new units that must operate these emerging EW systems. As part of what the Army calls new force design updates, every brigade combat team will have an EW platoon and a separate signals intelligence (SIGINT) network support team. Both formations will operate the forthcoming Terrestrial Layer System Brigade Combat Team (TLS-BCT) — the Army's first integrated EW, SIGINT, and cyber platform — mounted on Stryker armored combat vehicles. Two companies, Lockheed Martin and Digital Receiver Technology, are building prototypes for the Army, which today lacks electronic attack assets organic to brigades.

BAE Systems to install EW self-protection to defend P-8A Poseidon aircraft

BAE Systems received a $4 million contract from the Navy for a quick-turnaround demonstration of a new radio frequency countermeasure system for the P-8A Poseidon aircraft. The electronic warfare (EW) system will be a lightweight pod mounted to the aircraft that will add self-protection capability to the Poseidon. It consists of a small jammer, a high-powered amplifier, and the AN/ALE-55 Fiber-Optic Towed Decoy, and lures enemy missiles away from the aircraft to the towed decoy. BAE Systems will design, build, integrate and ship the aviation self-protection system in around five months followed by two months of flight testing on the Poseidon, beginning in early 2021. This rapid timeline stems from collaboration of small focus teams that developed an approach to the system's mechanical parts, company officials say. This effort reduces the process to five or six months from the 18 to 24 months it used to take.

Army fortifies radio communications to withstand enemy EW jamming

U.S. Army radio experts made critical advancements in 2020 to strengthen the radios they plan to use for multi-domain operations in contested and congested environments. Army experts worked with Persistent Systems LLC in New York City and Silvus Technologies Inc. in Los Angeles to bolster radios to stand up to electronic warfare (EW) attacks from adversaries such as China and Russia. The radios are "very, very difficult to jam," says Dan Duvak, chief of the RF Communications division of the Army's Combat Capabilities Development Command's C5ISR Center — Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance — at Aberdeen Proving Ground, Md. The new radios can avoid enemy jamming by detecting and evading interference, as well as by operating on reduced power, Duvak says. Radios from each company were among the most promising capabilities at the C5ISR Center's Network Modernization Experiment.

Lockheed Martin to equip the F-35A combat jet with AARGM-ER anti-radar missile

BY **John Keller**

EGLIN AIR FORCE BASE, Fla. — U.S. Air Force electronic warfare (EW) experts are ready to enable the F-35A joint strike fighter to attack and destroy enemy air-defense radar installations.

Officials of the Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., have announced a $9.3 million contract to the Lockheed Martin Corp. Aeronautics segment in Fort Worth, Texas, to integrate the U.S. Navy Advanced Anti-Radiation Guided Missile-Extended Range (AARGM-ER) into the F-35.

The AGM-88G AARGM-ER is a new and advanced radar-killing missile designed to enable U.S. jet fighter-bombers suppress enemy air defenses preceding bomber attacks.

Fitting the AARGM-ER to the Air Force version of the F-35 will enable the aircraft to join the Navy EA-18G Growler carrier-based electronic warfare jet in carrying out air-defense radar suppression missions.

The AARGM-ER is an advanced and extended-range version of the High-Speed Anti-Radiation Missile (HARM). It is a new variant of the AGM-88E missile that equips Navy carrier-based fighter-bombers and electronic warfare jets. HARM was a replacement for the AGM-45 Shrike anti-radiation missile, which was in service from 1965 to 1992.

AARGM is a supersonic, medium-range, air-launched tactical missile compatible with U.S. and allied strike aircraft. The AARGM-ER missile features several upgrades to the AGM-88E that focus on extending the weapon's operational range and survivability.

The AARGM-ER replaces the missile's rocket motor and tail to increase its range, while keeping the sensors and electronics of the AARGM-88E, which are being upgraded in a separate project. The AARGM-ER missile is scheduled to achieve initial operating capability (IOC) and start being fielded to Navy squadrons in 2023.

AARGM provides the U.S. Navy, U.S. Marine Corps, Italian air force, and now the U.S. Air Force with a weapon system for engaging and destroying enemy air defenses and time-critical, mobile targets. The AARGM also has precise Global Positioning System (GPS)/inertial navigation system (INS) guidance and network-centric connectivity.

The AARGM offers advanced signal processing and improved frequency coverage, detection range, and field of view, compared to earlier versions of the HARM system. It has time-critical standoff strike with supersonic GPS/INS point-to-point or point-to-millimeter-wave-terminal guidance.

It also has missile impact zone control to prevent collateral damage through tightly coupled, digital terrain elevation database-aided GPS/INS, as well as counter-emitter shutdown through active millimeter-wave-radar terminal guidance.

The F-35 with its advanced avionics is a fifth-generation single-seat, single-engine, all-weather stealth multirole jet fighter-bomber designed to perform ground attack, aerial reconnaissance, and air defense missions. It is one of the most advanced combat jets in the world.

The AARGM-ER is an advanced and extended-range version of the High-Speed Anti-Radiation Missile (HARM), which is designed to kill enemy fire-control radar sites.

For more information contact Lockheed Martin Aeronautics online at www.lockheedmartin.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

The GQM-163A Coyote supersonic target drone to help train ship crews to attack and defeat incoming hypersonic weapons.

Northrop Grumman to build 19 GQM-163A drones for training defenders to fight hypersonic cruise missiles

BY **John Keller**

PATUXENT RIVER NAS, Md. — Aerial target experts at the Northrop Grumman Space Systems segment (formerly Orbital ATK) in Chandler, Ariz., are building supersonic target drones for the U.S. Navy and Army to help hone missile-defense skills — particularly against hypersonic weapons.

Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced a $57.1 million order to Northrop Grumman to build 195 GQM-163A lot 14 Coyote supersonic sea skimming target base vehicles — 16 for the Navy and three for Japan.

The Navy will use the supersonic target drones to help surface warship crews practice how to detect and defeat incoming supersonic anti-ship missiles. The Army also uses the Coyote to test and evaluate the Lower Tier Air and Missile Defense Sensor (LTAMDS) limited user test target system.

LTAMDS, under development by Raytheon Co. and Lockheed Martin Corp., is to be an advanced 360-degree land-based missile-defense radar system to replace the ageing Patriot missile system that has been in the U.S. inventory for more than three decades.

The GQM-163A Coyote supersonic sea skimming target provides an affordable target to simulate supersonic sea-skimming and other emerging supersonic and hypersonic cruise missiles. It also supports research in ship-defense systems and fleet training.

The supersonic target drone is designed to help Navy ship crews

learn to defend themselves against modern anti-ship missiles like the French Exocet and the Russian-made SS-N-22 Sunburn and SS-NX-26 Oniks, which may be operational with military forces in Iran, Syria, and other countries in the Middle East.

The Coyote drone also could help surface warship crews and land-based counter-missile battery crews learn to fight effectively against a new generation of hypersonic cruise missiles that could reach speeds of Mach 5 or faster.

The Sunburn anti-ship missile can fly at three times the speed of sound, giving targeted vessels little time to react. It carries a 705-pound explosive warhead — twice the destructive payload of the Exocet and three times as fast.

The Oniks missile, more advanced than the Sunburn, can fly as fast as Mach 2.5, and carries a 661-pound warhead. Not only is this missile far faster and more powerful than the Exocet, but it may have the capability to maneuver on its terminal flight to its target, which could make defeating it difficult, if not impossible.

The Sunburn and Oniks missiles have sufficient destructive payloads to pose serious threats to large U.S. warships like aircraft carriers, which are at the heart of U.S. power-projection strategies around the world.

The GQM-163A Coyote supersonic sea skimming target is a non-recoverable, supersonic aerial target, capable of speeds of Mach 2 or greater and altitudes from 13 to 66 feet above the surface of the ocean, Northrop Grumman officials say. Northrop Grumman won a contract to develop the GQM-163A in 2000, and the target drone has been operational since 2005.

The GQM-163A drone simulates sea-skimming cruise missiles by flying faster than twice the speed of sound as low as 12 feet off the surface of the ocean. The target drone also can simulate high-altitude cruise missile attacks that plunge down at ships from higher than 30,000 feet.

On this order Northrop Grumman Space Systems will do the work in Camden, Ark.; Chandler, Ariz.; Vergennes, Vt.; Cincinnati; Oconomowoc, Wis.; Lancaster, Pa.; and other U.S. locations, and should be finished by December 2023. For more information contact Northrop Grumman Space Systems online at www.northropgrumman.com, or Naval Air Systems Command at www.navair.navy.mil.

Military forces in the future may be able to discard their heavy bulky night-vision goggles for lightweight night-vision eyeglasses that will offer wide fields of view.

DARPA eyes lightweight night-vision eyeglasses with wide field of view

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking industry to develop night-vision devices far smaller and lighter in weight than today's night-vision goggles; the new devices would be about the same size and weight as a typical pair of eyeglasses.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a broad agency announcement (HR001121S0013) in January for the Enhanced Night Vision in eyeglass form factors (ENVision) project.

Today's night-vision goggles typically are as bulky as four inches long and as heavy as 2.2 pounds. This causes a large torque on the wearer's neck, which limits the wearer's agility and often leads to chronic injury over prolonged use of these electro-optical devices.

Today's night-vision goggles also burden the wearer with a narrow field of view and generally have limited spectral access to the near-infrared spectral band, which limits situational awareness.

This drawbacks from refractive optics for imaging, and image-intensifier tubes — two technologies in modern night-vision systems that have remained largely the same since their inception.

Instead, the DARPA ENVision program seeks to overcome these lim-

itations by developing enhanced direct-view night-vision systems that are of a size and weight near those of typical eyeglasses.

These small and lightweight night-vision eyeglasses would extend visual access beyond near infrared to include shortwave, midwave, and long-wave infrared spectral bands through a common aperture, giving users access to spectral ranges from 1.5 to 12 microns. These night-vision eyeglasses, furthermore, would widen the user's field of view to natural eyesight of about 100 degrees.

Optical specialists have attempted to widen the fields of view for today's night-vision goggles, but improvements come at the cost of increased systems size, weight, and wear-and-tear on the user. The ENVision project seeks to explore the next technical leap in night-vision technologies by achieving direct vision of the infrared through photon upconversion.

While current night vision systems use a multi-step process, the physics to upconvert infrared photons directly to visible light in one step has been known since the invention of the laser in 1960. Direct photon upconversion involves the absorption of two or more photons and re-emission of a photon of higher energy.

Currently, these processes are inefficient and are limited in the bandwidth of light that can be upconverted simultaneously. Yet recent advances in material systems such as polaritonic structures and sensitized core-shell nanoparticles have opened up new avenues in exploring photon upconversion.

The process of photon upconversion-based night vision would eliminate the need for several components and could lead to even simpler, all-optical night-vision systems in the future, such as night vision contact lenses, DARPA researchers say.

Planar optics and planar image intensifiers could enable direct vision of several infrared bands through one common aperture. Structured materials such as diffractive optics and metamaterials enable one to embed optical functionalities far beyond those of traditional refractives into one optical element.

While wide field of view, broad bandwidth, and high imaging quality all are achievable individually, combining these traits in practice remains a challenge. In addition to planar optics, image intensification is necessary to convert the often weak infrared light into visible photons detectable by the naked eye.

The ENVision program will last for four years in two 2-year phases, and has two technical areas: prototypes and upconversion. Those participating in the first technical area will develop prototypes of enhanced night vision systems in eyeglass form-factors, while those in the second technical area will investigate broadband direct photon upconversion.

DARPA briefed industry by webcast on 21 Jan. 2021. Companies interested were asked to send abstracts by 2 Feb. 2021, and full proposals by 23 March 2021. Submit proposals to the DARPA BAA Website online at https://baa.darpa.mil. More information is online at https://beta.sam.gov/opp/dfd7b79857804364bfb0d509443a9c35/view.

Navy briefs industry on upcoming research on laser weapon, character recognition

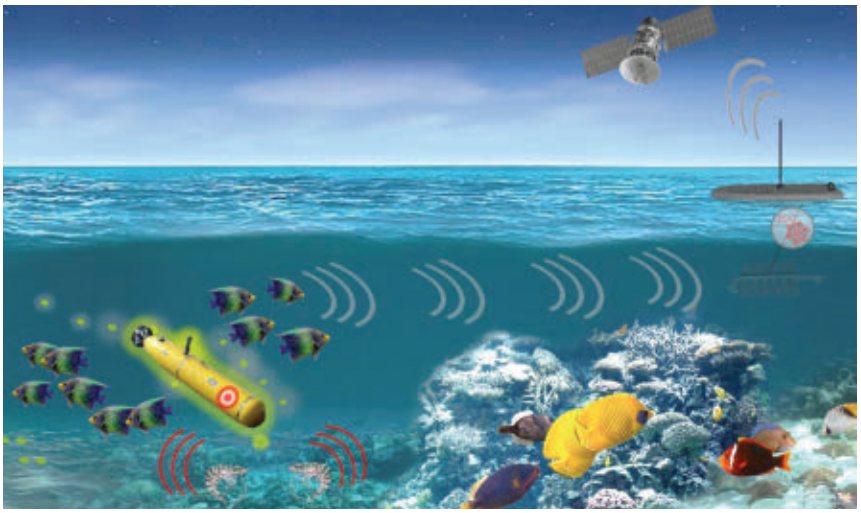
SAN DIEGO — Officials of the U.S. Naval Information Warfare Systems Command (NAVWAR) in San Diego briefed industry in December on eight topics related to an upcoming request for prototype projects (RPP) on behalf of the Naval Information Warfare Center Atlantic in Charleston, S.C., and Naval Information Warfare Center Pacific in San Diego.

The eight topics to be covered at the industry day were:

- Combatant Craft Next Generation Processor & CANBus Integration (21-LANT-0174) as a replacement for processor hardware and software;
- STRATSTAR phase-one (21-LANT-0175) to develop a prototype laser weapon that is tightly coupled with command and control features in one system;
- AIT Solution for OM&S Inventor (21-PAC-0176) to develop automated information technology for inventory control at 98 percent accuracy;
- Electronic Maneuver Warfare Mobile Module (21-LANT-0177) to develop prototype electronic emitter detection, identification, classification, and localization capable of remote operation;

- Dynamic Interoperability in the Battlespace (21-LANT-0178) to develop prototype capability for tactical data exchange between systems that have incompatible data formats and standards;
- Maritime Imaging Sensor Text Recognizer Tool (21-LANT-0179) prototype for text and character recognition to identify maritime vessels;
- Littoral Combat Ship (LCS) Plan to Perform (21-LANT-0180) to improve material availability of Littoral Class Ships; and
- Human Machine Teaming for Tactical Decision Making (21-LANT-0181) prototype advanced analytic algorithms for rapid decision making in the battlespace.

For each of these eight topics, Navy officials say they expect to issue requests for prototype projects (RPPs) for white papers, enhanced white papers, or full proposals to be solicited via N65236-18-9-0001.



Upcoming U.S. Naval Information Warfare Systems Command research projects will involve laser weapons, imaging sensors, and sensor processing.

More information on the Information Warfare Research Project, how to become a consortium member, or how to attend the industry day is online at www.theiwrp.org.

High-definition thermal camera core introduced by BAE Systems

The BAE Systems Sensor Solutions segment in Lexington, Mass., is introducing the Athena 1920 high-definition thermal camera core for long-range and demanding applications in security, surveillance, and targeting systems. The Athena 1920 combines infrared image clarity with a wide field of view, and is compact, lightweight, and low-power. Additional applications for this thermal camera core include aerial reconnaissance, perimeter security, and asset monitoring. The Athena 1920 features a 1920-by-1200-pixel vanadium oxide (VOx) uncooled microbolometer pixel array using 12-micron pixel technology. The camera's 60 Hz frame rate delivers clarity and minimizes motion blur in dynamic scenes. The high-definition sensor offers nearly eight times the field of view of traditional camera cores, and with its 51-by-40-by-21-millimeter size 70-gram weight are suited for high-performance applications where size, weight, power, and cost are important factors. The Athena 1920 camera core is manufactured at the BAE Systems sensor facility in Lexington, Mass. For more information contact BAE Systems Sensor Solutions online at www.baesystems.com.

SOFTWARE TOOLS

QinetiQ chooses AdaCore software to upgrade command-and-control system

Software experts from QinetiQ in Bristol, England, needed software design and development tools to address software tool obsolescence. They found their solution from AdaCore in New York City.

QinetiQ has selected the AdaCore Mentorship Service to address software tool obsolescence by modernizing the development environment for the company's Trials Control System (TCS) — a command-and-control system designed for the training, test, and evaluation of military equipment.

The upgrade from the legacy SPARK programming language to the latest version of the technology, SPARK 2014, was to sustain the safety-critical software development capability required by TCS.

SPARK is a computer language and toolset that brings mathematics-based confidence to software verification. The latest version of SPARK provides QinetiQ with the foundation for a sound formal verification framework and static analysis toolset.

One of the key features of SPARK technology is the ability to express behavioral properties that software engineers must implement correctly, and then checked by the verification toolset.

The AdaCore Mentorship Service provides QinetiQ with hands-on guidance from AdaCore's formal software-verification experts through customized on-site training, virtual project meetings, and follow-up support.

QinetiQ also has selected a multi-year subscription contract for AdaCore's software development tools, including GNAT Pro and SPARK Pro.

"As the lead engineer of the QinetiQ TCS product, I can thoroughly recommend AdaCore's Mentorship Service," says Michael Smith, technical lead of software engineering at QinetiQ. "Faced with the complexities of upgrading a code-base dating from 2004 and comprising several hundred thousand lines of code, I was keen to engage early on with AdaCore."

AdaCore Mentorship Services can include virtual and on-site training sessions, project meetings to monitor project progress and discuss outstanding issues, access to tool evaluations to explore benefit to your project, and direct code assistance on the customer application.

For more information contact AdaCore online at www.adacore.com, or QinetiQ at www.qinetiq.com.

SENSORS

Army picks General Atomics to develop AI-based smart sensor for unmanned aircraft

U.S. Army unmanned aerial vehicle (UAV) designers needed artificial intelligence (AI) capability for the Army's Predator, Reaper, and future military UAVs. They found their solution from General Atomics Aeronautical Systems Inc. in Poway, Calif.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., announced a $92.3 million contract to General Atomics last week that covers research, development, test, and evaluation of AI for the smart sensor prototype unmanned aerial platform.

The contract came from the Joint Artificial Intelligence Center (JAIC) in Washington to enhance the autonomous sensing capabilities of unmanned aircraft.

The goal of the JAIC Smart Sensor project is to advance AI technology by demonstrating object recognition algorithms using an unmanned aircraft, as well as employing onboard AI to control the aircraft's sensors and direct autonomous flight.

General Atomics will deploy the technology on the MQ-9 Reaper remotely piloted aircraft configured with several different sensors, including the General Atomics Reaper Defense Electronic Support System (RDESS) and Lynx synthetic aperture radar (SAR).

The General Atomics Metis product will be used to command the MQ-9. Metis is an intelligence, surveillance and reconnaissance (ISR) tasking and intelligence-sharing application that enables operators to specify effects-based mission objectives and receive automatic notification of actionable intelligence.

General Atomics designs and builds unmanned systems, radars, and electro-optic and related mission systems, including the Predator UAV and the Lynx multi-mode radar.

General Atomics produces a variety of ground control stations and sensor-control and image-analysis software, offers pilot training and support services, and develops meta-material antennas.

For more information contact General Atomics Aeronautical Systems online at www.ga.com.

THERMAL MANAGEMENT

Meggitt to provide liquid cooling for avionics aboard P-8A maritime patrol jet

U.S. Navy avionics experts needed a large electronics-cooling system for thermal management of electronic components and sensors aboard the U.S. Navy P-8A Poseidon maritime patrol jet. They found their solution from Meggitt Defense Systems Inc. in Irvine, Calif.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., has announced a $27.4 million order to Meggitt for 31 P-8A liquid air palletized systems (LAPS) over the course of three years.

The electronics cooling order calls for Meggitt to deliver 10 LAPS units in order year two; 11 LAPS units in order year three; and 11 LAPS units in order year four.

Meggitt's liquid palletized solution provides essential cooling to mission-critical equipment and sensors to ensure safe flight. The system can provide as much as 64 kilowatts of cooling for the aircraft when operating above 10,000 feet, and 20 kilowatts of ground cooling.

The LAPS electronics-cooling system provides thermal management for the computer processors, electronic and electro-optical sensors, and other heat-generating avionics aboard the P-8A aircraft.

The P-8 is a militarized version of the Boeing 737-800 single-aisle passenger jetliner hardened for long-range ocean missions like surveillance, maritime patrol, and anti-submarine warfare. It is replacing the Lockheed Martin P-3 Orion maritime patrol turboprop aircraft.

Ultimately, the Navy plans to buy 108 P-8A aircraft from Boeing, which is building the Poseidon at its factory in Renton, Wash. The 737 fuselage and tail sections are from by Spirit AeroSystems in Wichita, Kan., and move to Renton where technicians will assemble the finished aircraft.

The P-8A's flight management system and the stores management system have been developed by GE Aviation Systems in Grand Rapids, Mich. The cabin has as many as seven operator consoles.

The Poseidon's MX-20HD digital electro-optical and infrared (EO/IR) multi-spectral sensor turrets come from L-3 Communications Wescam in Burlington, Ontario. The MX-20HD is gyro-stabilized and can have as many as seven sensors, including infrared, CCDTV, image intensifier, laser rangefinder, and laser illuminator.

On this order Meggitt will do the work in Irvine, Calif; Sumner, Wash.; Niagara, N.Y.; and other U.S. locations, and should be finished by November 2024. For more information contact Meggitt Defense Systems online at https://meggittdefense.com, or Naval Air Systems Command at www.navair.navy.mil.

COMMUNICATIONS

NOAA chooses TSi for global search-and-rescue satellite terminal

Search-and-rescue experts at the U.S. National Oceanic and Atmospheric Administration (NOAA) in Washington, needed a global search-and-rescue satellite ground terminal for the agency's facility in Wahiawa, Hawaii. They found their solution from Techno-Sciences (TSi) in Lanham, Md.

TSi officials announced in December that NOAA has selected their company to deliver the Horizon Medium Earth Orbit Local User Terminal (MEOLUT) to enhance NOAA's Medium Earth Orbit Search and Rescue (MEOSAR) ground segment at Wahiawa, Hawaii.

MEOSAR is the next-gen version of the Cospas-Sarsat international search-and-rescue satellite system that has helped save more than 50,000 lives since 1982.

The key technology innovation in the latest TSi Horizon MEOLUT is a custom-designed phased array antenna integrated with TSi's proprietary MEOLUT signal processing and control techniques. NOAA, the U.S. agency responsible for the U.S. SARSAT program, acquired its first operational MEOSAR system in 2011.

The TSi MEOLUT is designed to improve detection and location accuracy of emergency distress beacons for personnel, aircraft, and maritime vessels in distress.

With near horizon-to-horizon coverage to capture 406 beacon signals relayed from orbiting satellite constellations immediately after line-of-sight is established, TSi's Horizon MEOLUT delivers enhanced search-and-rescue coverage and second-generation signal processing capabilities in a compact form factor with no moving parts, company officials say.

By pointing to satellites near the horizon, TSi's Horizon MEOLUT can detect and locate emergency beacons with greater accuracy than traditional dish antennas.

This enhanced detection ability, combined with TSi's Selective Schedule Algorithm, enables the system to monitor diverse regions, including the translation of oblong and irregular data points that are invisible to traditional systems.

For more information contact TSi online at www.technosci.com, or NOAA at www.sarsat.noaa.gov/meosar.html.

HYPERSONICS

BAE Systems to develop rugged weapon data link radio for hypersonic weapons

U.S. military researchers needed a weapon

data link radio to help steer hypersonic weapons to their targets. They found their solution from the BAE Systems Electronic Systems segment in Merrimack, N.H.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a $4 million contract to BAE Systems to develop two weapon data link prototypes for test and integration of the future hypersonic Tactical Boost Glide (TBG) vehicle.

The TBG program is a joint DARPA and U.S. Air Force effort to develop technologies for future air-launched, tactical-range hypersonic boost glide systems.

Boost glide uses a rocket to accelerate a weapon payload to high speeds, after which the payload then separates from the rocket and glides unpowered to its destination. The TBG data link radio will provide weapon tracking, fire control, and situational awareness as it helps steer hypersonic munitions to their targets.

Systems that operate at hypersonic speeds of at least five times the speed of sound (Mach 5) and beyond offer the potential for military operations from longer ranges with shorter response times and enhanced effectiveness compared to current military systems, DARPA officials explain.

Such systems could provide significant payoff for future U.S. offensive strike operations — particularly as adversaries' capabilities advance. The TBG program has three primary objectives: vehicle feasibility, effectiveness, and affordability.

Vehicle feasibility seeks to develop aerodynamic and aerothermal performance, controllability, and robustness for a wide hypersonic operational envelope. Effectiveness seeks to develop subsystems necessary for hypersonic munitions. Affordability seeks to reduce costs and increase value of TBG research.

TBG is a two-phase effort that plans to include ground and flight testing to mature critical technologies, and aims to demonstrate system performance. The program builds on previous boost glide systems research.

For more information contact DARPA online at www.darpa.mil/program/tactical-boost-glide, or BAE Systems Electronic Systems at www.baesystems.com.

SPACE ELECTRONICS

Boeing chooses rad-hard DC-DC converters from Vicor for O3b mPOWER satellite system

Communications satellite designers at the Boeing Co. needed radiation-hardened DC-DC converter power modules for the O3b mPOWER satellite system. They found their solution from Vicor Corp. in Andover, Mass.

Designers at the Boeing Defense, Space & Security segment in St. Louis are using the Vicor SM-ChiP-packaged radiation-hardened DC-DC power suppliers for the O3b mPOWER satellite system, owned and operated by SES S.A. in Betzdorf, Luxembourg.

The O3b mPOWER space communications system is under construction and due to be launched this year. The initial satellite constellation comprises 11 high-throughput and low-latency satellites in a medium Earth orbit (MEO), ground infrastructure, and intelligent software.

The system provides several terabits of global broadband connectivity for applications such as cellular backhaul to remote rural locations and simultaneous international IP trunking.

The O3b mPOWER satellites use shapable and steerable spot beams that can shift and scale in real-time to suit different users, and will join the SES existing constellation of 20 first-generation O3b satellites in MEO.

The Vicor SM CHiPs can power low-voltage application-specific integrated circuits (ASICs) that take as much as 300 Watts from a 100-volt nominal power source. Boeing tested these power devices to be resilient to the effects of 50 kilorads of total ionizing dose radiation, and immune to single-event upsets.

Vicor makes the power devices immune to single-event upsets by using a redundant architecture that houses two identical and parallel power trains with fault-tolerant control integrated circuits in one high-density SM-ChiP package.

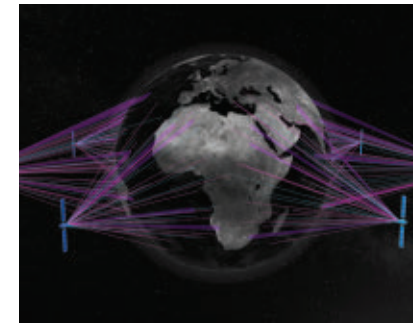
Advanced communications satellites require high power density and low noise, Vicor officials say. Vicor soft-switching, high-frequency ZCS/ZVS power stages within metal-shielded ChiPs reduce the power system noise floor to enable reliable signal integrity and performance.

The complete power-source-to-point-of-load solution consists of four SM-ChiPs: the BCM3423 100-volt nominal 300 Watt K = 1/3 bus converter in a 34-by-23-millimeter package; the PRM2919 33-volt nominal 200-Watt regulator in a 29-by-19-millimeter package; and two VTM2919 current multipliers in K = 1/32 with an output of 0.8 volts at 150 amps and a K = 1/8 with an output of 3.4 volts at 25 amps.

The solution powers satellite's ASIC directly from the 100-volt power source with minimal external components and low-noise operation.

The Vicor radiation-tolerant power modules are available in the Vicor high-density SM-ChiP package with ball grid array (BGA) connections and optional solder mask for the top and bottom surfaces. The devices operate in temperatures from -30 to 125 degrees Celsius.

For more information contact Vicor online at www.vicorpower.com, Boeing Defense, Space & Security at www.boeing.com/company/about-bds, or SES S.A. at www.ses.com.



INTEGRATED CIRCUITS

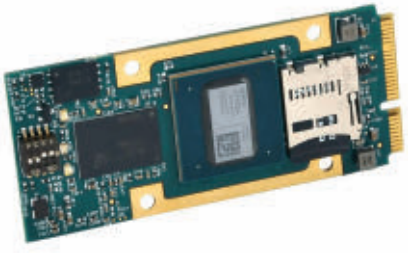
Rad-tolerant SuperFlash memory for space applications introduced by Microchip

Microchip Technology Inc. in Chandler, Ariz., is introducing the SST38LF6401RT radiation-tolerant, 64-megabit parallel-interface SuperFlash memory device for maximum reliability and robustness in the harsh radiation environment of space missions. The chip is a companion to Microchip's space-ready microcontrollers, microprocessors, and field-programmable gate arrays (FPGAs) that provide the building blocks for this scalable development model. Radiation-tolerant to 50 kilorads total ionizing dose — even while the Flash is still biased and operating — the SST38LF6401RT device enables systems to operate in a broad range of space applications where they cannot afford any loss of code execution that could lead to severe defects and system loss. It also is a companion to the Microchip SAMRH71 Arm Cortex-M7-based radiation-hardened system-on-chip processor and can also be used with the company's RT PolarFire FPGAs to support in-flight system reconfiguration. The device has pinout distribution compatibility with its industrial version for transition to the space-qualified plastic or ceramic versions at the printed circuit board level. Voltage operation of the SST38LF6401RT ranges from 3 to 3.6 volts. The SST38LF6401RT SuperFlash device is sampling in a ceramic version and supported by an evaluation board and demonstration software, available upon request. For more information contact Microchip Technology online at www.microchip.com.

EMBEDDED COMPUTING

Mezzanine card with Zynq UltraScale+ MPSoC) introduced by Acromag

Acromag in Wixom, Mich., is introducing the APZU series AcroPack mezzanine module that combines multi-core ARM processors, FPGA capabilities, and I/O interfaces on a rugged, high-density platform for embedded computing applications. Acromag's APZU series expands their offering of mini PCI Express-based AcroPack modules with a programmable I/O solution featuring the Xilinx Zynq UltraScale+ multiprocessor system-on-chip (MPSoC). The APZU series uses the Xilinx Zynq UltraScale+ multiprocessor system on chip (MPSoC) for I/O processing and programmable logic. Three models are available offering a choice of digital I/O interfaces: 28 TTL; 20 TTL and 3 RS422/485; and 14 LVDS signals. These mezzanine modules mount on a variety of AcroPack carrier cards for PCI Express, VPX, and other platforms that enable developers to mix and match I/O combinations on one board for embedded applications running on Linux, Windows, or VxWorks operating systems. The APZU's Zynq 3CG MPSoC combines a feature-rich ARM-based processing system and programmable logic in one device. Two dual-core ARM Cortex CPUs (A53 application processor and R5 real-time processor) deliver high-performance computation capability. For more information contact Acromag online at www.acromag.com.



RF AND MICROWAVE

Programmable attenuator with female SMA connectors offered by Broadwave

BroadWave Technologies Inc. in Greenwood, Ind., is introducing the model 631-031-063 voltage-controlled programmable attenuator for aerospace and defense applications. This voltage controlled programmable attenuator

features a 63-decibel dynamic range in 1-decibel steps, is rated 1-Watt average input power and has SMA female RF connectors. Attenuation accuracy is plus-or-minus 0.5-decibel or 2 percent of programmed and is controlled via solder terminal connectors. The supply voltage 12 volts DC at 30 milliamps nominal per section resulting in 10 milliseconds switching speed. The 50 Ohm RF and microwave attenuator has an operating frequency range of DC to 2200 MHz; a maximum voltage standing wave ratio (VSWR) of 1.40:1; and insertion loss of 3.5-decibels maximum. Other impedance and connector options also are available. For more information contact Broadwave Technologies online at www.broadwavetechnologies.com.

RUGGED COMPUTERS

Rugged computer for artificial intelligence (AI) introduced by Systel

Systel Inc. in Sugar Land, Texas, is introducing the Kite-Strike next-generation rugged computer for embedded edge supercomputing for deployment in harsh environments. The Kite-Strike integrates the NVIDIA Jetson AGX Xavier system-on-module, comes in a compact form factor, and enables real-time artificial intelligence (AI) inferencing, deep learning, and machine learning capabilities. The rugged computer provides centralized sensor ingest and data fusion support for mission-critical applications, and is configurable and modular. Kite-Strike is engineered and manufactured for low size, weight, and power consumption (SWaP), and offers data center performance in a compact, rugged embedded edge computer. In addition to the NVIDIA Jetson AGX Xavier SOM, the Kite-Strike offers the Volta Architecture graphics processing unit with 512 CUDA cores and 64 Tensor cores; an eight-core Carmel ARM v8, 64-bit CPU; 32 gigabytes of system memory; 32 gigabytes of eMMC 5.1 data storage; Gigabit Ethernet, USB, and CAN I/O; ARINC 429 and MIL-STD-1553 databus interfaces; and 4G LTE GPS. For more information contact Systel online at www.nvidia.com.

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