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TRENDS IN SHIPBOARD ELECTRONICS

Congress backs Navy push for more ships, combat power, unmanned vehicles, and hypersonic missiles. PG. 16

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Cover photo: Navy photo

Military & Aerospace Electronics®, USPS Permit 5901, ISSN 1046-9079 print, ISSN 2688-366X online, is published 12 times a year by Endeavor Business Media, LLC, 1233 Janesville Ave., Fort Atkinson, WI 53538. Periodical postage paid at Fort Atkinson, WI, and additional mailing offices. POSTMASTER: Send address changes to Military & Aerospace Electronics, PO Box 3257, Northbrook, IL 60065-3257. SUBSCRIPTIONS: Publisher reserves the right to reject non-qualified subscriptions. SUBSCRIPTION PRICES: U.S. \$171 per year; Canada \$198 per year; All other countries \$224 per year. All subscriptions payable in U.S. funds.

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Small-form-factor SOSA: the next trend in embedded computing



BY **John Keller**
EDITOR IN CHIEF

The next generation of open-systems small-form-factor embedded computing is nearly ready for industry, and is likely to become part of the upcoming Sensor Open Systems Architecture (SOSA) 2.0 industry standard that should see ratification later this year or early next.

It's called VNX-plus — written as VNX+. Its computer modules should be about the size of a deck of playing cards, and will be a downscaled version of 3U VPX embedded computing boards and backplanes, which are described in standards of the VITA Open Standards, Open Markets trade association in Oklahoma City.

The small size of VNX+ will fit into a five-inch tube to accommodate small-yet-powerful applications, including 100-millimeter cubesats, stealthy unmanned underwater vehicles (UUVs), and artillery-launched sensors for long-term monitoring of contested areas.

Advocates say the conduction-cooled VNX+ will have the look and feel of 3U VPX, but will be substantially smaller, and will help ease the transition to small-form-factor embedded computing systems. The goals of VPX+ are to reduce embedded computing size, weight, and power consumption (SWaP), systems costs, and time to market for small-form-factor embedded computing.

It's most promising applications include small unmanned aerial vehicles (UAVs), aircraft weapons pods, small satellites called cubesats, and future generations of smart munitions. Essentially the emerging standard is to enable industry-standard designs that used to require custom approaches, says Bill Ripley, an industry consultant for embedded computing specialist Samtec USA in New Albany, Ind., and a longtime pioneer and advocate of small-form-factor embedded computing.

VNX+ is a logical evolution of an earlier small-form-factor embedded computing standard called VNX, or ANSI/VITA 74, which was ratified by the American National Standards Institute (ANSI) in Washington back in 2017. VNX+ is intended to succeed where similarly sized VNX fell short. "There wasn't a driving need for VITA 74; it was ahead of it time," Ripley explains.

First and perhaps most importantly, VNX+ can handle far more power than VITA 74 ever could. VNX+ expands thermal performance to 80 Watts, where VNX could handle only 20 Watts. Plus, VNX+ is optimized for signal integrity at high speeds, where VITA 74 came on the scene before the speeds of today's high-speed switch fabrics even were envisioned. Plus the new standard is designed to accommodate today's fast databuses and switch fabrics.

The concept of VNX+ has worked, and "interest in VITA 90 has been overwhelming," Ripley says.

VNX+ also is being designed for to accommodate aerospace and defense applications today and in the future, with related standards in the works. The future VITA 90.4 is being designed to accommodate wedge locks for designers who need them, and VITA 90.5 is being designed for space applications.

VITA 90.5 will emulate many characteristics of the ANSI/VITA 78 SpaceVPX systems standard, which offers high performance, fault tolerance, and interoperable backplanes and modules for high-availability orbital space applications — like cubesats.

Like 3U VPX, the upcoming VNX+ standard will capitalize on OpenVPX standards, and take advantage of the commercial infrastructure that supports these standards. ←



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Wanted: radiation-hardened non-volatile memory for next-generation space uses

BY John Keller

KIRTLAND AIR FORCE BASE, N.M. — Spacecraft experts in the U.S. Space Force are reaching out to industry to find companies able to design next-generation radiation-hardened non-volatile memory chips for future military applications in space.

Officials of the U.S. Air Force Research Laboratory's Space Vehicles Directorate at Kirtland Air Force Base, N.M., have issued a solicitation (FA9453-21-S-0001) for the Advanced Next Generation Strategic Radiation hardened Memory (ANGSTRM) project.

▲ **ANGSTRM seeks to develop a strategic rad-hard non-volatile memory with state-of-the-art performance, advanced packaging, and radiation-hardening techniques.**

ANGSTRM seeks to develop a strategic rad-hard non-volatile memory device with near-commercial state-of-the-art performance by using advanced packaging and radiation-hardening techniques with state-of-the-art commercial technology.

Advancing strategic rad-hard non-volatile memory technologies is critical to support strategic missiles, missile defense, and military space systems, researchers say. Non-volatile memory devices retain their data even when they lose power.



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The U.S. military uses strategic rad-hard non-volatile memory across many space programs and strategic systems that must withstand the effects of naturally occurring radiation in space, as well as radiation from nuclear explosions.

Ideally, the DoD would have access to non-volatile memories with the performance and density of commercial state-of-the-art devices; unfortunately today's commercial technologies are not able to withstand the radiation and thermal environments where the military deploys systems. Many military systems, moreover, must use trusted on-shore electronics manufacturing.

Today's rad-hard non-volatile memory technologies are limited in performance and density, so system designers require several devices to meet on-board storage requirements, which drives the size, weight, power, and cost (SWaP-C) of system storage.

The U.S. Space Force researchers are interested in combining radiation hardening to state-of-the-art CMOS and memory technologies to scale density beyond the levels of a single chip, and create qualified strategic rad-hard non-volatile memory for use across military space and strategic systems.

A multi-phased development approach is necessary to assess the scalability of these technologies while still meeting the radiation requirements for the space and strategic environments.

Researchers want to industry to develop rad-hard memories with monolithic memory densities of 4 to 16 gigabits, and with multichip module densities of 32 to 128 gigabits that will last without refresh for 10 to 15 years.

Memory devices should operate with no more than 10 milliwatts of power, with 1 milliwatt performance preferred. Total standby power requirements are no more than 10 milliwatts, and as little as 10 milliwatts. These devices should operate in temperatures from -40 to 125 degrees Celsius, and eventually down to temperatures of -55 C.

Resistance to total-ionizing-dose radiation should be as low as 300 kilorads, and as high as 1,000 kilorads, with fewer than 10 to 12 single-event upset errors per bit day. Single-event latchup resistance should be more than 72 MeV-Cm²/mg, with single-event gate and dielectric rupture of 72 to 100 MeV-Cm²/mg.

Ultimately, the ANGSTRM project seeks to develop a full-scale prototype device, provide device characterization and

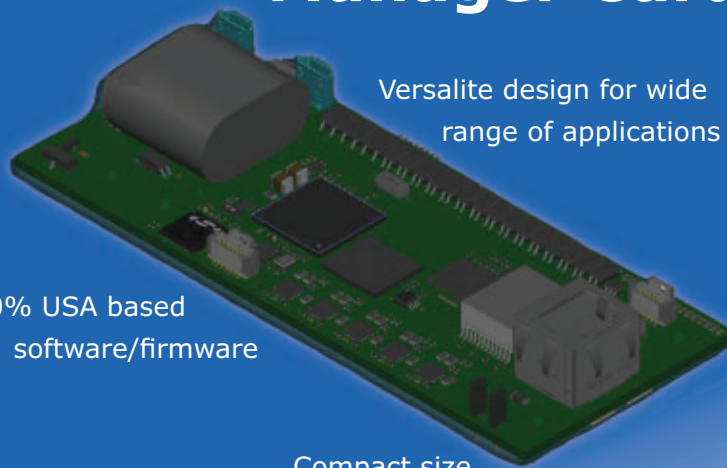
radiation test reports, and provide a qualification plan with a path to achieve a QML-standard product.

Companies bidding should demonstrate the capability for marketing and product support, and submissions must address the design, layout, and fabrication of the full-scale device in a trusted on-shore facility. Bidders also must provide space-qualification plans, discuss their strategic rad-hard design approach, and identify long-term sourcing strategies for intellectual property.

Companies interested were asked to submit white papers by 13 Feb. 2023. Bidders must prepare white papers using the template available online at https://valideval.com/star_documents/, saved as a PDF, and submitted via DoD Safe at <https://safe.apps.mil>. ←

Email questions or concerns to the Space Force's Francis Eggert at francis.eggert@spaceforce.mil, or Jeffery Martinez at jeffery.martinez.1@spaceforce.mil. More information is online at <https://sam.gov/opp/34f03218e37a451f91ab2a34dfada6bb/view>.

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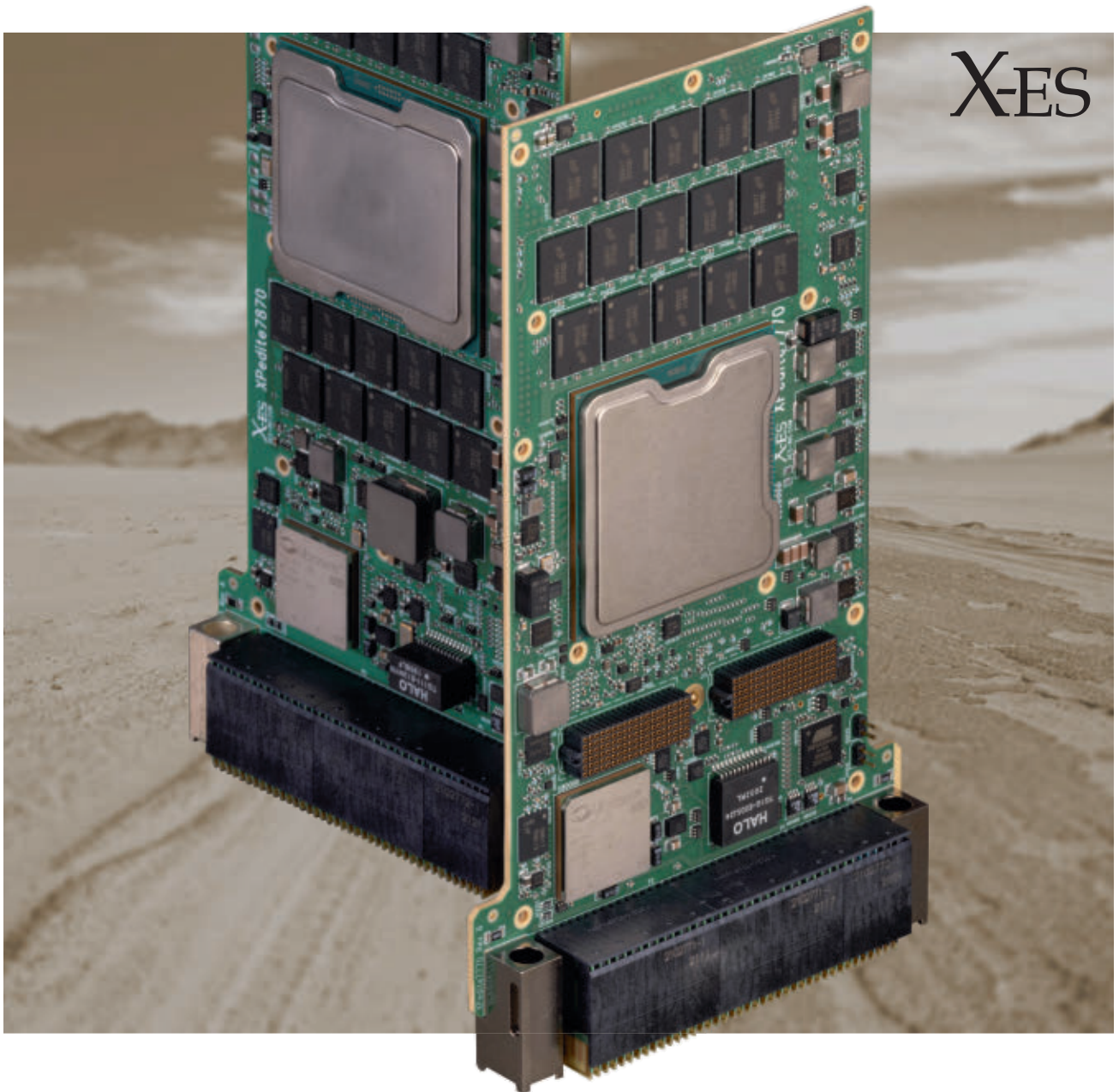
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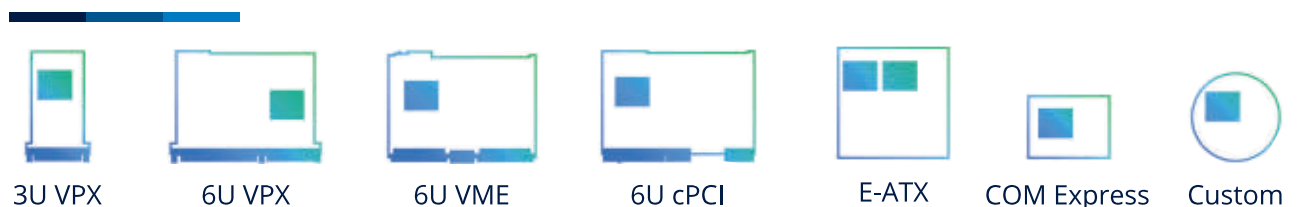


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Space Force eyes space nuclear power for small satellite propulsion and payloads

BY John Keller

KIRTLAND AIR FORCE BASE, N.M. — U.S. Space Force space experts are reaching out to industry for new ideas in space nuclear power generation for future propulsion and sensor payloads aboard small satellites.

Officials of the U.S. Air Force Research Laboratory Space Vehicle Directorate at Kirtland Air Force Base, N.M., issued an advanced research announcement (FA9453-21-S-0001-CALL-007) for the Joint Emergent Technology Supplying On-Orbit Nuclear power (JETSON) Low Power Mission Application project.

JETSON, which is part of the Space Technology Advanced Research - Fast-tracking Innovative Software and Hardware (STAR-FISH) initiative, seeks to develop enabling technologies for space-based radioisotope power systems.

Researchers are looking for new ways to develop compact radioisotope power systems, electric and hybrid propulsion for power conversion, power management, on-orbit mobility, thermal regulation, deployable structures, radiation shielding, and electronic hardening.

Today's space systems are evolving from a few exquisite satellites to proliferated systems for persistent communications; intelligence, surveillance, and reconnaissance; positioning navigation and timing; space domain awareness; and space power.

The continuous power levels obtainable using space nuclear power may provide advantages over current solar electric power for mission payloads and spacecraft — especially those relying on high delta-V electric propulsion, researchers explain.

Space nuclear power could enable a new generation of military small low-power applications that are not possible today. Work will involve integrating subsystem components, assessing technology readiness levels, component risk-reduction demonstrations, and model-based systems engineering models of a combined system of systems that uses space nuclear power.

The ideal design should balance electrical production with thermal dissipation overhead to reduce risk for near-term



JETSON seeks to develop enabling technologies for space-based radioisotope power systems.

thermal radiator development for a navigation beacon in support of cislunar operations near NASA's GATEWAY — a future multi-purpose outpost orbiting the moon.

Such a system, which would be a 1U design that consumes five Watts or less, should be able to display orbital agility via a propulsion system able to operate for one year of mission operations, and for as long as two years of extended mission operations. Electric propulsion may consume as much as 15 Watts of power.

Researchers do not intend to limit consideration to traditional cubesat dimensions, but prefer small spacecraft. The system will incorporate cyber security and DEVSECOPS, AND Test software should be designed to incorporate these concepts.

Companies interested were asked to submit white papers by 17 Feb. 2023 via DOD Safe at <https://safe.apps.mil>. Those submitting white papers should use the template available online at https://valideval.com/star_documents/. Companies submitting promising white papers may be invited to submit full proposals. ◀

Email questions or concerns to Lt. Col. Thomas Nix, the JETSON technical manager, at thomas.nix@spaceforce.mil; Michael Lopez, the JETSON program manager at michael.lopez.44@spaceforce.mil; Shawn Capehart, the JETSON contracting officer at shawn.capehart@spaceforce.mil. More information is online at <https://sam.gov/opp/bbe6876459bc4bec85685fb561cbaaf7/view>.

Raytheon to build 111 Tomahawk missiles with GPS, inertial, and terrain-matching guidance

U.S. Navy land-attack experts are asking Raytheon Technologies Corp. to build 111 BGM-109 Tomahawk Block V missiles able to attack ground and sea targets under terms of a \$171.2 million order. Officials of the Naval Air Systems command at Patuxent River Naval Air Station, Md., are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., to build 111 full-rate production Block V Tactical Tomahawk all-up round vertical launch system missiles — 50 of which are for the U.S. Army, 48 for the U.S. Navy, and 13 for the U.S. Marine Corps. Tomahawk is a long-range, all-weather, jet-powered, surface-attack subsonic cruise missile used primarily by the U.S. Navy and the United Kingdom Royal Navy in ship- and submarine-based land-attack operations. The missile also launches from land sites. For navigation and guidance, the missile uses a combination of inertial, GPS, and terrain-matching that uses an electro-optical sensor and radar altimeter to the terrain over which the missile is passing to an internal terrain database. The Tomahawk Block V has a data link that enables the missile to switch targets while in flight. It can loiter for hours and change course instantly on

command. The Tomahawk Block V is a recertified and modernized missile with upgraded navigation and communications. The Block Va can strike moving targets at sea. On this contract Raytheon will do the work in Ogden and Spanish Fork, Utah; Camden, Ark.; Huntsville and Anniston, Ala.; Clearwater, Fla.; Glenrothes, Scotland; Joplin, Mo.; El Segundo and Moorpark, Calif.; Middletown, Conn.; Midland, Ontario; Vergennes, Vt.; Minneapolis; Westminster, Colo.; Chandler, Ariz.; and other U.S. locations, and should be finished by November 2025. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Air Systems Command at www.navair.navy.mil.

Raytheon to build 408 AIM-9X Block II infrared-guided air-to-air missiles

U.S. Navy aerial warfare experts are asking Raytheon Technologies Corp. to build 408 AIM-9X precision short-range infrared-guided air-to-air missiles for jet fighters and other combat aircraft under terms of a \$317.4 million contract. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Raytheon Missiles & Defense *Continued on page 11*



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Air Force wants multi-aperture RF system for sensors, navigation, and communications

BY John Keller

EGLIN AIR FORCE BASE, Fla. — U.S. Air Force aerial weapons experts are reaching out to industry for help in developing a small radio frequency and millimeter-wave (RF/MMW) system for target engagement, navigation, weapons fuzing, communications, and multi-platform sensors capabilities.

Officials of the Integrated Seekers and Processing Branch of the Air Force Research Laboratory's Munitions Directorate at Eglin Air Force Base, Fla., issued a request for information (FA865123RFI04) for the first phase of the Multi-Aperture Networked Intelligence for Agile Combat (MANIAC) project.

MANIAC seeks to develop a tactical system concept, system models, and a detailed technical design for a low-size, -weight, -power consumption, and cost multifunction RF/MMW system.

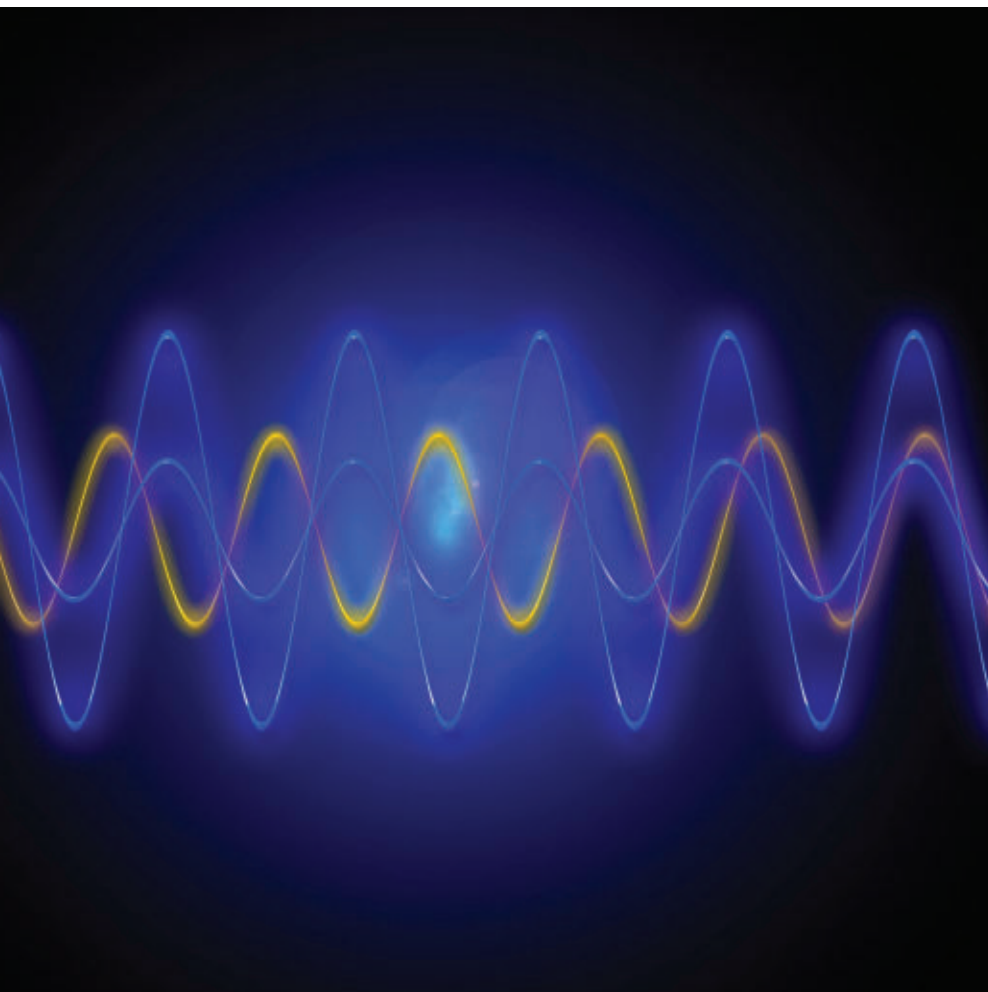
It should use active and passive sensing for homing and RF-aided inertial guidance; provide navigation for the system's own platform and nearby platforms; intra-fleet communications; and collaborative modes.

This RF and microwave capability should enable agile, sustained, and accurate operation in contested and degraded environments against ground-mobile targets while employed in solitary or collaborative small, low-cost, air-delivered munitions.

The proposed state-of-the-art system should improve size, weight, power consumption, and cost (SWaP-C) by use and reconfiguration of common multiband and wideband apertures; multichannel transceivers; and distributed hybrid processing controlled by an autonomous or cognitive resource-management system.

Companies interested should provide a capability statement; identify relevant past contracts; point of contact; CAGE code; and facility clearance. Companies that provide promising ideas may receive invitations to industry briefings and one-on-one discussions. A certified DD Form 2345, Militarily Critical Technical Data Agreement, must be submitted with the package. ←

Companies were asked to email information by 6 Feb. 2023 to the Air Force's Shannon Paradise at shannon.paradise@us.af.mil, or Jane Ellison at jane.ellison@us.af.mil. More information is online at <https://sam.gov/opp/313242a9cee94a49b033907bd-7c17ab7/view>.



The MANIAC project seeks concepts, models, and designs for a low-size, -weight, -power consumption, and cost multifunction RF/MMW system.

Continued from page 9

segment in Tucson, Ariz., to build lot 23 AIM-9X block II and block II-plus air-to-air missiles. These anti-aircraft missiles are for the U.S. Air Force, Army, and foreign allies. The order is for AIM-9X Block II and II-plus tactical missiles; captive air training missiles; missile containers; spare advanced optical target detectors; spare advanced optical target detector containers; guidance units; propulsion steering sections; guidance unit containers; spare block ii captive air training missile guidance units; tail caps; tail cap containers; tactical sectionalization kits; electrical units; dummy air test missiles; support equipment; general-purpose controllers; and non-recurring engineering. The AIM-9X is an infrared-guided heat-seeking missile that equips most jet fighters, fighter-bombers, and other offensive combat aircraft in the U.S. arsenal, and is for shooting down enemy aircraft close-by. The AIM-9X works by homing in on an enemy aircraft's hot engine exhaust. Variants of the AIM-9 Sidewinder have been deployed since the 1950s. This contract involves the latest versions of the AIM-9X, called the AIM-9X Block II and AIM-9X Block II-plus. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Air Systems Command at www.navair.navy.mil.

NASA awards Boeing sustainable flight demonstrator contract

The technologies demonstrated and tested as part of the Sustainable Flight Demonstrator (SFD) program will inform future designs and could lead to breakthrough aerodynamics and fuel efficiency gains. Boeing says that the technologies demonstrated and tested as part of the Sustainable Flight Demonstrator (SFD) program will inform future designs and could lead to breakthrough aerodynamics and fuel efficiency gains. When combined with expected advancements in propulsion systems, materials and systems architecture, a single-aisle airplane with a TTBW configuration could reduce fuel consumption and emissions up to 30% relative to today's most efficient single-aisle airplanes, depending on the mission. The SFD program aims to advance the civil aviation industry's commitment to reaching net zero carbon emissions by 2050, as well as the goals set forth in the White House's U.S. Aviation Climate Action Plan. Ultra-thin wings braced by struts with larger spans and higher-aspect ratios could eventually accommodate advanced propulsion systems that are limited by a lack of underwing space in today's low-wing *Continued on page 13*

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Collins Aerospace to build nuclear-hardened VLF military radios for strategic bombers

BY John Keller

HANSCOM AIR FORCE BASE, Mass. — Military communications experts at Collins Aerospace will build, upgrade, and maintain secure and jam-resistant very low frequency (VLF) radios to enable U.S. Air Force strategic bomber aircraft to communicate securely with national command authorities while on long-range missions.

Officials of the U.S. Air Force Nuclear War Center at Hanscom Air Force Base, Mass., are awarding a \$99.5 million contract to Collins Aerospace for Common Very Low Frequency (VLF)/Low Frequency Increment 1 Air Force Nuclear Weapons Center for VLF modernization production/interim contractor support and sustainment for the B-2, B-52, and potential future aircraft.

U.S. strategic bombers typically communicate over Advanced Extremely High-Frequency (AEHF) system satellite communications (SATCOM) links, as well as the legacy MILSTAR and military UHF satellite constellations.

Collins Aerospace began full-scale development of the Common Very Low Frequency Receiver (CVR) program in late 2013, which involved modifying, qualifying, and testing a B-2 bomber VLF communications system, consisting of a terminal and receiver, antenna, human machine interface (HMI) display, and ancillary cabling, rack, and equipment to enable receipt and display of emergency action messages.

Collins Aerospace experts also have performed systems engineering and requirements definition, prototype fabrication, qualification testing, airworthiness certification, and flight testing of the B-2 bomber's CVR.

Very low frequency communications are among the most durable and reliable communications modes for military use. Although VLF sends data relatively slowly, it is designed to survive and operate through nuclear explosions.

The CVR that Collins Aerospace built for the B-2 bomber is bridging between the UHF SATCOM, MILSTAR, and the AEHF SATCOM systems, Air Force officials say.

Collins Aerospace engineers have designed the B-2 CVR system to operate in the airborne nuclear combat environment, be secure, and be survivable, Air Force officials say. It is nuclear-hardened and meets stringent cryptographic requirements. ◀

On this contract Collins Aerospace will do the work in Richardson, Texas, and should be finished by November 2033. For more information contact Collins Aerospace online at www.collinsaerospace.com, or the Air Force Nuclear War Center at www.afnwc.af.mil.



Very low frequency communications are among the most durable and reliable communications modes for military use.

Continued from page 11

airplane configurations. For the demonstrator vehicle, Boeing will use elements from existing vehicles and integrate them with all-new components.

How a computer hacker unearthed the TSA no-fly list

We've all been bored on the internet, right? Aimlessly scrolling through Twitter or clicking through TV Tropes, eyes glazing over as we spend hours doing the online equivalent of re-checking an empty fridge. But some people, it seems, use their boredom-induced internet browsing for more than just re-reading all of Catra's tropes. Some use it to shine a light on the American surveillance state. Cyber security is obviously a concern for not only trade secrets in the mil-aero industry and the agencies and military branches they serve, but for the fine folks at the FBI, CIA, NSA, and others. A Swiss woman who goes by the nom de fouineur "mia arson crime" added another success to her digital snooping portfolio, including Nissan's source code and security footage from Tesla factories. This time out, she found her way into a server that kept default credentials in place and left with 1.5 million names and aliases of people on the FBI "no fly" list.

BAE Systems to integrate Collins communications systems in Bradley combat vehicles

Armored combat vehicles designers at BAE Systems will integrate Collins Aerospace secure communications networking and navigation systems into the U.S. Army Bradley Fighting Vehicle under terms of a \$10.4 million contract. Officials of the Army Contracting Command at Detroit Arsenal in Warren, Mich., are asking the BAE Systems BAE Systems Platforms & Services segment in San Jose, Calif., to integrate the Handheld, Manpack and Small Form Fit (HMS) next-generation radio and Mounted Assured Position Navigation and Timing Solution (MAPS) Generation 2 into the M2A3 and M3A3 Bradley Fire Support Team (BFIST) and Fire Support Sensor System (FS3) vehicle. The Collins AN/PRC-162 HMS is a two-channel networked communications ground radio that uses several narrowband and wideband waveforms for high-speed communications. For more information contact BAE Systems Platforms & Services online at www.baesystems.com; Collins Aerospace at www.collinsaerospace.com; or the Army Contracting Command-Detroit Arsenal at <https://acc.army.mil/contractingcenters/acc-dta/>. ←

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Leidos to defend U.S. combat aircraft from multispectral missiles and laser weapons

BY John Keller

WRIGHT-PATTERSON AFB, Ohio — U.S. Air Force researchers needed a company to develop prototype threat-warning avionics to help defend U.S. combat aircraft pilots from radar- and electro-optically guided missiles, laser weapons, and other anti-aircraft technologies. They found their solution from Leidos Inc. in Reston, Va.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, announced a \$40.8 million contract to Leidos for the Electro-Optic Sensing Defensive Electronic Warfare (EOS-DEW) program.

Leidos experts will investigate enabling technologies to help defend aircraft from multispectral guided missiles, hostile fire, and directed-energy weapon systems such as high-power lasers and electromagnetic weapons like high-power microwaves.

U.S. combat aircraft must penetrate and operate in enemy airspace, where they face a variety of sensor-guided missiles, machine guns, lasers, and electromagnetic weapons. The problem with this is existing countermeasures are becoming obsolete as enemy weapons technologies overtake them.

Air Force researchers are asking Leidos to find solutions to counter each new identified threat. For example, effective missile countermeasures rely on early launch detection and continual improvements in missile warning sensors. Directed energy threat detection, on the other hand, requires several different laser detection schemes.

Validating new sensor architectures requires specialized and customized testing that involves high fidelity threat simulation, radiometry, platform motion simulation, tracker characterizations, and data analysis techniques.

Leidos will focus on multi-spectrum threat warning for enemy missiles, laser weapons, and hostile fire. primarily focusing on o Missile sensing o Laser sensing o Hostile fire sensing; multi-spectrum threat simulation; sensing technology evaluation; fielded systems; and developmental components to advance the state of the art in multispectral threat sensing systems.

The company will perform component hardware and algorithm development and evaluation; investigate emerging



Leidos experts will find ways to help defend aircraft from multispectral guided missiles, hostile fire, laser weapons, and high-power microwaves.

technologies in threat detection techniques and discriminants; system development; threat signature simulation; and will evaluate environment development and integration.

Simulation development will involve replicating threat signatures in hardware-in-the-loop laboratory and field settings. Leidos will focus on threat signature simulations of missiles, lasers, hostile fire, kinematic motion, real-time radiometrics, atmospheric turbulence, and scene clutter.

Modeling and simulation work will involve aircraft and missile plume signatures; atmospheric effects; transmission; scattering; turbulence; missile-engagement 3D modeling; and laser propagation.

The company will perform work at the Naval Air Warfare Center (NAWC) test range, Calif.; Yuma Proving Ground, Ariz.; White Sands Missile Test Range, N.M.; Eglin Test Range, Fla., using government-provided threat warning systems, instrumented threat sensors and seekers, search-and-track sensors, other countermeasures equipment, data collection devices, support equipment, and portable laser equipment. ◀

For more information contact Leidos online at www.leidos.com, or the Air Force Research Laboratory at www.afrl.af.mil.



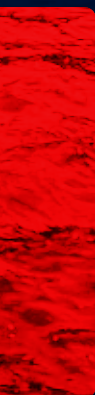
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**Congress
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Enabling technologies on the Navy's wish list include large unmanned underwater vehicles, hypersonic missiles, electronic warfare (EW), and digital signal processing.

BY Edward J. Walsh

U.S. Navy leaders say their top priorities are building more ships, fighting well in contested seas, extending battle ranges, increasing deception, and enhanced information warfare.

The Navy's priorities for shipbuilding and weapon systems in 2023 and beyond are spelled out in Chief of Naval Operations Adm. Michael Gilday's CNO Navigation Plan, released in July 2022. The plan unveils the CNO's six force design imperatives that seek to maintain combat credibility in increasingly contested seas; expand distance; leverage deception; harden defense; increase distribution; ensure delivery, and generate decision advantage.

Gilday says the imperatives enable distributed maritime operations, the Navy's foundational operating concept. Still, he argues that the fleet needs more ships.

U.S. and allied naval analysts point out that increasingly contested seas refers primarily to China's navy. An International Institute for Strategic Studies (IISS) report called Military Balance 2022, points out that "China's shipbuilding output remains prodigious."



◀ **Flight IIA Arleigh Burke-class destroyer Paul Ignatius (DDG 117) moors in port at Plymouth, England.** Navy photo

Fifth Fleet Commander Vice Admiral Brad Cooper announced the standup of a task force of the 34-nation Combined Task Force, which Cooper also commands, to respond to drone attacks and arms smuggling in waters around Yemen and by Iran. The force of as many as eight ships also would target human and drug trafficking in the region

Force planning

IISS notes that the Chinese navy has strengthened its near-seas capability with commissioning of 72 1,500-ton Type-056/056A corvettes since 2012, adding that “the commissioning of the first 40,000-ton Type-075 large helicopter-capable amphibious assault ship, continued aircraft-carrier development, and the commissioning of a growing number of frigates and destroyers reflect determined efforts to develop a blue-water navy.”

Last April, the IISS study reports, the Chinese navy commissioned its third 11,000-ton Type-055 guided-missile cruiser and a Type-094 nuclear-powered ballistic-missile submarine.

Another national security think tank, War on the Rocks in Washington, cites an Office of Naval Intelligence forecast that by 2030 China’s maritime force will total more than 800 warships, coast guard cutters, and large maritime militia ships.

The Navy also is watching Russian naval activity. Despite Russia’s grinding land war with Ukraine and loss of several ships, national security analyst Daniel Flott of the Defense and Statecraft Program of the Centre for Diplomacy, Security, and Strategy writes that “Russia still enjoys naval dominance in the Black Sea. The West should consider how to hold Russian naval targets at risk.”

The Navy faces increased tensions in Middle East waters. In April 2022 Navy

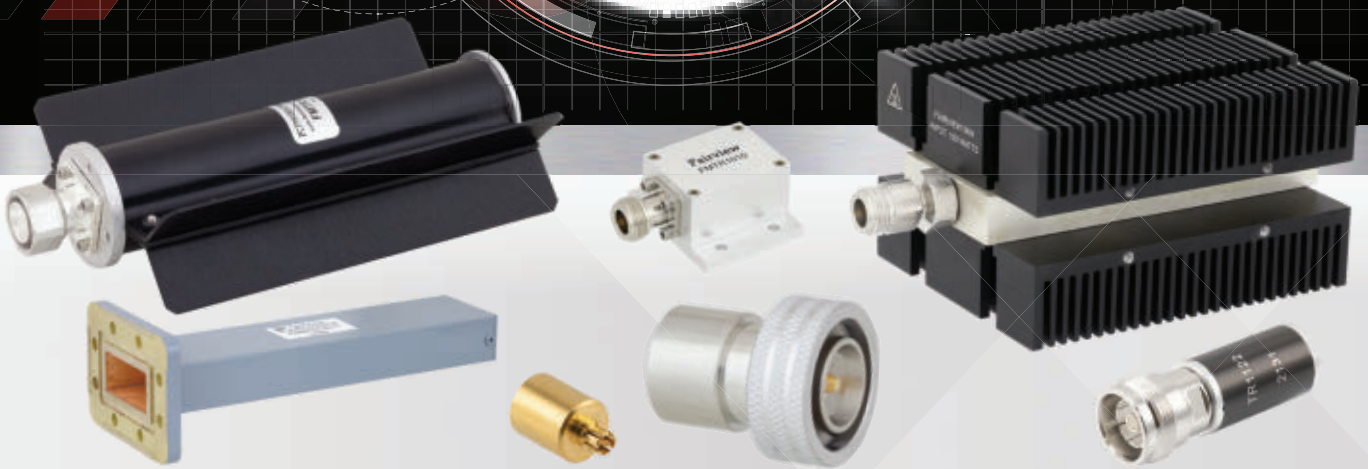
and new capabilities offered by unmanned systems, the Navy has moved past its Force Structure Assessment of December 2016 that called for a total force of 355 manned ships. A new so-called distributed fleet architecture still being developed would have three tiers: (1) fewer cruisers, destroyers, and large amphibious-assault ships; (2) more small combatants like frigates, large patrol craft, small amphibious attack ships, and logistics ships; and (3) small corvettes, manned and unmanned patrol craft, and large unmanned surface and undersea vehicles (USVs and UUVs).

The 2023 defense authorization act approved by Congress in December provides \$32.6 billion for construction of 11 ships, which is up from the Navy’s request for eight: two Virginia-class attack submarines, three Arleigh Burke-class destroyers, two



▶ **An F-35C Lightning II jet fighter-bomber makes an arrested landing on the flight deck of the Nimitz-class aircraft carrier USS Abraham Lincoln (CVN 72).** Navy photo

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expeditionary fast transport ships, one Constellation-class frigate, one San Antonio-class amphibious-assault ship, one fleet replenishment oiler, and one towing and salvage ship.

The authorization calls for multiyear contract buys of 25 ship-to-shore connectors, 15 Burkes, eight oilers, and five amphibious ships. The bill forbids the Navy from retiring 24 ships, including five of the nine littoral combat ships that Navy leaders hoped to remove from the fleet.

The 30-year shipbuilding plan lays out three potential force levels, called Alternatives 1, 2, and 3. All three project 300 ships by 2035. The first alternative aims at 316 by 2052; the second and third would get the Navy to 327 and 367, respectively, by 2052.

Yet as in past years, the Navy faces mismatched funding levels and strategic priorities. In Senate Armed Forces Committee testimony last May, Gilday said the Navy's 298-ship fleet "is not sized to handle two simultaneous conflicts" in the event of war with Russia and China. "It's sized to fight one and keep a second adversary in check." His July 2022 Navigation Plan calls for "more than 350 manned ships, about 150 large unmanned surface and subsurface platforms, and approximately 3,000 aircraft."

Competing analyses have produced different numbers. A 2019 Navy Integrated Naval Force Structure Assessment, according to the Congressional Research Service and press reports, arrived at 390 manned ships and 45 unmanned vessels. A U.S. Department of Defense (DOD) Future Naval Force Study was reported to call for as many as 530 ships.

Shipbuilding

Throughout 2022 the Navy's shipbuilders delivered new ships and moved forward on others. Huntington Ingalls Industries and

General Dynamics Bath Iron Works have switched from Flight IIA Arleigh Burke-class (DDG 51) destroyers to the extensively redesigned and more heavily armed Flight III variant.

Huntington Ingalls is well along in construction of Flight III ships at its Pascagoula, Miss., shipyard: Ted Stevens (DDG 128), Jeremiah Denton (DDG 129), George M. Neal (DDG 131), and Sam Nunn (DDG 133). The first Huntington Flight III hull, Jack H. Lucas (DDG 125), completed builder's sea trials in December. Bath is working on Flight III hulls Louis H. Wilson Jr., (DDG 126), William Charette (DDG 130), and Quentin Walsh (DDG 132).

The Navy already is looking beyond the Burkes. In mid-2021 the Program Executive Office/Ships established a DDG(X) program office to study the next large surface combatant. The PEO said that the Navy hoped to fund the first DDG(X) in 2028.

In July 2022 Huntington Ingalls and Bath received one-year contracts for design analysis for a DDG(X) with options that could extend the work out to 2028.

The littoral combat ship program, which has experienced cost overruns and maintenance problems for years, is split between a Lockheed Martin Corp. and Fincantieri Marinette Marine team, which builds the Freedom variant ships with a conventional single hull and General Dynamics and Austal USA, which build the Independence ships with a trimaran hull.

Ten Freedom-type ships and 14 Independence ships have been delivered. Six more Freedom hulls and five Independence ships are under construction or in pre-production.

Due to concerns about littoral combat ship survivability, in April 2020 the Navy awarded Fincantieri a design and construction contract for the Constellation-class frigates. The new frigates

will be 496 feet long, with full-load displacement of 7,290 tons, with a maximum speed of 26 knots. The Constellation design is derived from the company's FREMM design used also by the French and Italian navies. The Navy plans to build 20 Constellation-class ships.

Last August the company started work on Constellation at its Marinette, Wis., shipyard. The Navy has exercised options for Congress and Chesapeake (FFGs 63 and 64); Fincantieri has options for seven

◀ **A Saildrone Explorer unmanned surface vessel and the guided-missile destroyer USS Delbert D. Black (DDG 119) operate in the Arabian Gulf.** Navy photo



more. Constellation is scheduled to enter service in 2026. In June Lockheed Martin won a \$10.5 million award for integration and testing of the Constellation-class combat system.

In July the Navy commissioned the San Antonio-class amphibious transport dock Fort Lauderdale (LPD 28), twelfth ship of the class. Huntington Ingalls is building Richard M. McCool Jr. (LPD 29) and Harrisburg (LPD 30) and in September the company started fabrication for Pittsburgh (LPD 31). Harrisburg and Pittsburgh are Flight II ships, which will provide the same capabilities as the Flight Is, but will introduce new production methods to reduce costs and replace the composite antenna mast with a steel one.

The Navy originally planned to build 13 Flight II San Antonios. Instead, the 2023 budget proposes ending Flight II production with one more ship, for a total class of 13 Flight I and three Flight II hulls. The Navy says it will begin studying a new LPDX class this year.

In October the Navy awarded Huntington Ingalls a contract for detail design and construction of Fallujah (LHA 9), the fourth America-class big-deck amphib. America and Tripoli (LHAs 6 and 7) are in the fleet and Bougainville (LHA 8) is under construction. The company started fabrication for Fallujah in late December.

The America-class ships are built with a combined gas turbine and diesel-electric propulsion system. The gas turbines are used for high speeds, maximizing their fuel efficiency, and the diesel-electric motors for lower speeds. The America-class initially were designed as aviation platforms without welldecks for deploying landing craft. Because of Marine Corps concerns the Navy modified the design for Bougainville and Fallujah to add welldecks.

The 2016 force assessment assumed 38 amphibious ships. Navy Secretary Carlos Del Toro has said he wants 31 amphibs. Marine Corps Commandant Gen. David Berger also pushed for 35 light amphibious warships that he says would present

smaller targets. The Navy has said it expects to start buying light amphibious warships in 2025.

The last of three nearly 16,000-ton Zumwalt-class destroyers built by Bath Iron Works — Lyndon B. Johnson (DDG 1002) — is going through combat systems testing. The first two ships, Zumwalt (DDG 1000) and Michael Monsoor (DDG 1001) are in the fleet. The three-ship class brings the Navy close to a true electric-drive integrated power system, a longtime Navy

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goal. The Navy chose an induction motor provided by General Electric's Power Conversion unit instead of more revolutionary permanent magnet motors that once were considered.

The ships originally were planned for naval surface fire support but have been shifted to the surface warfare mission because the Navy canceled the long-range land-attack projectile that was being built for the Zumwalts' advanced gun system, which will be removed from the ships this year.

The Navy's highest acquisition priority continues to be the 12-boat Columbia-class ballistic missile submarine (SSBN) program that will replace the in-service Ohio class as the sea-based component of the nation's strategic-weapons triad. The Columbias will be 560 feet long and displace 21,000 tons, and powered by a "life-of-ship" nuclear fuel core that will eliminate the need for a mid-life refueling.

The Navy awarded the District of Columbia (SSBN 826) contract to General Dynamics Electric Boat in November 2020. Electric Boat is teamed with Huntington Ingalls's Newport News Shipbuilding company for District of Columbia construction. Newport News is building the bow, stern, auxiliary machinery room, superstructure, and weapons modules. Last August Leonardo DRS delivered to Electric Boat the first unit of the main propulsion motor for District of Columbia.

Electric Boat laid the keel for the ship in June last year. The second ship will be Wisconsin (SSBN 827). The 14-boat Ohio class will start retiring in 2027, when District of Columbia is scheduled for delivery. Electric Boat says the ship will be ready for its first patrol in 2031. Starting in 2031 the Navy will replace the Ohios one-for-one with the new Columbia-class ships.



An MV-22 Osprey takes off from the amphibious assault ship USS Makin Island (LHD 8) during operations in the Pacific Ocean. Navy photo.

Electronic sensors

The Navy's most visible surface warfare system in 2022 was the SPY-6(v) long-range radar built by the Raytheon Technologies Corp. Missile and Defense unit. The SPY-6(v) will become the baseline radar for nearly all front-line surface combatants, carriers, and amphibious ships.

Raytheon won the SPY-6(v) contract in 2013, ousting Lockheed Martin, longtime builder of the SPY-1(v), the primary air-defense radar for Ticonderoga-class cruisers and Burke destroyers. Lockheed Martin will continue to provide the Aegis combat system for the Flight III Burkes.

Raytheon says the SPY-6(v) transmit-receive modules use monolithic microwave integrated circuits (MMICs) fabricated with gallium nitride that allow order-of-magnitude increases in processing speed and substantial size reduction in an open processing architecture.

The SPY-6(v)1 has been installed on Jack H. Lucas. Raytheon has delivered radar arrays to Huntington Ingalls for Ted Stevens and to Bath Iron Works for Louis H. Wilson Jr.

America-class amphibies and Nimitz-class aircraft carriers will get the SPY-6(v)2. New Ford-class flattops and Constellation-class frigates will get a three-array (v)3 system, called the Enterprise Air Surveillance Radar. Last July Raytheon delivered the first (v)3 radar arrays to Huntington Ingalls for John F. Kennedy (CVN 79), the second of four Ford-class CVNs. In-service Flight IIA Burkes will receive a (v)4 variant.

Raytheon designed the SPY-6(v) using a digital engineering process at the company's Immersive Design Center in Andover, Mass. Company officials says the IDC uses artificial intelligence and machine learning and a 32-foot-long light-emitting diode screen that provides a three-dimensional environment for the design work.

The Navy is pursuing digital engineering for combat system development at its Forge software factory in Riverdale, Md. Sigma Defense Systems LLC in Perry, Ga., says it's supporting the Forge by providing teams to develop an integrated combat system that consists of "loosely coupled, modular, low cost, and scalable software components" for surface combatants, aircraft carriers, and amphibious ships, outside the traditional acquisition process.

Lasers and weapons

In August 2022 Lockheed Martin delivered a high-energy laser with integrated optical dazzler and surveillance unit (HELIOS) for testing aboard the destroyer USS Preble (DDG 88). The HELIOS, a 60-plus kilowatt laser, is designated Increment 1 of the Surface Navy Laser Weapon System (SNLWS) program.

Company officials say the HELIOS is an “endless magazine that never runs out of bullets.” The laser draws its energy continuously from the ship’s power system. The HELIOS is able to destroy surface and airborne threats and “dazzle” or blind optical sensors aboard hostile ships and aircraft, and optical seekers of anti-ship missiles.

The company says the HELIOS already is integrated with the Aegis combat system. The system is targeted at in-service Flight IIA Burkes but not the Flight IIIs because the power generation capability of the Flight IIIs is heavily dedicated to the SPY-6(v). Adding HELIOS would require taking something else off.

In June the Missile Defense Agency awarded Raytheon an \$867 million contract for SM-3 Block IIA missiles that will go aboard Burke DDGs and Japan’s Aegis destroyers. The SM-3, fitted with a kinetic interceptor rather than an explosive warhead, is capable of destroying short and intermediate-range ballistic missiles. Navy officials say the SM-3 Block IIA is a component of the Phased Adaptive Approach for missile defense in Europe, and is now operational at MDA’s Aegis Ashore site in Romania.

Raytheon won a November award for the air-defense rolling

airframe missile (RAM) for the Navy and for the German navy. The company continues to build the Evolved Seasparrow Block 2, Mk 15 close-in weapon system, and Standard missile Block III.

Raytheon also won contracts for full-rate production for the Block V Tomahawk all-up round and the over-the-horizon weapon system or OTH-WS, which launches a Naval strike missile and is planned for the littoral combat ships.

The Navy is upgrading the Cooperative Engagement Capability (CEC), a shipboard, airborne, and shore-based system that creates an integrated targeting network. In September Raytheon, longtime systems integrator for CEC, received \$77 million in new options for CEC engineering support, including work for Japan, Australia, and Canada, and a \$27 million award in July for the CEC planar array assembly for the U.S. and Canadian navies.

In September L3Harris Technologies in Melbourne, Fla., won a \$32 million contract for CEC spares and signal data processors, and an October CEC award for \$40.9 million.

Raytheon received an Office of Naval Research contract last April to study flexible digital beamforming and other radar functions under the Agnostic Signal Processing for Increased

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Radar Efficiency (ASPIRE) research initiative, a two-year effort to develop new radar signal generation capabilities and improve radar signal-processing designs, and reduce weight and power requirements for Navy radars.

The Navy's Conventional Prompt Strike initiative is collaborating with the Army's Long Range Hypersonic weapon program to develop sea- and land-based hypersonic missiles. DOD accelerated hypersonic missile research following China's launch of a hypersonic weapon in October 2021. Hypersonic weapons will travel at Mach 5, more than 4,000 mph. Both the Navy and Army programs will use a hypersonic glide body.

In late October the services launched a rocket at the NASA Wallops Island, Va., test facility containing 11 experiments to gather data on advanced electronics components needed for hypersonic weapons. In mid-November Raytheon and Northrop Grumman both received additional MDA funding for work on Glide Phase Interceptor concepts through July of this year.

The Navy is upgrading ship navigation. In October the Navy's Operational Test and Evaluation Force ruled Northrop Grumman's shipboard electronic chart display and information system (ECDIS) operational suitable for surface ships. The



The guided-missile destroyer USS Zumwalt (DDG 1000) conducts a live-fire missile exercise at the Point Mugu Test Range in the Pacific Ocean. Navy photo

system will go aboard 115 ships—carriers, surface combatants, and amphibians. The company separately won awards for production of ECDIS software and its integrated bridge systems for two Burke destroyers.

Unmanned systems

A Navy Unmanned Campaign Framework, released in March 2021 announced that the Navy was “aligning our unmanned systems to executive Distributed Maritime Operations ... tightly coupling our requirements, resources and acquisition policies.”

L3Harris, teamed with Swiftships Inc. in Morgan City, La., is working on a \$35 million Navy contract for a prototype medium unmanned surface vehicle (MUSV). The contract includes options for eight vehicles. In July the Navy awarded Leidos Inc. an \$11.9 million contract for an MUSV design.

The Navy's vision includes larger USVs and large and extra-large UUVs. In September 2020 the Navy awarded contracts for studies of LUSV designs to Huntington Ingalls, Lockheed Martin, Bollinger Shipyards, Fincantieri Marinette Marine, Gibbs & Cox, and Austal USA. The studies have been completed.

In early 2019 the Navy tapped a Boeing and Huntington Ingalls team for the extra-large (XLUUV) program, including construction of five vehicles called Orcas. Last September Boeing won an \$11.6 million award for engineering support for the XLUUV program.

However, in April 2022 CNO Adm. Gilday said that the Navy is rethinking its MUSV plan based on the results of encouraging UUV testing by the Fifth Fleet in Mideast waters.

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Last October Fifth Fleet Commander Vice Adm. Cooper said the Navy plans to have 100 unmanned vehicles “available for patrol in waters around the Arabian Peninsula by the end of summer 2023.” The Fifth Fleet has provided a testbed, called Combined Task Force 59, for a force of unmanned systems since 2021.

The Navy says the three new unmanned vehicle types will have mutually supporting missions. The MUSV will be 190 feet long and displace 500 tons, and use an open-architecture sensor payload for intelligence, reconnaissance, surveillance, and electronic warfare missions.

The LUSV will be 200 to 300 feet long, displace 1,000 to 2,000 tons, and operate as a weapons platform, armed with anti-ship and land-attack missiles. The XLUUV would deploy the Navy’s Hammerhead mine which, tethered to the seabed, could deliver an anti-submarine torpedo. Last April General Dynamics Mission Systems won a \$14 million award for design of a Hammerhead prototype.

The surface Navy is deploying a wide array of sea- and airborne unmanned systems. In July the Program Executive Office for Unmanned and Small Combatants said an unmanned

influence sweep system (UISS), built by Textron Systems, had reached its initial operating capability. The system, integrated with a semi-autonomous mine countermeasures USV deployed from littoral combat ships will perform acoustic and magnetic minesweeping.

In the smaller UUV arena, Huntington Ingalls’s Mission Technologies Unmanned Systems unit announced in November the development of a new vehicle called Remus 620. The system is derived from the company’s Remus 300, designated by the Navy as Lionfish.

The company says the Remus 620, with a 275 nautical-mile range, will conduct mine countermeasures, hydrographic surveys, intelligence gathering, surveillance, and electronic warfare. The system resembles two in-production UUVs, the Mk 18 mod 2 Family of UUV Systems, which includes the LBS-UUV and the LBS-Razorback. The Remus 620 will be deployable from subs, surface ships, and helicopters. In September Huntington Ingalls received a \$17.2 million award for engineering support for the Mk 18.

On the airborne side, the Navy’s new MQ-8C Fire Scout unmanned aerial vehicle late last summer demonstrated the



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ability to shift control from ship to shore within the Navy's Expeditionary Advance Base Operations tactical concept.

The MQ-8C, built by Northrop Grumman-Bell Helicopters using a Bell 407 commercial helicopter design, has a cruising speed of 115 knots and maximum speed of 135 knots. It will operate at up to 16,000 feet and remain on station with full payload for 12 hours. The system will perform intelligence-gathering, surveillance, reconnaissance, and over-horizon targeting missions, and even combat logistics. The Navy plans to use the '8C aboard new Constellation-class and potentially other ships.

Power systems

The Navy's perennial goal for shipboard power is integrated electric drive—the capability to use the propulsion system, whether gas turbine, diesel, or nuclear, not only to push the ship through the sea but also to power all ship systems. PEO/Ships, in announcing the standup of the DDG(X) office in mid-2021, said the Electric Ships program office would be merged with

the new office to “leverage expertise in developing and implementing an Integrated Power System (IPS), a key foundation of these future surface combatant ships.”

In April last year The Leonardo DRS Naval Power Systems segment won a \$24.4 million award for design, testing, and delivery of a multi-application shipboard energy magazine low-rate production unit, a modular, scalable family of power conversion modules that will provide mission-adaptable flexibility for future ships.

In other power efforts, in September Maritime Power & Energy Solutions, a subsidiary of L3 Harris Technologies, received a sole-source \$57 million contract for support for the 400 hertz and 60 hertz power systems for the Aegis combat system, and in September the Naval Surface Warfare Systems Philadelphia awarded Kato Engineering of North Mankato, Minn., an \$18 million award for 20 ship-service brushless generators.

In May Lockheed Martin's received \$14 million in additional funding on a contract for Arleigh Burke machinery control system shipsets for the DDG 51 modernization program and new Flight III construction.

In a significant research step, in November the Office of Naval Research awarded a \$9.9 million contract to the University of South Carolina for exploration of digital twin and advanced control technologies that could improve resiliency of shipboard power systems. ←



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Holistic data access in shipboard computing at the edge

BY David Freeman

The artificial intelligence (AI) era is upon us, making AI of paramount importance for shipboard electronics at the tactical edge in applications ranging from mission planning to combat operations, and to battlefield logistics.

The legacy approach of shipboard and shore-based naval systems offers only limited interoperability, which limits the ability of naval forces to exploit data at the edge.

Military leaders must deal with issues that involve federated data silos, latency, environmental issues, and size, weight, and power consumption (SWaP), as well as the technical skill gaps of layering stopgap measures on industrial platforms.

Furthermore, many modernized legacy systems won't hold-up to the rigors of a hostile maritime engagement. From adversarial attacks on infrastructure, communication blackouts, and increased

latency in already-strained networks to systems, there are key challenges in the way that warfighters handle data at the edge.

Advances in high-performance computing and data storage are crucial parts of the AI revolution, but until now these technologies have been limited to the data center. Developments in standard rackmount all-flash network-attached storage (NAS) can make AI processing an easy fit into many shipboard electronics applications.

Traditional storage systems aboard maritime vessels face the same SWaP limitations as their land and air counterparts, so taking equipment out of a data center and placing it at the edge normally requires technological compromises.

Nevertheless, a new concept has emerged that ensures environmental field readiness, low-latency *Continued on page 29*

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The background of the entire page is a photograph of a rescue team in a Zodiac boat. The team consists of several members wearing helmets and life jackets, some holding oars. They are on the water, and the sky is a vibrant mix of orange, red, and purple, indicating a sunset or sunrise. The boat is moving, creating a wake in the water. On the left side of the image, there is a vertical blue bar with a white geometric pattern of interlocking squares.

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Continued from page 27

processing, scalability, and data security at the edge for military platforms, while still optimizing SWaP and meeting critical requirements like MIL-STD-167 for shipboard vibration and shock as well as MIL-STD-461 for EMI emissions and MIL-STD-810 for environmental concerns.

A universal data storage approach enables fast and secure access to big data, as well as to AI and machine learning at the edge to enable users can make critical decisions quickly.

Enormous amounts of flash storage today can be deployed at the edge for data-driven applications — without compromising performance, capacity, or scalability.

Examples of this are in implementations like the new Rugged Data Storage (RDS) system from Mercury Systems and partners VAST Data and NVIDIA to engineer solutions that solve these issues.

The RDS model of edge-based solutions changes enterprise storage with a universal, single-tier flash cloud for all types of data that eliminates bottlenecks and complex storage tiering; traditional archival media and hard disk drives are no longer needed.

Instead, RDS uses commercial flash technology and software algorithms from VAST Data to make the most of write



The Rugged Data Storage (RDS) system from Mercury Systems helps give fast and secure access to big data, AI, and machine learning at the edge aboard naval vessels.

endurance. It also helps reduce disk space requirements via data reduction and compression. A flash-based rugged data storage system enables an enhanced level of military intelligence never before achieved. ◀

David Freeman is senior product manager of sensor systems at Mercury Systems in Andover, Mass.

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The role of image and video processing

Some of the latest embedded processing technologies are influencing image processing, which takes advantages of artificial intelligence and machine learning.

BY Jamie Whitney

Today's military and its partners in the technology sector enable warfighters at the front to have the most up-to-date intelligence. Electro-optics enable this by working in concert with high-performance embedded computing image and video processors to distill the veritable "fire hose" of information down to actionable intelligence. This is done thanks to the speed at which data is processed by today's cutting-edge systems.

Tim Morin, a technical fellow at Microchip Technology in Chandler, Ariz., says that vision systems are tasked with a heavy workload in military and aerospace environments for applications like sensors and avionics.

In the military, Morin cites their use in:

- autonomous target identification in smart munitions like drones and missiles;
- satellite-based hostile target identification for hostile land installations, aircraft, surface warships, and submarines;
- integrated head-up displays for targeting and situational awareness for combat pilots; and
- situational awareness using head-mounted vision systems for infantry.

In aerospace, Morin lists:

- vision-based navigation or star tracking;
- spectral sensing used for terrestrial terrain mapping (Earth, lunar surface); and
- artificial intelligence (AI)-based navigation taking satellites out of orbit;

Regarding avionics, Morin selected vision-based pilot monitoring inside the aircraft as an example.



▲ **Mercury's AMMP modular scalable mission computer uses artificial intelligence and machine automation to help improve decision accuracy and response times for aircraft pilots.**

According to Ike Song, vice president and general manager of platform systems at Mercury Systems in Andover, Mass., much of that capability is enabled by developments in the commercial sector.

"Mil-aero image processing is moving steadily from 1K to 4K processing, and trends in the commercial world are driving this advancement at a much faster rate. Urban Air Mobility (UAM) and autonomous vehicle companies are making significant investment in machine learning and 8K processing for pattern recognition and visual navigation, which can then be leveraged and adopted by the military at a much lower cost. This technology will allow the military to use

affordable sensors for accurate navigation and automatic target recognition."

Mark Littlefield, the senior manager of the Elma Electronic embedded computing products and systems solutions division based in Fremont, Calif., explains that open systems standards also provide vendor-agnostic platforms.

"As data inputs continue to increase, we're entering a critical era of data availability to turn this information into intelligence, and provide actionability in defense operations," Littlefield says. "Leveraging proven technology on a common platform reduces integration issues and development time as well as shorten deployment. This can be seen in The Open Group's Sensor Open System Architecture (SOSA) initiative, which is bringing availability of common platforms that use the latest GPGPU processors. From this, we are seeing more image and data processing capabilities emerge."

COTS concerns

SOSA's open-systems and commercial-off-the-shelf (COTS) approach not only fulfills U.S. Department of Defense (DOD) requirements, but it also provides system components provides increased capabilities at lower costs, says Paul Garnett, the chief architect, business development at Curtiss-Wright Defense Solutions in Ashburn, Va.

"The main drive is the availability of the technology – the need has always been there but now the means is available through the use of GPU devices from the commodity graphics market at an affordable price point," says Garnett. "The affordability of high-performance GPUs means that lower cost vehicles can also support a more advanced capability."

While intelligence for warfighters boosts the likelihood that they won't be taken out of the fight, AI- and machine-learning capable unmanned vehicles continue to show their efficacy as a force multiplier and to keep those on the front lines safe.

In the end, that intelligence is often presented to humans-in-the-loop who decide what, if anything, to do with it. "Image processing requires powerful computing with software algorithms to process and identify objects of interest from electro-optical sensor input," Song says. "Displays need to support protocols like SDI, DVI, HDMI and ARINC 818 to display this information in real-time."



Helicopters and other military vehicles use vision systems enabled by rugged embedded hardware to land and operate in degraded visual environments (DVE).

Electro-optical sensors add a lot of data to the situational awareness pipeline. "Advances in electro-optics increase the quality — and amount — of information available, high performance embedded computing is able to process that immense amount of real-time data and present it in a digestible form through modern rugged displays," says Curtiss-Wright's Garnett. "The computation and software have the potential both to process the data in innovative ways to alleviate operator task saturation, but also to introduce new ways of presentation/analysis, all in real-time, for the best possible mission outcomes. If you can't measure or see the threat, you can't manage or respond to it.

"Real-time image processing is critical for automatic target recognition, blue force and red force tracking, minimizing friendly fire, speeding the OODA loop for faster operations, performing accurate battle damage assessments, and running visual navigation and sense-and-avoid systems that will reduce pilot workload," Garnett continues. "Embedded solutions that deliver this level of high-performance processing to the platforms in theater are critical to delivering real-time access to this information to our customers."

Increasingly, that actionable data is being used by the system that is collecting the information itself thanks to machine learning and artificial intelligence enabled by graphics processing units (GPUs) and general-purpose GPUs (GPGPUs).

Richard Jaenicke, the marketing director for safety and security-critical products at Green Hills Software (GHS) in Santa Barbara, Calif., says that the COTS approach is being expanded into the higher levels of integration. GHS offers the



Elma Electronic's Jetsys-5320 drives critical AI applications at the edge with a rugged small form factor enclosure.



Aitech released its A179 ultra SFF systems for unmanned vehicles that are AI-enabled with low power consumption. The A179 systems are available with a set of four rugged high-speed cameras with very low latency.

WHO'S WHO IN IMAGE AND VIDEO PROCESSING

Abaco Systems

Huntsville, Ala.
<https://www.abaco.com/>

Aitech Defense Systems Inc.

Chatsworth, Calif.
<https://aitechsystems.com/>

Atrenne Computing Solutions

Brockton, Mass.
<https://www.atrenne.com>

Combat Proven Technologies (CP Tech)

San Diego
<https://cp-techusa.com/>

Core Systems

Poway, Calif.
<https://core-systems.com/>

Crystal Group

Hiawatha, Iowa
<https://www.crystalrugged.com/>

Curtiss-Wright Defense Solutions

Ashburn, Va.
<https://www.curtisswrightds.com/>

Dawn VME Products

Fremont, Calif.
<http://www.dawnvme.com>

Extreme Engineering Solutions (X-ES)

Verona, Wis.
<https://www.xes-inc.com/>

LCR Embedded Systems

Jeffersonville, Pa.
<http://www.lcembeddedsystems.com>

Mercury Systems

Andover, Mass.
<https://mrcy.com>

Neosys Technology Inc.

New Taipei City, Taiwan
<https://www.neosys-tech.com/en>

Pixus Technologies Inc.

Waterloo, Ontario
<https://pixustechnologies.com/>

Systel Inc.

Sugar Land, Texas
<http://www.systelinc.com/>

Teledyne FLIR

Wilsonville, Ore.
<https://www.flir.com/>

INTEGRITY-178 tuMP real-time operating system (RTOS), which provides a unified solution for multicore processors.

“One example is the Replacement Multi-Function Controls and Displays (RMCD) on the C-5M Super Galaxy transport aircraft,” Jaenicke says of the higher-level integration. “On the C-5M, PU-3000 multicore avionics computers from CMC Electronics will be combined with VDT-1209 video display terminals from Intellisense Systems to form the full C-5M cockpit display system, including the primary flight displays. The PU-3000 multicore avionics computers run the INTEGRITY-178 tuMP RTOS to provide the foundation for real-time safety-critical operation to the highest RTCA/DO-178C Design Assurance Level (DAL A).”

Eye on AI

The U.S. military continues to leverage the growing list of capabilities machine learning and AI enable in more and more machines that operate in concert with — and sometimes independently of — soldiers, sailors, airmen, and Marines.

Microchip’s Morin says “that cameras are used more than ever before in aerospace and defense applications. More cameras add weight and power requirements. Customers are moving towards a higher resolution to capture more details in images. The need to drive more pixels and the increased use of AI drive the need for high-performance embedded computing.”

That focus on AI was a universal trend when mil-aero industry experts were asked what they saw as technology driving development of image processing systems and components. Curtiss-Wright’s Garnett explains that processing power is now meeting long-standing demand for it while component cost



Microchip’s PolarFire field programmable gate array (FPGA) system-on-chip (SoC) offers a hardened real-time, Linux capable, RISC-V-based microprocessor subsystem on the mid-range PolarFire FPGA family for applications that require low power consumption, thermal efficiency, and defense-grade security in embedded computing systems.

comes down. In short, systems can do more at a lower cost and that allows the proliferation of the technology into more vehicles.

“We are seeing increasing use of GPUs to support machine learning/AI in imaging systems for threat detection/SA/sighting systems,” Garnett says.

Elma’s Littlefield says that areas like machine condition-based monitoring and predictive maintenance, semi-autonomous driving and driver advisory systems are relying on the parallel processing architecture of GPGPU.

“Complex GPGPU inference computing at the edge is enabling visual intelligence, including high-resolution sensor systems, movement tracking security systems, automatic target recognition, threat location detection and prediction,” Littlefield says. “Much of the high compute processing taking place within these critical embedded systems relies on NVIDIA compact supercomputers and their associated CUDA cores and deep learning SDKs used to develop data-driven applications, turning data inputs into actionable intelligence.”

Unmanned importance

Aitech Systems in Chatsworth, Calif., provides rugged mil-aero embedded systems among other technologies. The director of its video and GPGPU product line, Dan Mor, says the continuing conflict in Eastern Europe highlight both the need and efficacy of crewless vehicles enabled by today’s image and video processing technology.

“The latest war in Ukraine proves how important unmanned ground mobile and avionic platforms are,” Mor says. “These platforms need high performance SWaP [size, weight and power] optimized systems for image and video processing at the edge, AI – for object recognition, classification and tracking and networking – for deterministic communication and real time decision making. New geo-politic world situations, threats and available technology drive the mil-aero market.”

Mercury’s Song says that while many

current unmanned aerial vehicles (UAVs) aren’t autonomous because a human pilot must be in the loop, “but by using more advanced image processing and AI/machine learning, the military will be able to build truly autonomous vehicles.”

While many UAVs and other unmanned systems are not yet fully autonomous, each camera, cable, sensor, board, and processor onboard systems contribute to the information available to commanders providing orders and to frontline warfighters.



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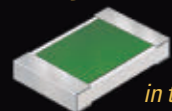
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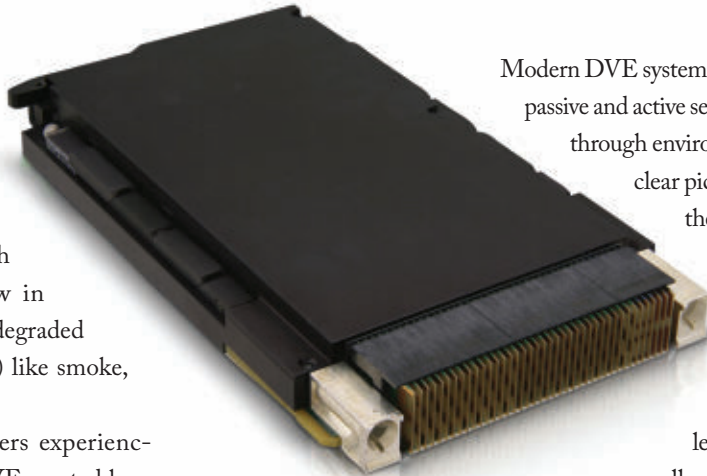
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Eyes in the sky

Image processing technology allows military aircraft to operate in areas that would have prohibited them in the past. With multi-sensor systems now in use, aircraft can operate in degraded visual environments (DVE) like smoke, fog, snow, and heavy rain.

“For example, helicopters experiencing takeoff and landing DVE created by a rotorwash-induced brownout or whiteout conditions can cause loss of visual reference with the ground and man-made obstacles at low altitudes,” GHS’s Jaenicke says. “Such DVE can cause a hard landing that often results in aircraft damage or loss as well as personnel injury. All aircraft are susceptible to DVE during flight created by low visibility conditions can result in Controlled Flight into Terrain (CFIT) or collision with other obstacles.



▲ Curtiss-Wright’s VPX3-4936 GPU module delivers 17.7 TFLOPS and 68 dense/136 sparse Tensor TOPS

Modern DVE systems use real-time fusion of multiple passive and active sensors capable of deep penetration through environmental obscurants to provide a clear picture of the environment around the aircraft. Hazard detection and highlighting software provides terrain and obstacle proximity alerts and symbology on the fused imagery aligned to terrain map data. Due to the level of criticality, DVE systems generally require safety-critical design up to RTCA DO-178 DAL A.”

Jaenicke notes GHS’ INTEGRITY-178 tuMP RTOS has been used on multiple DVE systems to provide the basis for safety certification. “Because both real-time sensor fusion and obstacle detection are computationally demanding, it helps to have a safety-critical RTOS like INTEGRITY-178 tuMP that can utilize all the processor cores in a modern CPU while maintaining safety-critical operation,” Jaenicke says. ◀

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Fourteen avionics suppliers to provide aviation parts support for KC-46 aerial tanker

BY John Keller

WRIGHT-PATTERSON AFB, Ohio – Fourteen U.S. avionics suppliers will share nearly two billion dollars to support the U.S. Air Force and allied KC-46 Pegasus aerial tanker aircraft.

U.S. Air Force aircraft maintenance experts will rely on these 14 electronics components suppliers to provide spare electronics parts for U.S. and allied KC-46A tankers under terms of contracts collectively worth a potential \$1.9 billion.

The 14 companies are:

- AAR Government Services Inc. in Wood Dale, Ill.;
- Aircraft Technical Development Inc. in Van Nuys, Calif.;
- Aviation Repair Technologies LLC in Blytheville, Ark.;
- Collins Aerospace in Cedar Rapids, Iowa;
- Davenport Aviation Inc. in Columbus, Ohio;
- Honeywell Aerospace in Tempe, Ariz.;
- S&K Logistics Services LLC in Saint Ignatius, Mont.;
- SOI Aviation Inc. in Calabasas, Calif.;
- Source One Spares LLC in Houston;
- The Boeing Co. in Seattle;
- VC Displays Inc. in Brooksville, Fla.;

▲ The Air Force will rely on 14 avionics suppliers to support the KC-46 aerial tanker, shown above.

- Velo Aviation LLC in San Diego;
- VSE Aviation Services Inc. in Miramar, Fla.;
- Silver Wings Aerospace Inc. in Homestead, Fla.

The KC-46 tanker aircraft is based on the Boeing 767-300 widebody passenger jet. The multirole aerial tanker can refuel all U.S., allied, and coalition military aircraft compatible with international aerial refueling procedures. In addition to refueling other aircraft in midair, the KC-46 also can carry passengers, cargo, and medical patients.

The KC-46 aircraft can detect, avoid, defeat, and survive threats using several layers of electronic protection that enable it to operate safely in medium-threat environments, Boeing officials say.

Honeywell Aerospace, Northrop Grumman Corp., and Raytheon Technologies Corp. are among the companies providing avionics subsystems and components for the KC-46.

Honeywell Aerospace in Coon Rapids, Minn., provides the air data inertial navigation system for the KC-46, while the company's facility in Phoenix provides the auxiliary power unit. The Honeywell Aerospace facility in Tucson, Ariz., provides the KC-46 cabin pressure control system, while the company's facility in Urbana, Ohio, provides the tanker's lighting system.

The Northrop Grumman Electronic Systems segment in Rolling Meadows, Ill., provides the KC-46's Large Aircraft Infrared Countermeasures (LAIRCM), while the Raytheon Intelligence & Space segment in El Segundo, Calif., provides the tanker's digital radar warning receiver and digital anti-jam global positioning system (GPS) receiver.

The Raytheon Collins Aerospace segment in Cedar Rapids, Iowa, provides the KC-46 integrated display system with 15.1-inch diagonal liquid crystal displays, which are based on the avionics suite for the Boeing 787 Dreamliner passenger jet.

Collins Aerospace also provides the KC-46's tactical situational awareness system, remote vision system 3-D and 2-D technology for the boom operator, the communications, navigation, surveillance (CNI) system, networking, and flight-control systems.

The Leonardo DRS Technologies Inc. Laurel Technologies Partnership in Johnstown, Pa., provides the KC-46's aerial refueling operator station (AROS). The Eaton Aerospace facility in Grand Rapids, Mich., provides the tanker's electromechanical and cargo door actuation systems.

Woodward Inc. in Skokie, Ill., meanwhile, provides the sensor system, control unit, and telescopic and flight control sticks for the KC-46's aerial refueling boom.

GE Aviation Systems facilities in Grand Rapids, Mich., and Clearwater, Fla., provide the KC-46 mission control system avionics, which provide integrated communications management to support air traffic management data link, and enable the aircraft to perform with navigation precision not currently available to the tanker fleet.

GE Aviation also provides the KC-46 flight management system (FMS), which helps the aircraft fly relatively short flight paths and idle-thrust descents to reduce fuel consumption, while lowering emissions and reducing engine noise.

The KC-46 will replace the Air Force's fleet of KC-135 aerial refueling aircraft, which are based on the 1960s-vintage Boeing 707 four-engine passenger jet. Boeing will build as many as 179 KC-46 aircraft. ←

On these contracts the 14 companies will do the work in various locations, and should be finished by October 2027. After the initial minimum award delivery order, all vendors will compete for follow-on orders.

Raytheon to build ESSM radar-guided missiles for surface ship defense

BY John Keller

WASHINGTON – Missile experts at Raytheon Technologies Corp. will build next-generation shipboard missiles able to defeat a wide variety of aircraft and missile threats with active radar guidance that can operate independently of the launch ship under terms of a \$397.7 million order.

Officials of the U.S. Naval Sea Systems Command in Washington are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., for RIM-162 Evolved Seasparrow Missile (ESSM) Block 2 assemblies, shipping containers, and spare parts. This order exercises options on a six-year contract the Navy awarded to Raytheon in September 2021 potentially worth \$1.3 billion.

The radar-guided ESSM program is an international cooperative effort to design, develop, test, and procure ESSM missiles for enhanced ship defense. The ESSM Block 2 first was deployed with the Navy and allied navies last year. It is a ship self-defense missile with a dual-mode X-band radar seeker than can engage enemy planes and missiles at ranges beyond 25 miles. RIM stands for radar intercept missile.



Compared with its ESSM Block 1 predecessor, the ESSM Block 2 has increased maneuverability and other enhancements that enable the missile to defeat future threats to U.S. and allied navies operating in hostile environments, Raytheon officials say. The ESSM Block 2's active seeker will support terminal engagement without the launch ship's target illumination radars.

In addition to the U.S. Navy, the governments of Australia, Belgium, Canada, Denmark, Germany, Greece, The Netherlands, Norway, Portugal, Spain, and Turkey will operate ESSM Block 2 anti-air missile.


The ship defense ESSM is a medium-range, semi-active homing missile that makes flight corrections via radar and midcourse data uplinks. The missile provides reliable ship self-defense capability against agile, high-speed, low-altitude anti-ship cruise missiles, low velocity air threats like helicopters, and high-speed, maneuverable surface threats.

The missile is 12 feet long and has 10-inch-diameter control and rocket motor sections that taper to an 8-inch-diameter guidance section with a radome-protected antenna for semi-active homing and a warhead. It has a high-thrust, solid-propellant rocket motor and tail control via a thrust vector controller.

The first production ESSM Block 1 was delivered in late 2002 and has been in full operational use in the U.S. since 2004.

On this order Raytheon will do the work in Tucson, Ariz.; Edinburgh, Australia; San Jose, Westlake Village, and Torrance, Calif.; Raufoss, Norway; Mississauga and Cambridge, Ontario; Ottobrunn, Germany; Nashua, N.H.; Hengelo, Netherlands; Koropi Attica, Greece; Canton, N.Y.; Ankara Turkey; Grenaa, Denmark, and should be finished by March 2027. ←

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



The radar-guided ESSM program is an international cooperative effort to design, develop, test, and procure ESSM missiles for enhanced ship defense.

Radiation-hardened power switch controller introduced by CAES

CAES in Arlington, Va., is introducing the Smart Power Switch Controller (SPSC) for power electronics designs in high-reliability space applications. The SPSC offers extensive fault detection, isolation, and recovery capabilities in one package. The radiation-hardened device features a high level of space assurance, wide temperature range, and quick fault detection and recovery. The Smart Power Switch Controller offers extensive fault detection, isolation and recovery capabilities in one package. The device offers PMBus, which communicates over an I2C serial bus. This two-wire command, configuration and control protocol can manage dozens of power switch channels with a small host controller. The device is also a power bus protection device, with the ability to detect high- and short-circuit faults and isolate the circuit in 250 nanoseconds. CAES's radiation-hardened design techniques meet high-reliability mission profiles and can withstand harsh environments, including QML-Q and QML-V for military and space-grade qualification. For more information contact CAES online at <https://caes.com>. ←

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Military researchers eye unmanned vehicle swarms for reconnaissance and attack

BY John Keller

ARLINGTON, Va. – U.S. military researchers are asking industry to develop the ability dynamically to control swarms of unmanned autonomous vehicles to help penetrate sensitive enemy military areas.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a broad agency announcement (HR001123S0010) for the Autonomous Multi-Domain Adaptive Swarms-of-Swarms (AMASS) project.

AMASS seeks to develop theater-level measures to counteract enemy counter-anti-access and -area-denial technologies by using a common command-and-control language for theater-level counter-anti-access / area denial (A2/AD) capabilities.

The \$78 million project will go to one contractor, which will develop ways to command unmanned autonomous swarms using a common command language for reconnaissance and attack of protected enemy areas.

▲ **The DARPA AMASS project seeks to develop theater-level measures to counteract enemy counter-anti-access and -area-denial technologies by using a common command-and-control language.**

Researchers say unmanned aircraft, surface vessels, and ground vehicles have perhaps the best chance of operating inside enemy protected areas by taking advantage of artificial intelligence (AI) and machine autonomy to enable unmanned vehicles to operate in enemy territory safely and undetected using a distributed command system.

AMASS will build on previous research to create a swarms-of-swarms system that simultaneously will threaten high-valued enemy assets, introduce intolerable cost-exchanges, and enable operations within enemy secure areas.

Affordable unmanned swarms with diverse sensors and weapons would be pre-positioned forward and launched remotely, providing rapid response and adaptability without putting human operators of ships, aircraft, and land vehicles at risk.

AMASS will capitalize on technologies developed for DARPA's System-of-Systems Enhanced Small Unit (SESU) program, which demonstrated that many heterogeneous autonomous swarms present a significant dilemma to enemy defenses.

SESU developed technologies to plan and carry-out counter-anti-access missions with swarms; swarm behavior software that enables the swarms to carry-out missions independently and adapt to change; communications, navigation, and weapons payloads; and modeling and simulation.

Central to the AMASS program is the ability to plan and carry-out missions that use thousands of autonomous vehicles to damage or destroy enemy anti-access capabilities.

To facilitate seamless operations of disparate swarms, AMASS will develop a common swarm language called the Swarms-of-Swarms Protocol (SOSP) to enable swarms running different autonomy software to interact with the AMASS command system.

The SOSP language will enable the AMASS command system to request services, negotiate, and exchange information with available swarms. The language will help control several heterogeneous swarms with different capabilities. AMASS will adapt to new threats and theaters of operation using open software and hardware interfaces that can be modified rapidly. ◀

Companies interested were asked to respond by 10 Feb. 2023. Email questions or concerns to DARPA at HR001123S0010@darpa.mil. More information is online at <https://sam.gov/opp/2929a61ea2bd44f7a68095449e1fd68d/view>.

Gigabit Ethernet cameras for aerial imaging introduced by Teledyne DALSA

Teledyne DALSA in Waterloo, Ontario, is introducing the M/C8200 and M/C6200 Genie Nano-10 Gigabit Ethernet cameras for application upgrades requiring high-speed data capture and transfer. The image sensors are for electronics manufacturing inspection, industrial metrology, intelligent traffic systems, aerial imaging, sports, and entertainment. The M/C8200 and M/C6200 are based on the Teledyne e2v 67M and 37M monochrome and color sensors, and offers higher interface speeds and resolutions than previous generations. "The Teledyne e2v Emerald 67M global shutter CMOS image sensor provides excellent performance and image quality for high-end optical inspection," says Manny Romero, senior product manager at Teledyne DALSA. The Genie Nano-10 Gigabit Ethernet 67M camera is one of the smallest 10 Gigabit Ethernet vision camera in the industry achieving full resolution image transfer at speeds to 15 frames per second. The M/C8200 and M/C6200 offer wide operating temperature ranges, PTP synchronization, and commonality of sizes with other Genie Nano cameras. Coupling a 59-by-59-millimeter form factor, system designers can switch from 1-, 2.5-, 5-Gigabit Ethernet to 10-Gigabit Ethernet vision without the need for software changes. Genie Nano 10 Gigabit Ethernet cameras are engineered to deliver high-speed, dependable results for applications such as electronics manufacturing inspection, industrial metrology, intelligent traffic systems, aerial imaging and sports and entertainment. For more information contact Teledyne DALSA online at www.teledynedalsa.com/imaging.

AUVSI to help states prepare for the future of advanced aviation

The Association for Uncrewed Vehicle Systems International (AUVSI) announced the launch of "Drone Prepared," a multi-state initiative to help lawmakers ensure that their state or locality is ready for the benefits the future of uncrewed and autonomous flight will bring to their communities. AUVSI notes that commercial drone operations are already providing essential services to the American public and hold immense promise to simultaneously provide workforce, economic, and environmental benefits to the communities where they operate. Examples of commercial drone operations include infrastructure inspections, package delivery, wireless internet and cell connectivity, agricultural surveying and many more. Drones are also being used by first responders to save lives serving search and rescue, firefighting, and police departments across the country. "State, local, and tribal governments have a key role to play in the growing drone economy and the Drone Prepared campaign provides critical resources for communities to understand the complex, evolving industry and begin preparing in ways that will welcome the industry, and its benefits, to their geographies," said Michael Healander, President & CEO at Airspace Link, an AUVSI Premium Member. Michael Smitsky, Director, Government Affairs at AUVSI, said: "The potential for expansion of commercial drone operations remains tremendous. We welcome opportunities to share with lawmakers how they can unlock scalable, secure and sustainable commercial drone operations that will benefit their communities – while maintaining the highest levels of airspace safety and regulatory compliance." ◀



Police for the first time deploy beyond-visual-line-of-sight drones in Israel

BY Jamie Whitney

HERZLIYA, Israel - Israeli Police, a civilian police force, needed an autonomous uncrewed aerial system to conduct command, surveillance and intelligence missions beyond visual line of sight (BVLOS) for the first time. They found their solution from FlightOps in Herzliya, Israel.

Using the FlightOps Ltd. multi-drone operating system, the Israel Police deployed a drone owned by FlyTech in Jerusalem in October to conduct the missions.

The uncrewed areal system (UAS) was placed at the Modi'in-Maccabim-Reut station to serve as a first responder to incidents throughout the city. The FlightOps operating system works by installing software onto a drone of any type, which converts the drone into an autonomous aircraft.

The drone then communicates with a cloud-based operation center through 5G networks allowing for automated fleet operation in shared airspace.

This system performed several missions in Modi'in-Maccabim-Reut, a city between Tel-Aviv and Jerusalem with approximately 93,000 residents.


▲ **Israeli Police have deployed beyond-line-of-sight unmanned aircraft from FlyTech in Jerusalem.**

Immediately after a traffic accident was reported, the drone was dispatched and arrived at the scene before the rescue teams, providing the police control room with a live and clear picture of the scene.

As part of another late-night incident, the police reported a suspected terrorist, and a drone was dispatched to the scene, providing the patrol unit with aerial infra-red video of the roofs and open air to assist in the search. One of the longest trips reached 10.4 kilometers - or 6.5 miles.

Ayalon Highways, the Civil Aviation Authority, the Innovation Authority and the Smart Transportation Administration conducted the experiment as part of the Israeli National Drone Initiative (INDI).

The experiment was conducted to test the operation of a drone as a first responder (DFR) to police hotline calls. Only a few minutes after receiving a call, the drone was dispatched to provide a complete and real-time situation picture to the forces in the field. ◀



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▲ such a space helmet-mounted display could enable communications between crew and mission control by adding dynamic visual cueing.

NASA wants augmented reality helmet display for astronauts outside the spacecraft

BY John Keller

CLEVELAND – U.S. space researchers are asking industry to develop an augmented reality display system for use on the bubble of an astronaut's spacesuit helmet to help space crews make quick decisions without help from mission controllers on Earth.

Officials of the National Aeronautics and Space Administration (NASA) Glenn Research Center in Cleveland have issued a request for information (80GRC023R0002) for the Joint Augmented Reality Visual Informatics System project.

This spacesuit augmented reality display system would be a spacesuit-compatible augmented reality system with display, control, and computer subsystems to help astronauts complete tasks while they are working outside of their spacecraft.

Augmented reality (AR) blends a view of the physical world with digital images, video, text, or other information. It helps produce visual overlays to imagery, or provides written information beside what the viewer sees, such as a digital repair manual application.

Future suited crew operations must be self-reliant because communications delays in space slow the ability for crew members to interact with Earth-based mission control in real-time.

In the near-term, such a space helmet-mounted display could enable communications between crew and mission control by adding dynamic visual cueing. In the long-term, this display could help enable interplanetary human exploration by

supplementing — and in some cases replacing — Earth-based mission support, and enable the crew to make quick decisions on their own.

NASA researchers would like to develop ability to display information comfortably to the suited crew member via a minimally intrusive see-through display located on the helmet bubble about four inches from the astronaut's eyes. Researchers are not considering head-worn displays for this project.

Instead, the spacesuit augmented reality display system would work like a fighter pilot's head-up display, except the spacesuit helmet volume prohibits conventional HUD designs. It also will require an eye-box much larger than typically seen for head-worn systems.

The eye box should be 50 by 50 millimeters, or larger; have at least a 30-degree field of view; eye relief of 40 to 100 millimeters; brightness of at least 1,000 nits; weigh no more than four pounds; and use no more than five Watts of power.

Ultimately, NASA researchers would like a full-color binocular display, but first-generation displays may be monochrome monocular. The display should fit on the spacesuit helmet bubble mold line, and not be large enough to interfere with normal crew operations.

Elements within the helmet-bubble must be compatible with a 100 percent oxygen atmosphere. Powered elements within the 100 percent oxygen will be subjected to special scrutiny to mitigate flammability and safety concerns. System elements must be rugged enough to operate in vacuum, dust, radiation, and extreme thermal environments.

Researchers also would like the display to mitigate vergence-accommodation conflict, which means that astronauts should be able to view information while gazing at far-away objects. Crew members should be able to use the display comfortably for as long as eight hours.

From industry, researchers would like answers to four questions: how existing augmented reality systems can be modified or scaled to meet requirements; how technologies under development could meet key optical requirements inside a space helmet; which requirements pose the most technically difficult challenges; and how the display could influence spacesuit design and meet environmental requirements. ◀

Companies interested were asked to email responses by 17 March 2023 to NASA's Rita Dickens at rita.k.dickens@nasa.gov. Email questions or concerns to Rita Dickens, the NASA Joint Augmented Reality Visual Informatics System contracting officer, at rita.k.dickens@nasa.gov. More information is online at <https://sam.gov/opp/3d2c644875e04a21bb40ae765afb26/view>.

Lockheed Martin hits cost snag in developing F-35 spherical electro-optical sensors

Combat aircraft experts at Lockheed Martin Corp. have hit a cost snag in developing and testing 360-degree electro-optical sensor systems for the U.S. F-35 joint strike fighter that are designed to give the pilot a spherical view of the airspace outside the cockpit. Officials of the U.S. Naval Air Systems Command have announced an \$11.2 million order to the Lockheed Martin Aeronautics segment in Fort Worth, Texas, to cover a cost overrun in the next generation electro-optical Distributed Aperture System (DAS) sensors for the F-35. The electro-optical DAS collects real-time, high-resolution imagery from six infrared (IR) cameras mounted around the aircraft and sends the imagery to the pilot's helmet-mounted display to provide a 360-degree spherical view of the environment. The next-generation electro-optical DAS is from the Raytheon Technologies Corp. Intelligence & Space segment in McKinney, Texas. Lockheed Martin integrates the system aboard the F-35. The electro-optical DAS sensor has been a particular challenge to design, build, and test. It's one of the most advanced sensors aboard modern jet fighter aircraft, and is expected to give pilots an unprecedented capability to see what's around the aircraft, and to help give early warning of incoming missile threats. The system's original manufacturer was Northrop Grumman Corp., but the Pentagon and Lockheed Martin switched suppliers of the system to Raytheon in mid-2018. The Raytheon-built DAS sensor system will be integrated into F-35 aircraft starting with Lot 15 aircraft, expected to begin deliveries in 2023. For more information contact Lockheed Martin Aeronautics online at www.lockheedmartin.com, Raytheon Intelligence & Space at www.raytheonintelligenceandspace.com, or Naval Air Systems Command at www.navair.navy.mil.

4K camera for machine vision and unmanned vehicles introduced by Active Silicon

Active Silicon Ltd. in Pinewood Mews, England, is introducing the Harrier 23x AF-Zoom IP 4K camera for networked surveillance, industrial inspection, medical imaging, unmanned aircraft, and remotely operated vehicles. The Ethernet zoom camera offers autofocus-zoom and IP capability, and offers real-time 4K video output and 23x optical zoom. It features a 8.3-megapixel Sony CMOS sensor and provides low-latency H.265/H.264 video output. The camera for machine vision offers a 23x optical zoom, 16x digital zoom, day and night mode with infrared cut filter removal, digital image stabilization, and the Open Network Video Interface (ONVIF) industry standard for camera control. These cameras also feature additional video output options like SDI, USB 3 and HDMI; global or rolling shutter and powerful zoom. For more information contact Active Silicon online at www.activesilicon.com. ◀

Raytheon to upgrade guidance hardware and boost cyber security on AIM-9X missiles

BY John Keller

PATUXENT RIVER NAS, Md. — U.S. Navy aerial warfare experts are asking Raytheon Technologies Corp. to upgrade electronics hardware and software in the U.S. AIM-9X precision short-range infrared-guided air-to-air missiles for jet fighters and other combat aircraft.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced a \$225.6 million five-year contract to the Raytheon Missiles and Defense segment in Tucson, Ariz., to carry out the AIM-9X Block II and Block II+ System Improvement Program Increment IV to include hardware and software development, test, and integration.

Raytheon engineers will update the AIM-9X infrared sensor, electronics unit, and guidance unit hardware, develop the missile's operational flight software versions 10.5 and 11.5 and integrated flight software, as well as provide program protection, cyber security, information assurance, and training for the AIM-9X system.

The AIM-9X is an advanced infrared- and heat-seeking air-to-air missile for the U.S. Navy, Air Force, and foreign allies.

Typically the missile homes-in on the hot exhaust of enemy aircraft engines.

The missile equips most jet fighters, fighter-bombers, and other offensive combat aircraft in the U.S. arsenal, and is for shooting down enemy aircraft close-by. Variants of the AIM-9 Sidewinder have been deployed since the 1950s.

The AIM-9X is among the latest versions of the AIM-9 missile family. It entered service in 2003 on the Navy F/A-18C Hornet fighter-bomber and on the U.S. Air Force F-15C jet fighter. It has an imaging infrared focal plane array seeker with 90-degree off-boresight capability for accuracy.

The missile is compatible with helmet-mounted displays such as the U.S. Joint Helmet Mounted Cueing System, and features 3-D thrust-vectoring control for increased turn capability. The AIM-9X also includes an internal cooling system.

This contract involves the latest versions of the AIM-9X, called the AIM-9X Block II and AIM-9X Block II-plus. This newest version has lock-on after launch capability for use with the F-35 Lightning II joint strike fighter and the F-22 Raptor advanced tactical fighter.

The AIM-9X Block II-plus features specialized external materials to enhance aircraft survivability for the F-35. Until another version of the AIM-9X is developed that will fit inside the F-35's enclosed weapons bay, the AIM-9X Block II-plus has stealthy coatings and structures to help reduce the missile's radar cross-section when the F-35 carries these missiles externally.

On this contract Raytheon will do the work in Tucson, Ariz.; Goleta, Calif.; Newtown, Pa.; North Logan, Utah, and at other U.S. locations, and should be finished by September 2027. ◀



Raytheon engineers will update the AIM-9X missile's infrared sensor, electronics unit, guidance unit, and develop the missile's operational flight software.

For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesand-defense.com, or Naval Air Systems Command at www.navair.navy.mil.



AVIONICS COMPUTERS

▲ Boeing to install Honeywell avionics computers aboard Air Force F-15 combat jets

Military avionics experts at the Boeing Co. are will integrate the Advanced Display Core Processor (ADCP) II into the avionics of the U.S. Air Force F-15 combat jet under terms of a \$7.5 million order.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, are asking the Boeing Defense, Space & Security segment in St. Louis to handle full-rate ADCP II production to install these computers onto F-15 aircraft.

Boeing is the prime systems integrator for all versions of the F-15 Eagle combat jet. The ADCP II flight computer comes from the Honeywell Inc. Aerospace segment in Phoenix.

The computer is based on commercial technology and provides multi-core processing capabilities. Its high-speed processing and interface designs enable advanced systems integration, increased mission effectiveness, augmented fault-tolerance, enhanced system stability, and aircrew survivability, Air Force officials say.

The ADCP II is pivotal to F-15 jet fighter upgrades to enable the 1970s-vintage aircraft to help maintain U.S. air superiority for the F-15's anticipated life cycle through 2040.

The computer provides mission processing for new advanced capabilities such as Eagle Passive/Active Warning Survivability System (EPAWSS), long-range infrared search and track capability (IRST), high-speed radar communications, and future software suite upgrades.

On this order Boeing will do the work in St. Louis; several other continental U.S. operating locations; and Lakenheath, England, and should be finished by July 2025. For more information contact Boeing Defense, Space & Security online at www.boeing.com/company/about-bds, Honeywell Aerospace at <https://aerospace.honeywell.com>, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

WEARABLE POWER

▼ Army chooses Galvion for soldier-wearable battery charging in harsh conditions

U.S. Army researchers needed a lightweight wearable power-management and battery-charging system to support cold weather operational testing in Alaska. They found their solution from Galvion Soldier Power LLC in Marlborough, Mass.

Officials of the U.S. Army Contracting Command-Aberdeen Proving Ground (ACC-APG), Aberdeen Proving Ground, Natick Contracting Division in Natick, Mass., have announced their intention to award a sole-source contract to Galvion for the Squad Power Manager project. The value of the contract has yet to be negotiated.

The Galvion SPM622 60-Watt roll kit and cables will support cold weather testing in Alaska by enabling battery charging with two solar blankets and generator mains that use an AC-DC power adapter.

The SPM622 can charge a wide range of batteries such as the Army's Conformal Wearable Battery (CWB) and the BB-2590 family of batteries. It also supports power and charge capability for tactical radios like the Army AN/PRC 148, 152, 163, and the Persistent Systems MPU5 tactical military radio for unmanned vehicle control.

The SPM622's bi-directional charging and load balancing capabilities can charge depleted batteries during testing to extend mission run times in austere environments. The SPM622 is the only readily available power management and recharging system that will be able to meet all of the requirements for this operational test, Army officials say.

The Galvion squad power system goes by the commercial name of Nerv Centr, which helps deployed soldiers store, deliver, harvest, and share power with reduced physical weight for operators on the battlefield.

Army soldiers today are part of a mobile network of users and radios, night-vision goggles (NVGs), Global Position



System (GPS) receivers, smartphones, laptop computers, unmanned aerial vehicles (UAVs), and other electronic equipment, Galvion officials explain.

The challenge is the power all of these devices with batteries across long distances and for extended durations. The Galvion Nerv Centr power supply and management products enable users to manage power at the individual or squad level like they manage ammunition and water by making sure power is available when needed, with reduced logistics costs.

The Galvion Nerv Centr power products include slim lithium batteries, power managers, and intelligent battery-charging systems. The slim lithium-ion units can store, deliver, and harvest power, while eliminating excess cabling and the need for spare batteries.

Nerv Center products use power managers and battery chargers that draw from any source to power equipment and recharge batteries simultaneously.

Nerv Centr systems include the SoloPack energy module that is the same size and weight as a 30 round ammunition magazine, and can provide enough energy for a 12-hour mission, Galvion officials say.

The Squad Power Manager (SPM) and Individual Power Manager (IPM) are compact rugged power-management solutions with intelligent software that enable the users at the squad and individual level to power a variety of equipment and recharge batteries with no reprogramming required.

Nerv Center's Mission Adaptive Charging Station (MAX-8) can charge several batteries through custom-made adapters, while automatically evaluating the power source and adjusting charge rates to minimize charge time. Galvion has created power kits for the U.S. Marine Corps, Air National Guard, and other international operators, company officials say.

More information on this upcoming contract is online at <https://sam.gov/opp/9ede5847ef7745b2b9718361c89ffe1f/view>. For more information contact Galvion online at www.galvion.com, or the Army Contracting Command-Aberdeen Proving Ground at <https://acc.army.mil/contractingcenters/acc-apg/about-us/>.

WEAPONS LAUNCHERS

► Lockheed Martin to build artillery launchers for extended-range smart munitions

Artillery fire support experts at Lockheed Martin Corp. will build M270A2 Guided Multiple Launch Rocket Systems (GMLRS) field artillery systems for the U.S. Army under terms of a \$476.8 million contract.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking the Lockheed Martin Missiles and Fire Control segment in Grand Prairie, Texas, to produce the GMLRS, which will fire MLRS rockets, Army Tactical Missile System (ATACMS) missiles, and the Army's future Precision Strike Missile (PrSM) and Extended-Range GMLRS rockets.

GMLRS is a heavy tracked mobile munitions launcher, transportable via C-17 and C-5 aircraft. The M270A2 is an upgraded variant of the Lockheed Martin M270 MLRS. The A2 version features the Common Fire Control System (CFCS), as well as new engine, transmission, launcher-loader modules, and improved armored cabs.

GMLRS smart munitions will have three variants: the Guided MLRS Unitary; Guided MLRS Alternative Warhead; and the Extended-Range Guided MLRS.

The CFCS will be common to the Army MLRS and to the High-Mobility Artillery Rocket System (HIMARS). The CFCS will help enable the MLRS to fire the extended-range GMLRS munition.

The Army ordered the first 50 M270A2 upgrade kits through a \$362 million contract in April 2019 with deliveries expected to complete by 2022. Last March the Army awarded a \$224 million order to Lockheed Martin to upgrade existing M270A1 and decommissioned M270A0 MLRS artillery pieces to the new M270A2 configuration.

On this contract Lockheed Martin will do the work locations to be determined with each order, and should be finished by August 2025. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com/en-us/who-we-are/business-areas/missiles-and-fire-control.html, or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa>. ◀



POWER ELECTRONICS

► High-voltage AC-DC integrated power stages for battery chargers offered by Infineon

Infineon Technologies AG in Munich is introducing the CoolSET 800- and 950-volt AC-DC integrated power stages for AC-DC converters, motor control, motor drives, solar energy systems, and auxiliary power supplies for home appliances. These fixed-frequency high-voltage power supplies are housed in a DIP-7 package, and combine a pulse-width-modulation (PWM) controller integrated circuit with the CoolMOS P7 superjunction metal oxide semiconductor field-effect transistors (MOSFETs) in one package. The power electronics devices use an avalanche-rugged superjunction MOSFET with a breakdown voltage of 950 volts to allow for a wide input voltage. The devices enable isolated and non-isolated topologies such as flyback or buck, and operate at switching frequencies of 100 and 65 kHz. An integrated error amplifier supports direct feedback from the primary output, and minimizes design complexity. The frequency reduction mode with soft gate driving and frequency jitter operation offers low electromagnetic interference and enhances the efficiency between mid- and light-load conditions. The devices also support continuous conduction mode and discontinuous conduction mode. For low AC line input conditions, continuous conduction mode can achieve low conduction losses and higher efficiency to meet international regulatory standards for energy efficiency. At the same time, the integrated MOSFET supports an ultra-wide input voltage range commonly associated with single-phase smart metering and industrial applications. In addition, the devices help to optimize the snubber circuitry to enhance efficiency and lower standby power consumption of the converter. All devices come with a suite of protection features with auto-restart to support the power supply system in failure situations. Active burst mode improves the light-load performance and enables ultra-low standby power consumption with small and controllable output voltage ripple. For more information contact Infineon Technologies online at www.infineon.com.



RUGGED COMPUTERS

▼ SOSA-aligned high-reliability computer for command and control offered by Concurrent

Concurrent Technologies plc in Colchester, England, is introducing the Helios vision computer system for mission-critical military applications. The ITAR-free commercial off-the-shelf (COTS) vision computer system offers optimized size, weight, power, and cost (SWaP-C) that operates reliably in harsh environments. The new vision computer is based on a high-performance Intel Core i7 processor mated with an Nvidia graphics module with sufficient I/O and storage for applications like command and control displays, degraded-vision enhancement, and 360-degree vehicle navigation. The system is designed in alignment with the Sensor Open Systems Architecture (SOSA) specification, which will enable



Concurrent Technologies to launch future rugged storage, sensing, and control systems by using a different mix of plug-in cards. For more information contact Concurrent Technologies online at www.gocct.com.

DISPLAYS

▼ Mil-spec avionics displays for pressure information introduced by Neuro Logic Systems

Neuro Logic Systems Inc. in Camarillo, Calif., is introducing two mil-spec ultra-rugged panel-mount displays for aerospace and defense applications. The PM-24-PIP-28 is a ruggedized liquid crystal display (LCD) monitor engineered for deployment in military avionics. The machined and welded aluminum alloy housing is gasket sealed to IP65 for dust, sand, water, and humidity. Pressure relief valves protect against high and low pressure variations including rapid decompression. The PM-24-PIP-28 features a 1920-by-1080-pixel FHD LCD panel with a wide color gamut. The Military-grade DC power supply accepts 12-to-36-volt DC inputs with transient and surge protection to MIL-1275/-704 standards. A proprietary heating circuit brings the display from cold storage at -40 degrees Celsius to operational temperature at 0 C in 10 minutes



NEW PRODUCTS

or less. Features in this mil-spec display include dual-link DVI and 3G-SDI video input with picture-in-picture and split screen operation. The PM-24-PIP-28 has been MIL and DO 160 tested and certified and is deployed on U.S. Air Force turbo-prop aircraft. The PM-27-SDI-28-313 is a rugged LCD monitor engineered for deployment on military aircraft and in other harsh environments. The machined and welded aluminum alloy housing is gasket sealed to IP65 against dust, sand and water incursion. The Quad HD LCD is optically bonded to 3-millimeter chemical-strengthened glass and tested to DO-313 impact standards to prevent adverse effects to the safety of the aircraft and its occupants. For more information contact Neuro Logic Systems online at <https://nlsdisplays.com>.

POWER ELECTRONICS

► High-current SMD fuse to cut batteries from power systems offered by SCHURTER

SCHURTER Inc. in Santa Rosa, Calif., is introducing the fast-acting UHP high-current SMD fuse to interrupt

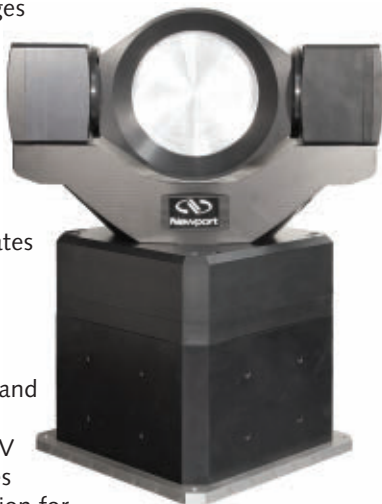
high-energy overcurrent safely in batteries for automotive, data center equipment, telecommunications equipment, and power tools. Specially designed for safety extra low voltage (SELV) applications, the UHP meets the high-breaking capacity requirements and fast trip time of an overcurrent situation by separating these immense energies galvanically. Today, lithium-ion batteries are the most prolific battery technology in numerous industries, and their areas of application continue to grow exponentially. Modern smart phones and EV cars, for example, rely heavily on lithium-ion batteries for their fast charging capabilities, energy storage, and extended battery life. In the event of a short circuit in the



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battery system, high amounts of stored energy can be released quickly. Such a short circuit event poses damage to the system and could result in a fire; the fuse serves as the primary protection against such unsafe conditions and must address the high current on the circuit board, where more power must be converted and dissipated. SCHURTER's UHP fuse disconnects the circuit at twice the rated current within a maximum of 15 seconds. The rated breaking capacity of the UHP is as much as 3000 amps of power, depending on the configuration. The UHP allows for reflow solder process compatibility and space savings on the circuit board. It operates in temperatures from -55 to 125 degrees Celsius. The UHP is available in six current ratings from 50 to 100 amps at 80 volts DC or 63 volts DC, depending on the required breaking capacity of 3000 or 2000 amps. It is cURus approved and meets the high-reliability requirements of AEC Q200. It is RoHS compliant, halogen-free, and bears the CE, UKCA, and REACH markings. Pricing for the UHP fuse starts at \$0.35 each at 500 pieces. For more information contact SCHURTER online at www.schurter.com. ←

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THE NEXT BIG THING IN RFSoc IS HERE

AND IT'S ONLY 2.5" × 4"

POWERFUL

SMALL

DEPLOYABLE

Models 6001 and 6003 QuartzXM modules enable the rapid integration and deployment of RFSoc technology. And the SWaP-friendly design is ideal for aircraft pods, unmanned vehicles and mast-mounted radars.

A Zynq® UltraScale+™ RFSoc plus a full suite of pre-loaded IP modules, robust Navigator® software, high-speed 100 GigE interfaces and fully integrated hardware from Mercury, formerly Pentek, helps shorten your development time and reduce your design risk.

[Form Factors]

QuartzXM Module
SOSA aligned 3U VPX
3U VPX
SFF platforms
PCIe