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# Air Force seeks to explore one of the last frontiers in RF communications



BY **John Keller**  
EDITOR IN CHIEF

Enabling technologies for electronic warfare (EW) capabilities are advancing quickly, which makes it urgent for the U.S. military to develop secure wireless RF and microwave systems that are somewhat immune to enemy attempts to jam, disrupt, or intercept.

Towards this goal, U.S. Air Force researchers are asking industry to develop radio communications that operate in one of the most difficult parts of the RF spectrum — frequencies approaching the never-before-achieved terahertz region, where state-of-the-art microprocessors, RF transmitters and receivers, and data conversion technologies so far have been unable to penetrate.

It's a tough proposition to explore these RF frequencies that operate at frequencies higher than 100 GHz. First, frequencies at these high ranges are unable to propagate well because these tiny waves absorb into the atmosphere and humidity so quickly. Recent attempts have been able to send RF energy only a few feet before evaporating into the air.

Still, the potential benefits are great. Since it's difficult to transmit and receive at such high frequencies, the probability of an enemy's ability to eavesdrop on them is essentially nil. Plus, their propagation characteristics make them steerable.

Potential benefits go beyond just point-to-point communications. RF energy at the terahertz level also holds promise for future medical sensors to detect skin cancers, and to enhance brain scans. Some experts say terahertz RF and microwave energy someday even might be able to detect odors.

The Air Force Research Laboratory Information Directorate in Rome, N.Y., have launched a research program that will take industry proposals until 2028 called the Ultra-Broadband Terahertz Radio Development project (FA8750-23-S-7009).

Radio frequencies above 100 GHz, commonly known as terahertz or sub-terahertz band, remain underused for communications, despite their potential to enable secure wideband applications for communications systems, Air Force researchers say.

Air Force researchers want to design, develop, and demonstrate an ultra-broadband radio that dynamically adjusts carrier frequency, output power, and data rate within the frequency range of interest — above 100 GHz.

Researchers want an ultra-broadband radio that dynamically adjusts carrier frequency, output power and data rate within 100 to 300 GHz using state-of-the-art modem design for fast flexible baseband that can support spreading bandwidth to 10 GHz and data rate of 1 megabit to 1 gigabit per second, as well as adapt to atmospheric conditions, link requirements, and the presence of interference. The system also should be able to form and shape the terahertz beams to control the signal's presence in time and space.

This project should be worth about \$10 million through 2028, and several contract awards are expected. For now, Air Force researchers are asking only for white papers.

Companies interested in participating are being asked to email white papers no later than 15 Dec. 2023 for 2024 awards; by 20 Sept. 2024 for 2025 awards; by 19 Sept. 2025 for 2026 awards; by 18 Sept. 2026 for 2027 awards; and by 17 Sept. 2027 for 2028 awards.

Email white papers to the Air Force's Ngwe Thawdar at [ngwe.thawdar@us.af.mil](mailto:ngwe.thawdar@us.af.mil), with copies to Claire Parisi at [claire.parisi@us.af.mil](mailto:claire.parisi@us.af.mil) and to Peter Ricci at [peter.ricci.1@us.af.mil](mailto:peter.ricci.1@us.af.mil). Email questions or concerns to the Air Force's Amber Buckley at [Amber.Buckley@us.af.mil](mailto:Amber.Buckley@us.af.mil). ◀



# Air Force asks industry to develop self-forming aerial networks for aircraft cooperation

BY John Keller

ROME, N.Y. — U.S. Air Force researchers are asking industry to develop on-demand, self-forming, and self-healing aerial communications networks to provide data and voice links to high-performance combat aircraft.

Officials of the Air Force Research Laboratory Information Directorate in Rome, N.Y., have issued a broad-agency announcement (FA875023S7002) for the Aerial Layer Networking & Transmission Technologies project.

Today's aerial layer networking requires significant pre-planning, and has limited interoperability, Air Force researchers explain.

▲ **The Aerial Layer Networking & Transmission Technologies project will capitalize on research in network monitoring and management and robust aerial networks.**

Instead, the Air Force wants to move to a significantly more on-demand, self-forming, and self-healing aerial layer network.

The Aerial Layer Networking & Transmission Technologies project will capitalize on research in network monitoring and management, robust aerial networks, and proof-of-concept capabilities.

*Continued on page 5*



# Raytheon to develop laser military wireless on-demand power network

BY John Keller

ARLINGTON, Va. — U.S. military researchers needed a company to design a high-altitude optical relay to create scalable on-demand power networks able to distribute about 10 kilowatts of electricity to military users as far away as 125 miles. They found their solution from Raytheon Technologies Corp. (RTX).

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced a \$10 million contract to RTX Raytheon in McKinney, Texas (formerly Raytheon Intelligence & Space) for the first phase of the Persistent Optical Wireless Energy Relay (POWER) project.

The goal is to demonstrate optical power-beaming relays not only as a resilient multipath alternative for expeditionary energy transport, but also to enable small-yet-persistent manned and unmanned aircraft to provide on-demand power for a wide range of military missions. Additional contracts may be awarded.

POWER optical technologies are expected to create an airborne relay capable of redirection, wavefront correction, and energy harvesting of optical beams. The ultimate goal is to use three airborne relay nodes hosted on existing aircraft to transmit energy from a ground source laser to 60,000 feet in altitude, and back down to a ground receiver 125 miles away.

To account for degradation of beam quality as the beam transmits atmospheric disturbances, Raytheon will develop a relay able to correct the optical wavefront as needed, and harvest energy from the optical beam to provide on-board auxiliary power.

POWER seeks balance energy generation, storage, and distribution for military missions by capitalizing on power beaming for near-instantaneous energy transport.

Military power today relies primarily on liquid fuels like jet fuel, gasoline, and diesel fuel, which are vulnerable to enemy attack and require significant infrastructure. Instead, POWER seeks to reduce the military's dependence on liquid fossil fuels, their delivery, and storage capacity.



**The goal is optical power-beaming relays for expeditionary energy transport and for small manned and unmanned aircraft.**

Speed-of-light energy transport through a multipath network would enable rapid reconstitution under attack, graceful degradation, and resilience by re-routing energy through the network in a matter of seconds or minutes, and restoring full capability by replacing nodes in minutes or hours.

The POWER program seeks to deliver 10 kilowatts of laser energy to the final ground node using a 50-kilowatt source laser, transmitted through three airborne relay nodes using system apertures smaller than one meter diameter.

In POWER's first phase, Raytheon will develop and mature a relay payload design, and design a relay platform. Later, the program will build a low-power demonstration relay, finally to demonstrate three airborne nodes relaying power to a ground receiver at White Sands Missile Range, N.M., using the High Energy Laser Systems Test Facility (HELSTF), and the RQ-4 Global Hawk large unmanned aircraft as an airborne relay. ◀

On this contract RTX Raytheon will do the work in El Segundo and Mojave, Calif.; Kent, Wash.; and Albuquerque, N.M., and should be finished by May 2025. For more information contact RTX Raytheon online at [www.rtx.com](http://www.rtx.com), or DARPA at [www.darpa.mil](http://www.darpa.mil).

*Continued from page 3*

This project is a follow-on to the Air Force Timely, Secure & Mission Responsive Aerial Warfighting Network Capabilities project, which seeks to develop aerial networking for contested, degraded and operationally limited environments.

The project also seeks to develop capabilities to manage and plan today's multi-link based airborne network environment and tomorrow's dynamic ad-hoc opportunistic architectures using autonomous human-in-the-loop network management and recovery to improve network reliability and survivability.

These new capabilities should enable the Air Force to transform current aerial layer networking a 'stitched together' state to one that is truly seamless, adaptive, and mission- environmentally-aware.

Of particular interest are hardware and software development; validation with model-based design and simulation; and hardware-in-the-loop validation techniques.

Focus areas are airborne network management and monitoring; network technologies to improve network monitoring; self-managing and self-healing autonomic wireless network capabilities; robust airborne networking in apertures, waveforms, and networking; aerial network security; heterogeneous aerial layer networks; next generation mesh networking; ad-hoc tactical edge mesh networking; and enhanced network robustness, resilience, and availability.

This project will involve technology demonstrations using advanced radios, waveforms, networking, and

management technologies; as well as low-cost demonstrations at Air Force facilities in Rome, N.Y. Funding will be about \$99.5 million, and involve several 36-month contracts.

Companies interested should email white papers to the Air Force's Timothy Weaver, the Aerial Layer Networking & Transmission Technologies program manager at [timothy.weaver.16@us.af.mil](mailto:timothy.weaver.16@us.af.mil). White papers for 2025 by 15 Sept. 2024, for 2026 by 15 Sept. 2025, and for 2027 by 15 Sept. 2026. ←

Email technical questions or concerns to Timothy Weaver at [timothy.weaver.16@us.af.mil](mailto:timothy.weaver.16@us.af.mil), and business questions to Amber Buckley at [Amber.Buckley@us.af.mil](mailto:Amber.Buckley@us.af.mil). More information is online at <https://sam.gov/opp/eff8f5cfd3943c2b6b8fc090b50fa30/view>.

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# Air Force hires 13 more companies for open-architecture command and control technologies

BY John Keller

**WRIGHT-PATTERSON AFB, Ohio** – U.S. Air Force researchers are enlisting the help of 13 additional technology companies to mature, demonstrate, and proliferate enabling technologies for military forces eventually to respond to global threats in 15 minutes or less under terms of contracts collectively worth nearly a billion dollars.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, have announced the 13 additional companies in the potential \$950 billion Joint All Domain Command and Control (JADC2) program.

This program seeks to develop and operate systems across air, land, sea, space, cyber, and electromagnetic spectrum military domains in an open-architecture family of systems that integrates several platforms to enable new warfighting capabilities.

The 13 additional companies selected last month that will share the \$950 million are:

- Applied Research Associates Inc. in Albuquerque, N.M.;
- Armaments Research Co. Inc. in Bethesda, Md.;
- BadVR Inc. in Pacoima, Calif.;
- CGI Federal Inc. in Fairfax, Va.;

- Flosum Corp. in San Ramon, Calif.;
- Management Services Group Inc., doing business as Global Technical Systems, in Virginia Beach, Va. (FA8612-23-D-B005);
- Convergent Solutions Inc., doing business as Exiger Government Solutions in McLean, Va. (FA8612-23-D-B006);
- Odyssey Systems Consulting Group LTD. in Wakefield, Mass.;
- Steeple Group LLC, doing business as Peregrine Defense, in Oklahoma City, Okla.;
- Picogrid Inc. in Hawthorne, Calif.;
- Rescue Rover LLC, doing business as AlphaBravo, in Gaithersburg, Md.;
- Rafael Systems Global Sustainment LLC in Bethesda, Md. (FA8612-23-D-B011); and
- Spotible Labs LLC in New York.

The 26 companies announced for this contract last summer are: ADDX Corp. in Alexandria, Va.; Capella Space Corp. in San Francisco; AT&T Corp. in Oakton, Va.; Applied Information Sciences Inc. in Reston, Va.; Atmospheric & Space Technology Research Associates LLC in Louisville, Colo.; Credence

Management Solutions LLC in Vienna, Va.; Edge Technologies Inc. in Arlington, Va.; EOS Defense Systems USA Inc. in Huntsville, Ala.; Exfo America Inc. in Richardson, Texas; Hermeus Corp. in Atlanta; Ierus Technologies Inc. in Huntsville, Ala.; Cyberspace Solutions LLC in Herndon, Va.; Labelbox Inc. in San Francisco; Nalej Corp. in New York; OST Inc. in McLean, Va.; Praeses LLC in Shreveport, La.; Real-time Innovations Inc. in Sunnyvale, Calif.; Riverside Research Institute in New York; Saber Astronautics LLC in Boulder, Colo.; Shared Spectrum Co. in Vienna, Va.; Shield AI Inc. in San Diego; Skylight Inc. in Sarasota, Fla.; Sparkognition Government Systems Inc. in Austin,



**The Joint All Domain Command and Control (JADC2) program. seeks to develop and operate systems across air, land, sea, space, cyber, and electromagnetic spectrum military domains.**



Texas; Tenet 3 LLC in Dayton, Ohio; Trace Systems Inc. in Vienna, Va.; Ultra Electronics Advanced Tactical Systems Inc. in Austin, Texas; and BrainGu in Grand Rapids, Mich.

In 2020, 24 additional companies were named to the program. They are: Altamira Technologies Corp. in McLean, Va.; Amergint Technologies Inc. in Colorado Springs, Colo.; Carahsoft Technology Corp. in Reston, Va.; Geosite Inc. in Stanford, Calif.; Lyteworx Automation Systems LLC in Alexandria, Va.; MarkLogic Corp. in San Carlos, Calif.; Rebellion Defense Inc. in Washington; Rhombus Power Inc. in Moffett Field, Calif.; Soar Technology Inc. in Ann Arbor, Mich.; Vidrov Inc. in New York; Advanced Simulation Research Inc. in Orlando, Fla.; Borsight Inc. in Ogden, Utah; Datanchor Inc. in New Albany, Ohio; Paste link here Digital Mobilizations Inc. in Warrenton, Va.; Elbit Systems of America in Fort Worth, Texas; F9 Teams Inc. in Seattle; Hewlett Packard Enterprise Co. in Reston, Va.; Infinity Labs LLC in Dayton, Ohio; Radiant Solutions in Herndon, Va.; Microsoft Corp. in Redmond, Wash.; Ortman Consulting LLC in Alexandria, Va.; Peraton Inc. in Herndon, Va.; Orbital Effects in Ann Arbor, Mich.; and Sierra Nevada Corp. in Sparks, Nev.

All of these companies will share as much as \$950 million over the next three years to mature, demonstrate, and proliferate capability across military systems and domains; as well as capitalizing on open-systems design, modern software, and algorithm development to enable JADC2.

These contracts provide awardees the opportunity to compete for efforts to develop and operate systems as a unified force across military air, land, sea, space, cyber, and electromagnetic spectrum domains in an open-architecture family of systems.

The Joint All Domain Command & Control (JADC2) — formerly referred to as Multi-Domain Operations (MDO) — seeks to develop technologies for multi-domain operations designed for real-time data collection, validation, and analysis; artificial intelligence (AI)-based human-augmented decision making; data security, identity, and trusted access; and real-time communications via decentralized network automation to speed-up military decision support, decision making, and communications. ◀

On these contracts, the companies will do the work at locations to be determined at the contract direct order level, and should be finished by May 2025. For more information contact the Air Force Life Cycle Management Center at [www.aflcmc.af.mil](http://www.aflcmc.af.mil).

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# Navy eyes electromagnetic weapons and high-power lasers for ship defense at sea

BY John Keller

**WASHINGTON** – U.S. Navy electromagnetic weapons researchers are surveying industry to find companies able to support research efforts into high-power RF and microwave weapons and high-power lasers to protect surface warships from missiles, swarming boats, and unmanned aircraft.

Officials of the Naval Research Laboratory (NRL) in Washington have issued a sources-sought notice (N0017323RGA01) for the High Power Electromagnetic Systems Development, Application, and Test project.

NRL needs contractors to help with design, prototyping, and evaluation not only of electromagnetic warfare technologies, but also of ultra-short-pulse and high-energy laser weapons.

Efforts involve improving RF, millimeter wave, and infrared countermeasures to defend against enemy missiles, improvised explosives, unmanned aircraft, and small-boat swarm attacks for ship defense.

High-power microwave technologies have been developed that require additional design, development, rapid prototyping, and limited production. Contractors will provide experienced

▲ **NRL needs help with design, prototyping, and evaluation of electromagnetic warfare technologies and ultra-short-pulse and high-energy laser weapons.**

scientific, technical, management, and logistics personnel.

Of specific interest is research support into high-power microwaves to counter electronic sensors, unmanned aircraft, anti-ship cruise missiles; support involves system analysis and design, prototype development, system test,

data collection, and computer simulation.

Contractors also will evaluate the vulnerabilities of jam-resistant navigation systems, and the type of jamming and deception systems capable of defeating them.

NRL is responsible for research into electromagnetic warfare systems such as directed-energy and electronic countermeasures systems for improved ship defense countermeasures that use high-power RF, high-power lasers, and electrostatic discharge systems to stop enemy vessels and blind their sensors.

From industry, NRL wants capabilities statements related to electromagnetic weapons and high-power lasers for ship protection, including prior experience, available staffing, and related information. Companies were asked to respond by August. ◀

### Lockheed Martin opens factory focused on small satellites

Lockheed Martin, a company that for decades has built school-bus-sized spacecraft for the U.S. government, has opened a facility to assemble small satellites, which are now in higher demand. The multi-million dollar facility will house the company's Space Development Agency (SDA) Tranche 1 Transport Layer satellites, among other smallsat programs and technology demonstrators. The 20,000-square-foot low bay clean room, located on the company's Waterton, Colo., campus, will feature six scalable parallel assembly lines and is configurable to host different classifications of missions concurrently. Built with flow and throughput in mind, the center is tailored to accommodate all stages of smallsat development, including spacecraft-level functional and performance testing. The facility hosts dedicated testing capabilities, including thermal cycle and electromagnetic chambers, scaled to efficiently build and test satellites ranging in size from CubeSats to smallsats. This facility is supporting the delivery of 180 satellites or more per year. Lockheed Martin is currently developing more than 50 satellites for the SDA's Transport Layer, which will provide military users with low-latency communication links through a resilient network of integrated capabilities from low-Earth orbit. Lockheed Martin's 10 Tranche 0 Transport Layer satellites are expected to launch this year, while its 42 Tranche 1 satellites will soon move into processing in the new factory to support a 2024 launch.

### Raytheon, Two Six seek to safeguard the military supply chain

U.S. military researchers have awarded two contracts for a project to safeguard the U.S. military supply chain from intentional or accidental interruptions — particularly for medicines, military metals, and the military food supply. Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have awarded contracts to Two Six Technologies

in Arlington, Va., and the Raytheon Technologies Corp. BBN segment in Cambridge, Mass., for the Resilient Supply-and-Demand Network (RSDN) program. RSDN seeks to develop data integration and analytical toolkit for military supply-and-demand networks. The goal is capabilities that are broadly applicable, but the initial focus is on pharmaceuticals, precursor components, and raw materials; — military metals; and military food, including meals ready-to-eat (MREs). *Continued on page 10*

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# General Atomics to demonstrate prototype unmanned jet fighter able to fire weapons

BY John Keller

ARLINGTON, Va. — U.S. military researchers needed a company to build and flight-test a prototype unmanned aerial vehicle (UAV) able to fire several of its own air-to-air weapons. They found their solution from General Atomics Aeronautical Systems Inc. in Poway, Calif.



**The LongShot aircraft essentially will be an unmanned jet fighter-bomber with missiles attached to hardpoints underneath the wings, on the fuselage.**

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced an \$82.6 million contract to General Atomics for the third phase of the LongShot project.

The LongShot aircraft essentially will be an unmanned jet fighter-bomber with missiles attached to hardpoints underneath the wings, on the fuselage, or possibly in internal weapons bays for enhanced stealthiness. The idea is to extend aircraft engagement ranges from beyond the reach of enemy weapons to reduce risks to manned aircraft.

The LongShot attack UAV design will be launched from aircraft, like a missile, but with the ability to deploy several of its own air-to-air weapons.

The LongShot will enable piloted aircraft to fire the UAV from standoff ranges far away from enemy threats. The unmanned LongShot, meanwhile, can fly closer to enemy targets to increase precision, while keeping human pilots out of harm's way.

General Atomics prevails in the competition to move LongShot to prototype and flight demonstration over competitors Northrop Grumman Corp. in Falls Church, Va.; and Lockheed Martin Corp. in Bethesda, Md.

Military air superiority today relies on advanced manned fighter aircraft to provide a penetrating counter-air capability to deliver weapons effectively, DARPA officials say. The LongShot prototype will be a flyable full-scale air-launched demonstration system capable of controlled flight before, during, and after firing its weapons.

On this contract General Atomics will do the work in Poway and Adelanto, Calif.; Mukilteo and Sedro-Woolley, Wash.; Detroit; Tucson and Yuma Proving Ground, Ariz.; Tulsa, Okla.; Buffalo, N.Y.; and Dugway Proving Ground, Utah, and should be finished by October 2025. ◀

For more information contact General Atomics Aeronautical Systems online at [www.ga-asi.com](http://www.ga-asi.com), or DARPA at [www.darpa.mil](http://www.darpa.mil).

*Continued from page 9*

Two Six Technologies won a \$1.9 million RSDN contract on Sunday, and Raytheon BBN won a \$7.9 million RSDN contract in April. The U.S. Department of Defense (DOD) has a critical need to secure its supply chain against intentional and unintentional disruptions, DARPA officials explain. Supply-and-demand networks are open, complex, evolving systems, and reflect external factors like conflict and climate change, as well as dispersed inventory management. These networks also are subject to imperfect knowledge; difficulty in predicting the results of large space of threats; and difficulty in predicting changes in the supply-and-demand network. For more information contact Two Six Technologies online at <https://twosixtech.com>, Raytheon BBN at [www.rtx.com/who-we-are/we-are-rtx/transformational-technologies/bbn](http://www.rtx.com/who-we-are/we-are-rtx/transformational-technologies/bbn), or DARPA at [www.darpa.mil/program/resilient-supply-and-demand-networks](http://www.darpa.mil/program/resilient-supply-and-demand-networks).

## NASA software developers take autonomy from simulation to flight

Self-flying air taxis may create a new era of transportation opportunities for passengers and cargo, shortening travel time using autonomous software that provide safe and reliable flight paths. From urban centers to rural communities, automated air taxis could grant passengers unprecedented access to the world around them. Before automation software can be used for flight it must be developed and tested to ensure its accuracy and safety. NASA's Advanced Air Mobility researchers at Armstrong Flight Research Center in Edwards, California, have been developing automation software as part of a collaboration with Sikorsky and DARPA, the

Defense Advanced Research Projects Agency. This research will ultimately test the software's responsiveness using two highly specialized helicopters as surrogate air taxis. Using customized test-tablets with scripted flight paths, software developers and pilots run software through precise simulations of air-to-air encounters, enabling a variety of conflict scenarios to test algorithms. The team will evaluate how the software prototype allows pilots using the tablet to initiate specific autonomous flight rules that would be common for air taxis in the highly complex, dynamic, and dense Advanced Air Mobility airspace.

### **Navy wants companies to apply AI and machine learning to weather forecasting**

U.S. Navy researchers have approached industry to find companies able to apply artificial intelligence (AI) and machine learning to global weather prediction to track atmospheric processes that influence fleet operations and mission planning. Officials of the Naval Research Laboratory (NRL) Marine Meteorology Division in Washington released a sources-sought notification (N0017323-RFI-HD01) for the Atmospheric Aerosol Prediction and Applications Research and Development

project. This initiative focuses on tropical cyclones like hurricanes and typhoons that can affect naval operations around the world. Other goals include AI and machine learning systems development; numerical weather prediction; fine-scale aerosol and cloud prediction; aerosol source characterization; data assimilation of remote-sensing data from aircraft and satellites; providing weather support directly to the warfighter; nowcasting to include model, satellite, and radar data; meteorological applications in decision making; weather influence on piloted and unmanned aircraft; weather effects on ship-board, airborne, and land-based communications, sensors, and weapons; meteorological influence on sensor performance; and atmospheric dispersion of chemical and biological agents. Navy researchers want the contractor to exchange weather forecasting and other data with University of Washington and National Oceanic and Atmospheric Administration (NOAA), Cooperative Institute for Research in the Atmosphere (CIRA), and Cooperative Institute for Meteorological Satellite Studies (CIMSS), as well as feed information to the Target Acquisition Weapons System (TAWs). Companies were asked to respond by August. ←

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# Unmanned vehicle systems:

# READY TAKE



**Uncrewed systems rely on advanced technologies like general-purpose graphics processing units (GPGPUs) to implement artificial intelligence and machine autonomy.**

BY Jim Romeo

**U**nmaned vehicle systems incorporate many different modes and variants being developed within the U.S. Navy, Army, Air Force, Marine Corps, and Coast Guard. Such a description is fitting, given the many different variants of remotely operated, unmanned assets for air, sea, underwater, and land operations.

Technology is advancing, and as it advances, programs are jockeying for funding and political support to build a strategic array of assets that can bring a new and improved dimension to the overall missions of the service branches for national defense and maritime support.

## **Program support across service branches**

In 2022, the Congressional Research Service emphasized the prominence and emergence of unmanned vehicles, namely unmanned underwater vehicles (UUVs) and unmanned surface vessels (USVs).

A recent report by the Congressional Research Service, “Navy Large Unmanned Surface and Undersea,” updated in September, outlined the budgetary considerations for three categories of unmanned vehicles: large unmanned surface vehicles (LUSVs); medium unmanned surface vehicles (MUSVs); and extra-large unmanned undersea vehicles (XLUUVs).





According to the report: “The Navy’s proposed fiscal 2024 budget requests \$117.4 million for LUSV research, \$85.8 million for the MUSV program, \$176.3 million for LUSV/MUSV enabling capabilities, \$104.3 million for the XLUUV program, and \$71.2 million for core technologies for UUVs including but not limited to XLUUV.”

The continues “the issue for Congress is whether to approve, reject, or modify the Navy’s acquisition strategies and funding requests for these large UVs [unmanned vessels]. The Navy’s proposals for developing and procuring them pose several oversight issues for Congress. Congress’s decisions on these issues could substantially affect Navy capabilities and funding requirements and the shipbuilding and UV industrial bases ... the Navy also wants to develop and procure smaller USVs and UUVs, as well as unmanned aerial vehicles (UAVs) of various sizes. Other U.S. military services are developing, procuring, and operating their own types of UVs.”

Regarding unmanned aircraft systems (UAS) the Congressional research service reported in July 2022 in a report “Unmanned Aircraft Systems: Roles, Missions, and Future Concepts,” [<https://crsreports.congress.gov/product/pdf/R/R47188>] that UAS assets are specifically part of a modernization strategy.

The report stated that “Unmanned aircraft systems (UAS) have gained increased prominence in U.S. military operations. The Department of Defense (DOD) is currently developing advanced UAS, along with optionally crewed aircraft, as part of its modernization strategy. The roles and missions of UAS are relevant to Congress in authorizing, appropriating, and providing oversight to DOD and the military services for these systems.”

### Replacing crewed aircraft?

The report proposed that unmanned could replace crewed aircraft for missions such as aerial refueling; air-to-air combat; strategic bombing; battle management and command and control

(BMC2); suppression and destruction of enemy air defenses; and electronic warfare (EW).

In addition, the report stated that DOD is “developing several experimental concepts—such as aircraft system-of-systems, swarming, and lethal autonomous weapons—that explore new ways of employing future generations of UAS. In evaluating appropriations and authorizations for potentially new and future UAS programs, missions, and concepts.”

More specifically, the Congressional research service reported in July 18 2022 in a report “Unmanned Aircraft Systems: Roles, Missions, and Future Concepts,” [https://crsreports.congress.gov/product/pdf/R/R47188] stated that UAS assets specifically are part of a modernization strategy.

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Proposing that they could replace crewed aircraft for several missions, including aerial refueling; air-to-air combat; strategic bombing; battle management and command and control (BMC2); suppression and destruction of enemy air defenses; and electronic warfare (EW).

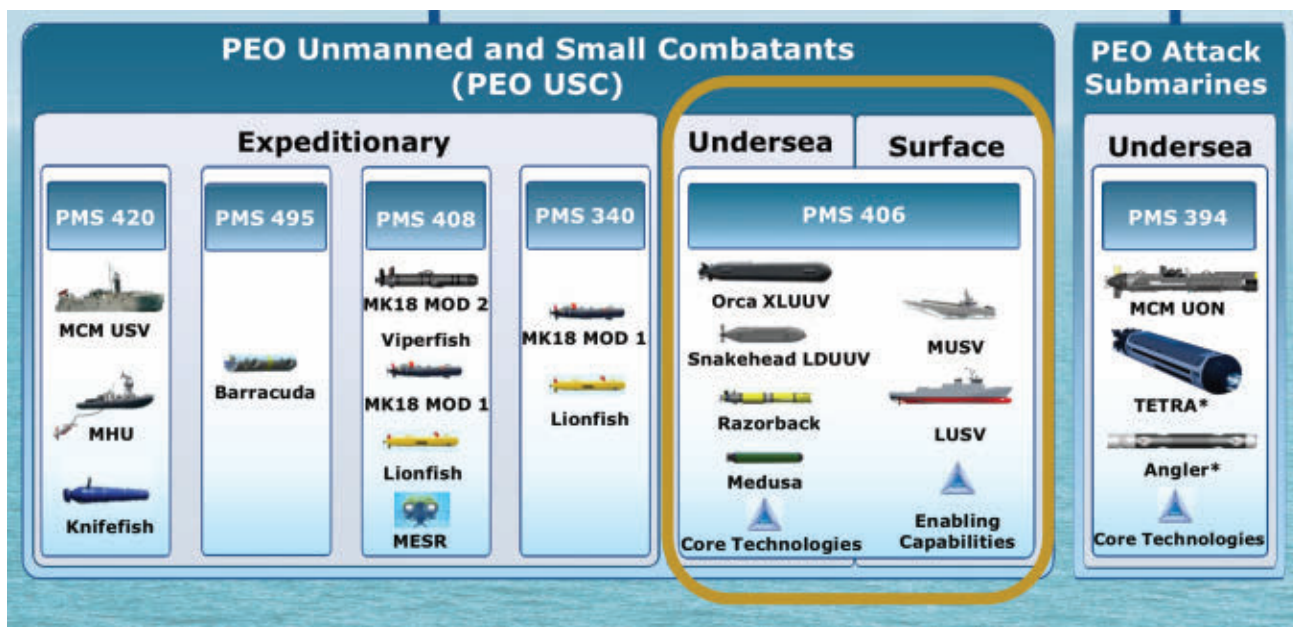
In addition, the report stated that DOD is “developing several experimental concepts—such as aircraft system-of-systems,



**The Sentry autonomous underwater vehicle (AUV) is part of the National Deep Submergence Facility (NDSF), which is sponsored by the National Science Foundation, the Office of Naval Research, and the National Oceanic and Atmospheric Administration.**

swarming, and lethal autonomous weapons—that explore new ways of employing future generations of UAS.

In the same report to Congress, the research service reported that the Air Force has begun to use the term “un-crewed” to describe remotely piloted or unmanned aircraft systems. They explain that The Air Force made this distinction “defining all aircraft flying without an aircrew onboard after it started developing optionally crewed aircraft, like the B-21 Raider.<sup>5</sup> An emerging class of UAS is loitering munitions—also called “Kamikaze drones”—which serve as a single use aircraft flying for extended periods of time (from dozens of minutes to potentially hours) that can observe and engage targets. This report uses the terms crewed and un-crewed to distinguish between different types of aircraft, and the term UAS for the broader system.”



The issue for Congress is whether to approve, reject, or modify the Navy's acquisition strategies and funding requests for these large unmanned vessels.



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## Coast guard involvement

The U.S. Coast Guard explained in the March 2023 report “Deputy Commandant for Operation, Unmanned Systems Strategic Plan, [<https://www.dco.uscg.mil/Portals/9/DCO%20Documents/2023%20Unmanned%20Systems%20Strategic%20Plan.pdf>] a plan to incorporate unmanned systems to assist in a broad range of Coast Guard missions.

The Deputy Commandant’s opening statement explained that: “In order to meet the challenges of an increasingly dynamic operational environment, we must adapt to the rapid pace of technological development. Unmanned systems play a key role and hold great promise to improve Coast Guard mission excellence. Unmanned systems can help us find mariners in distress. They can increase our capacity to detect illicit drug and migrant trafficking at sea so we can most effectively allocate finite boats, ships, and aircraft. unmanned systems can be a powerful tool in the monitoring of Illegal, Unreported, and Unregulated (IUU) fishing around the world. In a changing Arctic, unmanned systems can aid in the navigation of icebreakers, track icebergs and increased vessel traffic, and monitor the growth of other commercial activities. Our future will employ unmanned systems in an interconnected spectrum of interoperable systems and enable effective integration of artificial intelligence to deliver actionable data to Coast Guard operators in situations like these and many more. unmanned systems that enable optimal human-machine teaming provide game-changing opportunities for the Coast Guard.”

In evaluating appropriations and authorizations for potentially new and future UAS programs, missions, and concepts.”



**The MQ-1B Predator is an armed, multi-mission, medium-altitude, long-endurance remotely piloted aircraft that is employed primarily as an intelligence-collection asset and secondarily against dynamic execution targets.**

[<https://crsreports.congress.gov/product/pdf/IF/IF11876/3>] The Congressional Research Service also focused on The Army’s Robotic Combat Vehicle (RCV) Program, “describing it as “a vehicle being developed as part of the Army’s Next Generation Combat Vehicle (NGCV) family of vehicles.”

They stated that the Army plans to develop three RCV variants: light, medium, and heavy. “The Army reportedly envisions employing RCVs as scouts and escorts for manned fighting vehicles to deter ambushes and to guard the flanks of mechanized formations. As originally planned, RCVs are to be controlled by operators riding in NGCVs, but Army leaders say they hope that improved ground navigation technology and artificial intelligence (AI) might eventually permit a single operator to control multiple RCVs or for RCVs to operate in a more autonomous mode.”

## Boosting the utility of unmanned vehicles

There are many key initiatives in technology that help build the utility of unmanned air, underwater, and unmanned surface vessels. Such initiatives evolve over time and are improving as things like navigation systems, tracking technology, and positioning all improve with more drive to make unmanned vehicles useful to defense strategies and plans.

Scott Savitz is a senior engineer at the RAND Corporation, a technology think tank in Santa Monica, Calif. Savits says that in a nutshell, so much comes down to autonomy of the vehicle and controlling the same.

“The biggest drivers are improvements in autonomy and remote control,” says Savitz. “Undersea vessels must operate almost wholly autonomously, and surface vessels are operating on a complex two-dimensional interface between sea and sky—one that can be crowded with other vessels and potential obstructions. Improving their ability to navigate and operate autonomously, and communications that enable remote control for USVs despite being at zero elevation and lots of electromagnetic interference, changes everything. Secondary contributors include the reduced size/energy demand and greater effectiveness of sensors and processing power, improvements in energy harvesting and batteries’ energy density, and novel materials and vessel design.”

Brandon Tseng is the president and co-founder at Shield AI in San Diego. From his perspective, there are many different facets of technology that must be considered when discussing how and what success with unmanned vehicles are influenced by.

One such development is the development of intelligent mass (teams of drones) and AI pilots (similar to self-driving technology): Enabling operations even when GPS and communications are jammed, these technologies are vital for tracking, targeting, and striking.

“Their development represents a paradigm shift in autonomous warfare, reducing costs and increasing efficacy and Shield AI is one of very few companies developing these capabilities today,” says Tseng. “AI and autonomy software on un-crewed aircraft allows for quicker, more precise decision-making, independent of human reaction time and judgment.

Tseng points out some areas that should be focal points of effort and investment in future technology initiatives to implement unmanned vehicles.

“Increased Funding for AI pilots and AI/autonomy on the edge are key. “Recognizing the strategic importance of AI pilots, on par with stealth, nuclear, and hypersonic technology, there must be a significant increase in funding,” says Tseng. “The disparity in current resourcing could lead to astronomical costs in conflict, as the situation with China and Taiwan may illustrate.”

Tseng also highlights the importance of adaptation to a future that will be dominated by electronic warfare, as he says, “like we are seeing in Ukraine. With operations in contested areas like the South China Sea and Black Sea, new technologies and approaches must adapt to the challenges of GPS/comms jamming and integrated air defenses,” explains Tseng. “Low-cost drones and AI pilots – that can operate even when GPS and communications are jammed, and can track, target, and strike – are critical to winning any resultant conflict.”

Tseng says that advancements in low-cost drones, AI pilots, and various unmanned systems are setting new benchmarks in defense technology. “The sector’s future focus should include a strong emphasis on increased funding, edge autonomy, adaptation to diverse operational environments, and reevaluation of traditional defense configurations,” he says. “The urgency of these developments is underscored by the geopolitical tensions and the emerging needs of modern warfare.”

## Meeting technological challenge

With the development of new and better technology to promote unmanned vessels, comes continuous challenges that stand in the way of development, testing, and implementation of effective unmanned vehicles. Identifying and working around such challenges means finding and developing better critical paths to new success in the use of unmanned craft and vehicles.

Ryan Schaffernocker is the vice president of sea systems and ship-to-shore connector (SSC) at Textron Systems in Hunt Valley, Md. His viewpoints parallel that of many others by pointing out that initiatives in un-crewed surface vessels include autonomy and autonomous behaviors (including swarming), as well as AI for image recognition and self-learning, sensors, sensor fusion and predictive maintenance.



**Metal Shark's Sharktech 29 Defiant boat has been converted to unmanned surface vessel ) via the use of Sea Machines' SM300 autonomous command and remote-helm control technology.**

“Textron Systems is currently focusing on autonomous navigation in USVs,” says Schaffernocker. “There is ongoing research and development in industry for hardware and computing resources needed to implement these new technologies. Implementing autonomy allows for the sailor to be less in harm’s way while still working with the system. A notable trend is that smaller platforms are becoming more affordable due to the advancements in phone technology like GPS, mems-based INS and camera technologies. Algorithms continue to advance, and hardware systems are increasingly moving from analog to digital across all vessel platforms. Sensors are used to identify what the environment looks like; what objects are in that environment and what they’re predictably doing.”

Emil Kheyfets is the director for military and aerospace business development at Aitech in Chatsworth, Calif. Kheyfets, like others, emphasizes the importance of AI.

“The biggest trend we see in unmanned underwater and surface vessels is a use of the AI capable hardware (AI-at-the-Edge) for sensor data processing and for decision making,” says Kheyfets. “Small Form Factor AI capable systems are available, and they provide SWaP optimized solutions for unmanned applications.”

Chris Ciufio is the chief commercial officer and chief technology officer at General Micro Systems Inc. in Rancho Cucamonga, Calif. “For unmanned underwater and unmanned surface vessels, the key requirements—beyond the existing mandates of size, weight and power (SWaP)—are improved sensors and more on-board processing power,” he says. “The more autonomy and on-board decision-making one can add to the platform, the more effective it will be at executing its mission. More specifically, there’s almost nothing on the battlefield that can’t be improved by using artificial intelligence (AI) to assist or potentially replace



**The Remote Environmental Monitoring UnitS (REMUS) 100 is a compact, light-weight, autonomous underwater vehicle designed for operation in coastal environments as deep as 100 meters.**

the human operators controlling the UAS/drone. Culling in real-time through massive amounts of sensor data collected in real-time will allow the machine to adjust its flight or its intended purpose and be a more effective platform with a much-improved outcome. Adding more horsepower on-board via AI GPGPUs such as the Nvidia® AGX Jetson Orin is a game-changer. The GMS X9 Spider AI small form factor system directly accepts multi-spectral and multi-sensor inputs and is able to provide actionable intelligence in real time.”

### Trusting AI

Testing to ensure trust of AI capabilities is key. “One of the largest challenges is ensuring the ability to test the craft and software in simulation environments,” says Textron’s Schaffernocker. “The U.S. Navy and Coast Guard often work with industry and partner nations to develop testing opportunities in real-world environments. In 2022, Textron Systems was a participant in the Navy’s REPMUS (Robotic Experimentation and Prototyping using Maritime Uncrewed Systems) test event where the [Common Unmanned Surface Vehicle] CUSV ran autonomously and performed multi-missions and was tested and verified in a simulation environment. Sensor simulation can be a challenge due to the constant change in the technology and potential data overload. When multiple sensors are generating large amounts of data, managing that data and using it most effectively can be challenging. When Textron Systems integrates onto these platforms, the data from sensors is recorded, pushed to the cloud and then advanced algorithms sort through the data for anomalies and deep learning patterns for future analysis. As AI continues to progress, it’s becoming more important to understand what the technology is doing

and how to influence training to get proper results. Shared data sets will move AI and machine learning technology forward.”

Simulation environments, however, must have agile response times. “The main challenge is the response time of the control circuits of such unmanned systems,” says Aitech’s Kheyfets of Aitech. “Sending large amount of data from high-definition sensors to the external control center, processing that data and sending back control commands is a lengthy process which can also be impacted by communications jamming techniques used by adversary. Moving data processing and decision-making functionality to the unmanned craft significantly improves response time and reduces communication issues risks.”

“GMS is on a number of UAS platforms, some that are flying already—with names you’d recognize—and some in development,” says General Micro’s Ciufo. “The biggest challenges we see are the rapid pace of technology evolution, which tempts designers and end customers like the DoD into wanting more NOW. But most of these platforms need flight safety critical certification. For those that fly in controlled airspace, these certifications take time—usually years. This is an immediate disconnect between the latest tech and speed, and the go-slow because it’s prudent.”

Like self-driving cars, developing highly autonomous maritime systems seems easy until people try it, says Savits of the Rand Corporation. “Testing small, relatively inexpensive objects in confined areas is easy,” says Savitz. “Testing devices that are too expensive to lose repeatedly during testing, and that are designed for long ranges and diverse environments, is much harder. Doing so to the point that you’re confident enough to put them in environments where they haven’t been before, where they might be actively targeted electronically and with physical attacks or obstructions, is harder still.”



**The Boeing Echo Voyager is an autonomous extra large unmanned undersea vehicle (XLUV) for a variety of missions that were previously impossible due to traditional UUV limitations.**



## Accelerating technology

There are numerous examples of technological advancements that represent notable strides in the development of unmanned vehicles and the technology that drives it, and what you foresee to be areas of strong focus within this sector in the future.

“One notable technological advancement is the progression of communication links in the last ten years,” says Textron’s Schaffernocker. “Once large, bulky and unreliable, they’re now much smaller, lightweight and reliable, leading to improved performance. Sensor development and multi-spectral cameras and radar will have a major influence on future USVs. At Textron Systems, much of our earlier work started with uncrewed aircraft systems which were deployed to the U.S. Army, Marine Corps, and Navy. With decades of experience in uncrewed vehicle space, we then parlayed that technology and deep understanding to USVs and uncrewed ground vehicles. We’ll deploy our first USV to the Navy next year. The use of AI across the platforms will have major benefits, particularly when it comes to USV navigation.”

Using AI, however, requires low-power solutions that afford high performance. “AI-cable Super Computers based on the NVIDIA Jetson family modules provide small size high performance low power solutions for AI-at-the-Edge and fully autonomous applications,” says Emil Kheyfets. “Such systems are used more and more for unmanned applications. All military branches including NAVY are focusing on AI use to achieve decision superiority which is a key factor for success in modern warfare.” NVIDIA Corp. in Santa Clara, Calif., produces the Jetson and other implementations of general-purpose graphics processing units (GPGPUs) for high-performance embedded computing and AI.

There’s not only a pivotal technology that the efficacy of unmanned vessels relies on most. One must consider how the technology that exists at present integrates with warfighters in actual battle scenarios.

“I’m not going to trot out one particular technology that’s a game changer — besides GPGPUs as AI co-processors,” says General Micro’s Ciufo. “Rather, as we’ve seen in the war in Ukraine from both sides, the use of UAS is shifting not only the op tempo but is tilting the likely outcome of war. On the one side are the Russians who use very capable and relatively low cost Iranian Shahed-136 drones with deadly effect. On the other side is Ukraine, practically buying Walmart-quality drones and equipping them with sensors and equally deadly ordnance.

“Neither side’s drones are of the military-style quality present in U.S.- or Israeli-produced battlefield drones,” Ciufo continues. “Yet the drones are effective. My point is that technological



**The General Dynamics Knifefish medium-class mine countermeasure UUV is designed for deployment off the Littoral Combat Ship (LCS) for detecting, classifying and identifying buried mines and mines in high-clutter environments.**

advancements are coming weekly in the civilian market, and opponents looking for battlefield advantage are quickly adapting whatever will work and deploying it into battle. The U.S.-based UAS market needs to adopt this blitzkrieg-style development and deployment. I’m stopping short of saying we are wasting time by developing UAS platforms the traditional way, because there’s still the issue of Congressional budgets, the very scripted DoD development cycle, and the need for safety and long-term sustainment. But “notable strides” are made when the strides are quick. At the present pace, we are taking too long to get the latest technology onto the battlefield.”

## The road ahead

Unmanned vehicles still are in the early adoption stages. Implementation requires much trial, testing, and acceptance by defense leadership that yields a strong confidence that unmanned vehicles are not only safe, but effective and worth the investment in time and human capital to develop and refine.

“Every soldier movie I’ve seen in the last two years showcases a top-down battlefield operational picture that comes from a mysterious, persistent and un-noticed UAS broadcasting images of the bad guys up to no good,” says General Micro’s Ciufo. “That this is now engrained into movie writer’s schtick means the technology is mature and prevalent. Yet the DoD gives little thought to what the bad guys are doing about “counter-UAS” activities. Or how we are “hardening” our platforms to make them more secure and how they’re sanitized as the platform becomes compromised in-action or after a crash. We’ve read true stories of unencrypted video feeds being hacked (allowing the bad guys to watch themselves—and feed misinformation to operators), or how downed UAS technology has been captured and repurposed against America.” ◀

# The future of high-performance embedded computing

Fast processors, high-speed networking, and open-systems standards are combining to enable future military applications in object detection and target tracking, and offer a new role for artificial intelligence.

BY John Keller

State-of-the-art processors, fast networking and data sharing, open-systems standards, innovations in cooling and thermal management, and new systems architectures are converging on high-performance embedded computing systems to create new enabling technologies in real-time processing, artificial intelligence (AI), and machine learning for applications in image recognition, radar, electronic warfare (EW), signals intelligence (SIGINT), and more.

While these innovations promise new aerospace and defense capabilities that are almost beyond the imagination, these technologies also confront systems designers with challenges in packaging for small size, weight, and power consumption (SWaP), electronics cooling, and data security, and also threaten to outstrip expected new advantages in open-systems standard ecosystems sooner, rather than later.

## Advanced processors

Much of the innovation in high-performance embedded computing starts with microprocessors, which range from central processing units (CPUs), field-programmable gate arrays (FPGAs), general-purpose graphics processing units (GPGPUs), analog-to-digital (A/D) converters, and digital-to-analog (D/A) converters.

"We have scalable processors, which are targeted at the data centers," explains Denis Smetana, senior product manager at the Curtiss-Wright Corp. Defense Solutions segment in Ashburn, Va. "These are really high power, and difficult to cool. Yet Intel

has second-tier processors called the Xeon D family that have server-like performance, but that are targeted at the embedded market." The Curtiss-Wright CHAMP XD-4 embedded processor is one example of this.

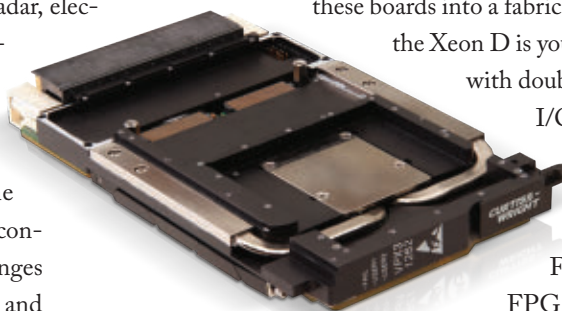
"The Xeon D brings server-class performance sized to the embedded market, and uses 100-gigabit Ethernet to connect these boards into a fabric," Smetana continues. "One aspect of the Xeon D is you can scale all the way up to 20 cores, with double memory cores, and quadruple the I/O bandwidth of previous generations of processors."

Curtiss-Wright also offers an FPGA board called the CHAMP FX-7, which has two AMD Versal FPGA-based systems on chip (SoC) for adaptive systems that combine floating-point processing and FPGA logic. "The other alternative is GPGPUs, with large arrays of processors," Smetana says. "We have GPGPUs on the CHAMP XD-4 and CHAMP FX-7, with PCI Express running at Gen-4 speeds to provide a

30-gigabyte data path in both directions."

Industry demand in increasing for high-performance processors like FPGAs and GPGPUs. "There is a high uptick in GPGPUs being used," says Mark Littlefield, director of system products at Elma Electronic in Fremont, Calif. "These processors and switches can support time-sensitive embedded computing, even though some people have been tentative about high-speed Ethernet."

Ken Grob, director of embedded technologies at Elma Electronic, says he agrees. "GPGPUs are being used more often,



▲ The Curtiss-Wright VPX3-1260 rugged 3U OpenVPX 9th Gen Intel Xeon single-board computer deliver all-in-one processing for high-performance embedded computing, general-purpose processing, and C5ISR applications.

and we are seeing that applied to non-traditional uses cases where the GPGPU is used more in video applications. We also are seeing GPGPUs used in signal processing, using an algorithm that once was implemented in an FPGA before, but now we are see it in GPGPU. You can do that quicker and with less overhead with GPGPUs.”

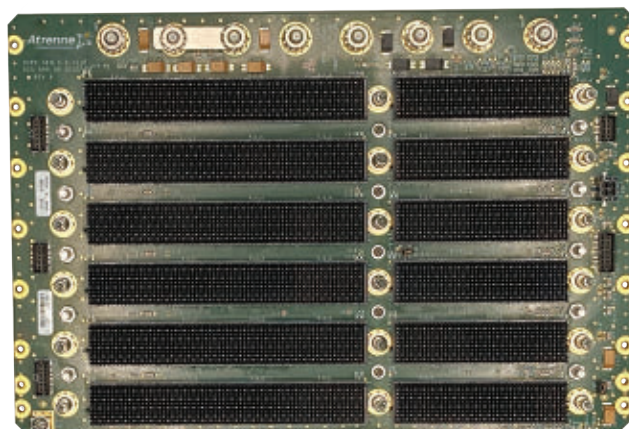
Where in the past there were no alternatives to FPGAs for high-performance embedded computing, some systems designers today are turning to GPGPUs,” Grob says. “From one FPGA environment to another the dependencies are more difficult when moving from one flavor of FPGA to another. In the FPGA, the algorithm is implemented in software, however, and running on a GPGPU library is much quicker to port that from a software point of view, rather than in VHDL from one FPGA environment to another.”

Another FPGA challenge that GPGPUs are seeking to solve is the availability of human FPGA programmers. “FPGA development talent is expensive and difficult to find,” Elma’s Littlefield points out. “There are just not that many people out there who have studied FPGAs enough to be effective developers. It is a different talent, and a different beast entirely. “GPGPUs are getting so capable in performance that it opens the door to other alternatives,” Grob says.

### Networking and data sharing

Two of the most influential network fabrics for high-performance today are Ethernet and PCI Express, also known as PCIe. Today embedded computing systems are moving from PCI Express Generation 3, which moves data at 32 gigabytes per second, to PCI Express Gen 4, which moves data at 64 gigabytes per second. Leading-edge designs are moving toward PCI Express Gen 5, which moves data at 128 gigabytes per second.

“Right now we are looking at going from PCI Express Gen 3 performance to Gen 4 and Gen 5, and also to Ethernet,” says Bill Hawley, senior hardware engineer at Atrenne Computing Solutions, a Celestica company in Brockton, Mass. “We see demand from customers form PCI Express Gen 4 and Gen 5, and I see that continuing. The need for bandwidth and speed is something that will continue.” Systems designers typically use



**This OpenVPX, six-slot Gen-5 backplane is from Atrenne Systems in Brockton, Mass.**

PCI Express links to connect components on circuit boards, or when data movement must be as deterministic as possible.

When moving data from board-to-board, or from enclosure-to-enclosure, Gigabit Ethernet is the default choice, where nabling technologies are moving from 10-Gigabit Ethernet, to 40-gigabit-Ethernet, to 100-Gigabit Ethernet, and beyond.

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Demanding aerospace and defense applications are driving the need for increasing network bandwidth. “Real-time applications are the drivers — things that must be as expeditious as possible, and speeds close to now,” Hawley says. Radar applications, for example, “need data sooner rather than later so I can respond. That’s why we are seeing the emphasis on performance.”

### Gigabit Ethernet

Ethernet has emerged as the data plane of from a previous hodge-podge of switch fabric topologies, which in past years included Serial RapidIO, InfiniBand, Fibre Channel, StarFabric, and Firewire. “Everything we’ve seen so far has been Ethernet, or a derivative of Ethernet, that is data plane related, with PCI Express on expansion plane, Atrenne’s Hawley says.

“The data plane connects through a packet switch, and all boards in a system can communicate over the data plane, which is Ethernet,” Hawley continues. “Ethernet is a very flexible architecture, but the problem is Ethernet requires a lot of software intervention, so the latency of Ethernet packets can be large, versus PCIe that takes two or three modules that takes more than one payload module. The latency issues with Ethernet have to do with its large software stack. That is not there with PCIe. It’s all handled in hardware, which is a good real-time thing, as opposed to software.”

High-speed switch fabrics are all going to Ethernet now,” says Elma’s Littlefield. “It’s built into FPGAs and GPGPUs now. Biggest hurdle was determinism and latency, and that is being handled now with time-sensitive networking (TSN). Speeds are growing in rate, and in the next five to seven years you will see 400-gigabit Ethernet.

The road to Gigabit Ethernet has not been easy, however. v100 Gigabit Ethernet has not been trivial to implement,” Littlefield points out. “It has had signal-integrity issues, and it’s been more of a challenge to get everything lined up with the board products and backplanes. People today, however, are adapted to that, and are working through getting all those bits and pieces together.”



▲ The DRF3182 3U VPX direct RF board from Mercury Systems is powered by the Intel Stratix 10 AX SoC FPGA, and is for electronic warfare, radar and ELINT applications.

The shift in the embedded computing industry towards networked architectures, rather than conventional databus architectures, is driving the growth of Ethernet, says Aaron Frank, senior product manager at Curtiss-Wright.

“We’ve seen a growth from 10-, to 40-, to 100-Gigabit Ethernet technologies, driven by a net-centric approach where more of the data is being put across Ethernet, so Ethernet continues to grow,” Frank says. Still, Gigabit Ethernet represents only part of the path forward because systems designers simply cannot brute-force data over the network and expect the best possible results.

“It’s not just enough to put a 100-Gigabit network on a system,” Frank says. “The system has to be able to ingest, process, and deliver that much data, in terms of results. It’s becoming a system-level end-to-end solution to use these faster speeds and interfaces, with the growing use of optical interfaces. We used to deal with 1 gigabit Ethernet, copper could keep up, but now more of the interfaces are moving to optical. We are doing many things to make it easier for the systems integrator to use optical interconnects.”

### Open-systems standards

Perhaps the most influential emerging open-systems standards on high-performance computing today are the Sensor Open Systems Architecture (SOSA) and the Modular

Open Systems Approach (MOSA) design guidelines. These standards seek to create an open ecosystem in which components from many vendors will function well together, facilitate rapid upgrades over time, and save money over the life cycle of embedded computing systems.

“People are able to make use of technology faster with SOSA,” says Elma’s Littlefield. Although industry experts have expressed skepticism about the value of SOSA since the standard’s inception, “That skepticism has gone by the wayside at this point,” Littlefield says. “It took us three years to get to that point.”

The SOSA standard and the MOSA design approach have convinced even the



▲ This 1/2 ATR enclosure from Pixus typically uses OpenVPX in three to six slots, offers conduction cooling, with options for sealed versions with heat exchangers for high-power systems.

industry's doubters because of their proven utility. "The market knows what to design to now," says Elma's Grob. "It offers a rich set of boards that are interoperable, and when you actually see that you can do it, becomes a driver for time to market. We can integrate much more quickly than we could before."

The ability for several different vendors to provide interoperable components in different aerospace and defense systems is a chief motivation of SOSA and MOSA. SOSA requirements are focusing on their certain slot profiles, and subsets and combinations of these profiles that are seeing a lot of commonality," says Justin Moll, vice president of sales and marketing at Pixus Technologies in Waterloo, Ontario.

"One thing that is popular now is our SOSA-aligned chassis hardware manager," Moll says. "We provide the pinouts if the customer provides his own backplane. SOSA committees have the goal of incorporating compatible chassis management hardware using



▲ **This customized conduction-cooled embedded computing enclosure from Pixus houses individual Advanced Mezzanine Card (AMC) modules, and can support designs for OpenVPX and other open-systems designs.**

similar design approaches. These types of things are being proposed in the SOSA committees, and there needs to be agreements on connectors and pinouts. It is not defined in SOSA, but the committees will define it."

Moll also calls attention to a SOSA sister standard called the Modular Open Radio Frequency Architecture (MORA), which concerns RF and microwave systems rather than embedded processing. "That's where using standardized or open-standard solutions for RF are being developed. We have ruggedized a lot of National Instruments ubiquitous software-defined radios, and designed it into weather-proof IP-67 versions for outdoor use, as well as full-mil-rugged versions with 38999 connectors on them, for signals intelligence and powerful software-defined radios for electronic warfare and various communications and control drone detection and deterrence."

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SOSA and MOSA also are paying-off for Curtiss-Wright. “Our systems now are SOSA- and MOSA-aligned for multi-mission capabilities, where it can be used for one program and reconfigured for another mode of operation, so can avoid putting in a whole different architectures,” says Curtiss-Wright’s Frank.

“That drives decisions, and aligns with the MOSA approach. MOSA drives down to SOSA, and seeks truly to use standard interconnects, and use standards effectively across the industry to help drive down the costs of long-term support and technology-refresh costs — the total costs of ownership.”

## Artificial intelligence

Of all the potential aerospace and defense applications of future high-performance computing systems, “it’s impossible to ignore artificial intelligence,” says Chris Ciufo, chief technology officer at General Micro Systems Inc. in Rancho Cucamonga, Calif. “AI is finding its way onto the battlefield, and we have customers asking for systems with artificial intelligence built into the system.”

Demand for artificial intelligence is beginning to influence the very architectures of today’s most advanced embedded computing systems, Ciufo says. “In years past we might have shipped a mission computer equivalent by upgrading a single-board computer with additional I/O. Now people want us to add a GPGPU, which is an a vector co-processor that goes along with the mission computer’s general-purpose processor, to create artificial intelligence capability.”

Often the most expedient approach for adding AI to embedded computing is to add GPGPU capability to conventional microprocessors and FPGAs. GPGPUs essentially are massive parallel processors that can execute many computing tasks simultaneously.

“Artificial intelligence means now you can take this system with GPGPU and CPU and throw at it computer and point it to a data base of sensor data, use AI algorithms, and you can do what an AI engine does, which is facial recognition, target tracking, object recognition,” Ciufo says.

This kind of GPGPU-enabled artificial intelligence capability also should be able to apply AI-based image recognition to a two-dimensional image and infer details in its 3D image. “You now can look at a 2D facial image and infer based on the sculpting of your face what the back of your head looks like,”



## EMBEDDED COMPUTING

For more information on embedded computing search for “embedded computing” at [www.militaryaerospace.com](http://www.militaryaerospace.com)

Ciufo says. “Imagine a soldier with a weapon or sensor, and this computer can fill in parts of the picture that you can’t see, of what is waiting around the corner. You can infer what the person hiding around the rock can look like.”

U.S. military experts essentially are looking at modern machine vision capabilities on the assembly line — chiefly looking for manufacturing flaws by uncovering details in the image that normally should not be there — and extending those capability to military operations. “The trend is the

U.S. Department of Defense sees what’s going on in machine vision in the industrial market,

and wants this on the battlefield as a force multiplier,” Ciufo says.

“Look at the actionable intelligence we can get from our embedded systems, and we can be a much more lethal force. We are seeing this requirement for mission computing with an AI co-processor much more frequently than we used to.”

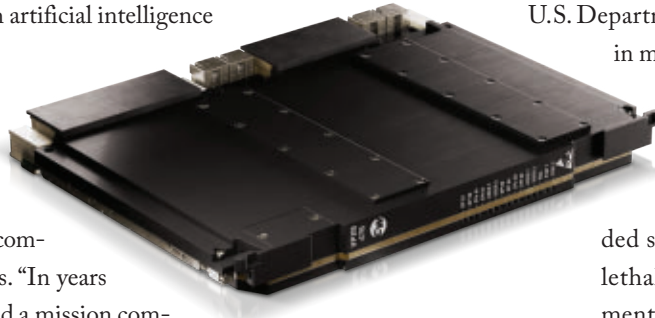
Today’s high-performance computing capabilities are making artificial intelligence applications much more feasible than they were decades ago. “I think AI is here to stay this time,” says Elma’s Littlefield.

“Deep learning used to be so computation-

ally intensive that it wasn’t really practical with slow processing then. Now people are finding more ways to make use of it.”

Among the most promising applications of artificial intelligence in the military involves real-time object detection and recognition, Littlefield says. This could lead to self-protection systems aboard armored combat vehicles that could detect incoming fire, determine the kind of weapon involve, and deploy countermeasures or counter-fire quickly enough to avoid being hit.

In addition, Littlefield says, “The Air Force is talking about huge swarms of autonomous vehicles controlled by single or multiple aircraft.” That capability will be built on real-time object detection and recognition.



▲ **The CHAMP-FX7/VPX6-476 SOSA-aligned 6U VPX dual-AMD Versal Premium adaptive system-on-chip from Curtiss-Wright is a rugged adaptable real-time processing board featuring the AMD Versal adaptive system-on-chip.**



Real-time embedded computing and artificial intelligence also are influencing future electronic warfare systems, says Bill Conley, chief technology officer at Mercury Systems in Andover, Mass. "With continued research into AI, what gets fielded is the most state-of-the-art algorithms we can come up with."

Conley points to the U.S. Navy Advanced Electronic Warfare (ADVEW) suite for the F/A-18E/F Super Hornet carrier-based jet fighter-bomber for aircraft survivability. "Fourth-generation aircraft must be able to sense what is in their environment, not fly too close to threats, and if they do to protect themselves," Conley says. "Pilots are seeing a lot of different radars, most of which that are not threats, and must find the one that could be a threat. Pilots must sort their way through signals to find the real signals of interest."

This kind of EW challenge is just getting bigger. "It used to be you are looking for a needle in a haystack. Now you are looking for a needle in a stack of needles," Conley says. It relies on automatic change detection, which is becoming very powerful. EW techniques have been developed by humans, and now the machine measures the substantial changes during a mission, and that means a lot more data is being ingested and used in the EW system. Data fusion from many sources sets up what is the critical data that has to flow that can feed the fusion algorithm."

### What the future holds

The pressing need for artificial intelligence in future military applications points out how quickly threats are changing. Is the current state of the art in open-systems standards, fast processors, and high-speed networking up to the challenge? The simple answer is no, says Mercury's Conley.

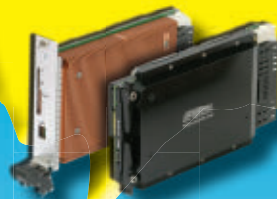
"The systems you start the war with, and the systems you end the war with,

often are very different," Conley says. "You need to look at the speed of technology introduction. When you are in the fight, open systems are much less important than it is to bring the best capability into the fight."

It may be that the pace of open-systems standards development, approval, and

industry acceptance simply will not be fast enough to meet the demands of future warfare. "How do we introduce innovation at a speed and scale that results in a change of strategic outcome and result," Conley asks. "That is where openness is helpful, but in itself may not be sufficient to fully solve that problem." ◀

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# Lockheed Martin to build electronic warfare (EW) avionics for Apache helicopters

BY John Keller

REDSTONE ARSENAL, Ala. – U.S. Army combat helicopter designers are asking Lockheed Martin Corp. to build and sustain electronic warfare (EW) systems to enable the AH-64E Apache Guardian attack helicopter to detect and identify enemy radar threats.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced a \$192.2 million order to the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y., to build the Modernized-Radar Frequency Interferometer (MRFI).

The MRFI identifies intelligence, surveillance, and reconnaissance (ISR) emitters, and helps the AH-64E pilot to detect and engage an enemy radar threat long before the aircraft becomes vulnerable. The system quickly detects, identifies, and locates enemy radar, and then ranks these hostile radars in order of priority for subsequent ground attack.

The order calls for Lockheed Martin to provide production, sustainment hardware, and technical, logistical, test and engineering support for the MRFI, which is part of the AH-64E's digital receiver-based AN/APR-48B avionics system, which performs target acquisition and cueing for the helicopter's fire-control radar system.

▲ **The Modernized-Radar Frequency Interferometer (MRFI) identifies intelligence, surveillance, and reconnaissance (ISR) emitters, and helps the AH-64E pilot to detect and engage enemy radar threats.**

The system also can deliver warning of radar directed anti-aircraft threats and serve as the controller for an integrated aircraft survivability equipment. The system provides high sensitivity and precision angle of attack in a lightweight modular configuration.

The AN/APR-48B system primarily operates on a dual-redundant MIL-STD-1553B databus aboard Apache helicopters. Other commercial I/O interfaces available for future growth include Gigabit Ethernet, RS-232, and RS-422. ◀

On this contract Lockheed Martin will do the work in Owego, N.Y., and should be finished by August 2023. For more information contact Lockheed Martin Rotary and Mission Systems online at [www.lockheedmartin.com/en-us/who-we-are/business-areas/rotary-and-mission-systems.html](http://www.lockheedmartin.com/en-us/who-we-are/business-areas/rotary-and-mission-systems.html), or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa/>.

### RF power dividers and RF couplers introduced by Fairview Microwave

Fairview Microwave in Lewisville, Texas, is introducing RF power dividers and RF couplers for test and measurement, feedback, monitoring, and control applications. The RF power dividers and RF couplers provide maximum power ratings as strong as 30 Watts and operating frequencies ranging as high as 70 GHz. They offer connectorized options that include SMA, N-type, 1.85-, 2.4, and 2.92-millimeter connectors, as well as three-way, four-way, and eight-way configurations. The RF couplers sample signals either forward or in reverse, and their signal-splitting enables users to multiply one signal into many signals with minimal loss to distribute power equally across systems. For more information contact Fairview Microwave online at [www.fairviewmicrowave.com](http://www.fairviewmicrowave.com).

### Gallium nitride RF power amplifier for X-band radar applications introduced by Comtech PST

Comtech PST Corp. in Melville, N.Y., is introducing the model BMCAP99109-1500 gallium nitride (GaN) solid state power amplifier module for X-band radar applications. The X-band power amplifier operates at frequencies of 9 to 10 GHz, 9.0-10 GHz,

and offers typical peak output power of 1500 Watts. The AB linear design features pulse width and duty factor protection as well as thermal and load voltage standing wave ratio (VSWR) fault monitoring. The gallium nitride amplifier has an optional digital interface for control and status monitoring, and offers fast blanking and low phase noise. The amplifier offers power gain of 62 decibels nominal; power gain variation of  $\pm 2$  decibels; pulse width of 0.25 to 100 microseconds; duty cycle of less than 6 percent; pulse droop of less than 0.015 decibels per microsecond; pulse rise & fall time of less than 50 nanoseconds; input VSWR of less than 2:1 output load VSWR of less than 2:1. The amplifier has an RF input sample of -15 decibels relative to carrier (dBc); RF Pulse of on-off isolation of more than 110 dBc; DC voltage input of 28 volts DC; DC supply current of 12.5 amps RF to DC; and efficiency of 25 percent. The RF and microwave amplifier operates in temperatures from -40 to 65 degrees Celsius at the baseplate; operates in humidity of 0 to 95 percent non-condensing; offers resistance to the effects of operating shock and vibration per MIL-STD-810F; and operates at altitudes to 30,000 feet. The amplifier measures 9.6 by 6.8 by 2 inches, and weighs 5.5 pounds. For more information contact Comtech PST online at <https://comtechpst.com>. ←



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# Air Force asks industry for EW attack receiver for pedestal-mounted training device

BY John Keller

**HILL AIR FORCE BASE, Utah** – U.S. Air Force combat training range experts are reaching out to industry to find companies able to design and build a Common Electronic Attack Receiver (CEAR) for AN/MST-T1V Mini-Multiple Threat Emitter System (Mini-MUTES) B-Pedestals.

Officials of the Air Force Life Cycle Management Center Weapons segment at Hill Air Force Base, Utah, have issued a sources-sought notice (FA8210-23-SS-MMCEAR) for the Mini-Multiple Treat Emitter System (Mini-MUTES) Common Electronic Attack Receiver (CEAR) project.

The CEAR was developed in 2014 by SRC Inc. in Syracuse, N.Y., to replace the Joint Threat Emitter (JTE) and Unmanned Threat Emitter (UMTE) legacy electronic attack receivers.

Component obsolescence has rendered Mini-MUTES legacy electronic counter measures (ECM) receivers no longer useable and have been replaced with a placeholder ECM receiver for the Mini-MUTES modernization proposal pedestals.

The system's legacy ECM receiver, all assemblies, subassemblies, and most components are obsolete and cannot be

▲ **Component obsolescence has rendered Mini-MUTES legacy electronic counter measures (ECM) receivers no longer useable.**

manufactured from existing drawings or materials, and there are no Mini-MUTES B-Pedestals with operational ECM receivers in the field for aircrew training.

The Air Force is trying to find a company to re-engineer and test three developmental Mini-MUTES CEARs, and build 23 representative articles CEARs for integration into Mini-MUTES B-pedestal for airborne electronic warfare training.

The intent is to use existing CEAR electronic circuit cards to design and manufacture a replacement ECM receiver for the Mini-MUTES B-Pedestals to mitigate obsolescence and reinstate EW training capability. ◀

The intent is to build an ECM receiver to replace the current hardware and software integrated with the redesigned remote emitter unit control processor. Industry was asked to respond by July. More information is online at <https://sam.gov/opp/c27449f9650b4bcb92837e92429655f5/view>.



# Navy orders 24 unmanned aerial vehicles (UAVs) and 62 sensor payloads from Boeing Insitu

BY John Keller

**PATUXENT RIVER NAS, Md.** – U.S. Navy unmanned aerial vehicle (UAV) experts are spending \$32 million on small unmanned aircraft and UAV sensor payloads for persistent surveillance for the Navy, U.S. Marine Corps., and U.S. allies.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have announced a \$32 million order to Boeing Insitu Inc. in Bingen, Wash., for four RQ-21A Blackjacks, 20 ScanEagles, 62 ScanEagle payloads and turrets, as well as support equipment and spare parts.

▲ **The ScanEagle UAV provides persistent surveillance and reconnaissance imagery on land or at sea.**

The Boeing Insitu ScanEagle UAV is 5.1 feet long with a 5.6-foot wingspan. It weighs as much as 48.5 pounds and can carry a 7.5-pound sensor payload. The UAV can fly for more than 24 hours at altitudes as high as 19,500 feet, and at speeds to 80 knots.

The ScanEagle UAV can fly on gasoline or heavy fuels like jet fuel, diesel, or kerosene. It provides persistent surveillance



and reconnaissance imagery on land or at sea at lower costs than other surveillance methods for military and agriculture missions.

ScanEagle can carry a sensor payload consisting of visible-light camera, medium-wave infrared imager, or both integrated in one turret. The UAV also has an analog digitally encrypted video data links, as well as encrypted or unencrypted command-and-control data links.

The UAV can be launched autonomously and uses a no-nets recovery system that recovers with its wing tip on a rope that hangs from a boom.

The Boeing Insitu RQ-21 is a twin-boom, single-engine, monoplane UAV for surveillance and reconnaissance. It can be launched and recovered on land or at sea without runways, using a pneumatic launcher and net-type recovery system. The contract was announced on 18 Dec. 2014.

The 81-pound Blackjack — so-named in September 2013 — is eight feet long with a 16-foot wingspan designed to carry multi-sensor payloads in large pod below its nose. The UAV can fly as fast as 104 miles per hour, cruises at 63 miles per hour, can fly as long as 24 hours, and can fly as high as 19,500 feet. It is a version of the Insitu Integrator UAV.

The multi-mission RQ-21A Blackjack's open-architecture payload bays can be customized with visible-light and infrared cameras, communications and other tools to give warfighters on the forward edge of battle situational awareness information.

It can integrate new payloads quickly, offers roll-on, roll-off capability to move the system quickly from ship to shore, and aboard cargo aircraft. The UAV can carry sensor payloads as heavy as 39 pounds.

The Blackjack's standard sensor payload consists of a visible-light imager, mid-wave infrared imager, laser rangefinder, infrared marker, communications, and Automatic Identification System (AIS).

The RQ-21A will provide persistent maritime and land-based tactical reconnaissance, surveillance, and target acquisition (RSTA) data collection and dissemination capabilities to the warfighter.

For the Marine corps it will provide the marine expeditionary force, divisions, and regiments with a dedicated intelligence, surveillance, and reconnaissance (ISR) system that sends information to the tactical commander in real time.

For the Navy the Blackjack will provide persistent RSTA information to Navy ships, Marine Corps land forces, Navy expeditionary combat command forces and Navy special warfare units. ◀

On this order Boeing Insitu will do the work in Bingen, Wash.; and locations outside the U.S., and should be finished by June 2026. For more information contact Boeing Insitu online at [www.insitu.com](http://www.insitu.com), or Naval Air Systems Command at [www.navair.navy.mil](http://www.navair.navy.mil).



## Navy wants companies to build unmanned aircraft and sensors for cold-weather polar use

BY John Keller

**PANAMA CITY, Fla.** — U.S. Navy cold-weather experts are surveying industry to find companies able to build unmanned aircraft for surveillance and navigation in the harsh environmental conditions near Earth's polar regions.

Officials of the Naval Surface Warfare Center in Panama City, Fla., have issued a sources-sought notice (N61331-23-SN-Q31) for the Unmanned Aircraft Systems Capable of Ice Detection and Mapping, Maritime Domain Awareness, and Logistics Support in arctic Environment project.

These unmanned aircraft must be able to operate reliably from ships or land sites in the frigid polar regions for ice detection and mapping, domain awareness, object recognition, payload delivery, GPS-limited navigation at high latitudes.

Unmanned aircraft must be able to launch and recover from air bases and surface ships on long-endurance in arctic winter temperatures, in fog, and in round-the-clock darkness. Extreme cold severely limits battery power available for UAV propulsion, navigation, and sensor payloads. This request for information is for planning purposes only.





◀ **The Navy needs unmanned aircraft with cold-weather sensors and communications that are small and lightweight enough to operate aboard 10-pound UAVs.**

The arctic region is a strategic national security concern, and is extremely challenging because harsh and rapidly changing weather, austere infrastructure, and a general lack of operational experience.

Current unmanned aircraft are

limited in arctic environment — particularly those deployed from small surface ships.

Of particular interest are cold-weather sensors and communications that are small and lightweight enough to operate aboard UAVs ranging in size from about 10 pounds to about 1,300 pounds for maritime domain awareness.

These cold-weather UAVs and sensor payloads should be able to assess weather conditions, detect treacherous ice, classify and map terrain, and recognize objects as small as a person in a 20-foot boat.

These UAVs should be able to launch and recover from unimproved surfaces and from surface ships with helicopter decks. Unmanned aircraft should be at technology readiness levels ranging from deployable prototypes to operational systems.

Those with promising UAVs and sensors may be invited to a live demonstration in December 2023 at Oliktok Point, Alaska, with a follow-on demonstration in March 2024 at Pituffik Space Base, Greenland.

For these cold-weather UAVs and sensor payloads, Navy experts want to know about support equipment; operating clothing requirements; launch and recovery; system size, weight, and power consumption (SWaP); sensor payload types; UAV performance; operational duration; iced detection; icing and de-icing capability; autonomous operation capability; teaming capability, and swarming capability; noise; and cost. ◀

Companies interested were asked to email the Navy's Brandon Hayes at [Brandon.d.hayes11.civ@us.navy.mil](mailto:Brandon.d.hayes11.civ@us.navy.mil) and Jonathan Faranda at [jonathan.d.faranda.civ@us.navy.mil](mailto:jonathan.d.faranda.civ@us.navy.mil), with a copy to [usn.pentagon.cnr-arlington-va.mbx.Frozen-Flyer@us.navy.mil](mailto:usn.pentagon.cnr-arlington-va.mbx.Frozen-Flyer@us.navy.mil), by August. More information is online at <https://sam.gov/opp/1d9d76deb1584fddb71f84bb9a510be6/view>.

### **United Airlines selects Eve Air Mobility for electric commuter flights to San Francisco**

Eve Air Mobility, a subsidiary of Embraer in São José dos Amps, Brazil, and Chicago-based United Airlines announced plans to bring urban air mobility (UAM) to San Francisco by launching electric commuter flights throughout the Bay Area. Eve's eVTOL will move passengers to United hub airports and through dense urban environments. Eve's eVTOL is all-electric and has a range of 60 miles. The aircraft features a lift and cruise configuration with dedicated rotors for vertical flight and fixed wings for cruise, with no components required to change position during flight. It will have a human pilot at launch but will evolve towards uncrewed operations in the future. Eve noted that eVTOL flights in the Bay Area are expected to have a positive economic impact on the community including new employment opportunities. Positions ranging from pilots and aircraft service technicians to training and technical services are among the numerous roles that will be needed as eVTOL flights are introduced and expand. ◀

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# Lockheed Martin to build prototype 300-kilowatt laser weapons for rocket defense

BY John Keller

REDSTONE ARSENAL, Ala. — U.S. Army aerial defense experts needed a company to develop prototype 300-kilowatt laser weapons to protect soldiers and installations from rockets and aircraft. They found their solution from Lockheed Martin Corp.

Officials of the Army Rapid Capabilities and Critical Technologies Office (RCCTO) at Redstone Arsenal, Ala., announced a \$220.8 million contract to Lockheed Martin Aculight in Bothell, Wash., for the Indirect Fire Protection Capability-High Energy Laser (IFPC-HEL) Prototypes project.

High-energy laser weapons significantly help the Army defend against low-cost threats on the modern battlefield. The IFPC-HEL project calls for Lockheed Martin Aculight to develop enabling technologies to help Army leaders protect fixed and semi-fixed sites from rockets, artillery, mortars, UAVs, helicopters, fixed-wing aircraft, and similar threats.

The company will pursue enabling technologies for prototype 300-kilowatt laser weapons to disable or destroy these kinds of

▲ **Lockheed Martin will help the U.S. Army develop prototype 300-kilowatt laser weapons to protect soldiers and installations from rockets and aircraft.**

battlefield threats. Laser weapons prototypes will be at least as powerful as 250 kilowatts.

This effort will provide as many as four complete laser weapons that comprise beam control, beam director, battle management, power, and thermal management integrated onto an Army-furnished platform that incorporates an

Army-directed laser weapon.

The aerial defense laser weapon systems prototypes will be delivered as early as summer 2024 for live range testing. Army leaders say they may award additional contracts to additional companies to deliver high-energy laser weapons prototypes. ◀

On this contract Lockheed Martin will do the work in Bothell, Wash.; Moorestown, N.J.; Owego, N.Y.; Oldsmar and Orlando Fla.; Sunnyvale, Calif.; and Huntsville, Ala., and should be finished by October 2025. For more information contact Lockheed Martin Aculight online at <https://www.lockheedmartin.com/en-us/capabilities/directed-energy.html>, or the Army Rapid Capabilities and Critical Technologies Office at <https://rapidcapabilitiesoffice.army.mil>.

# Lockheed Martin to upgrade electro-optical submarine imaging system

BY John Keller

WASHINGTON – Submarine combat systems experts at Lockheed Martin Corp. will continue a project to upgrade and support a U.S. Navy electro-optical surveillance system designed for several classes of attack and guided-missile submarines.

Officials of the Naval Sea Systems Command in Washington announced an \$15.4 million order to the Lockheed Martin Rotary and Mission Systems segment in Manassas, Va., for components and engineering for the AN/BVY-1 Integrated Submarine Imaging System (ISIS).

This electro-optical system provides mission-critical, all-weather, visual, and electronic search, digital image management, indication, warning, and platform architecture interface capabilities for Los Angeles-, Ohio-, and Virginia-class submarines, Navy officials say. The system has the potential for installation on current and future ballistic missile submarines.

The ISIS submarine electro-optical surveillance system rolls-up existing components and near-term capabilities into an architecture for inserting future capabilities as they become available, including items taken from the Virginia-class submarine photonics program, Navy officials say.

ISIS is a backfit system to integrate all imaging capabilities on existing Navy submarine classes. It is part of the Navy's submarine Photonics Imaging System, a non-hull-penetrating replacement for existing optical periscopes. The Photonics Imaging System uses a wide portion of the electromagnetic spectrum with advanced daylight cameras, infrared thermal imaging sensors, and communications intercept and electronic warfare support.

The ISIS program seeks to replace the optical light path of existing submarine periscopes with high-definition cameras and fiber optic digital imagery. The project seeks to use infrared cameras for image enhancement, provide active and passive range finding control, and install image enhancement capabilities and analysis tools for real time and recorded imagery.

The ISIS program also will provide Navy submarines with image recording, storage, and recall capabilities, as well as provide the ability to transmit imagery off the submarine to other naval and joint forces.

ISIS revolutionizes Navy submarine surveillance capabilities by integrating digital video and still images from devices on a submarine's exterior and presenting real-time imagery and analysis on existing control room tactical displays.



**ISIS provides all-weather, visual, and electronic search, digital image management, indication, and warning for Los Angeles-, Ohio-, and Virginia-class submarines.**

ISIS provides digital image enhancement for data from a modern submarine's photonics mast, which uses optical fiber to move imaging data from a raised mast aboard a submerged submarine through tiny openings in the submarine's hull to tactical displays around the interior of the vessel.

The photonics mast replaces or augments the traditional periscope aboard U.S. submarines. The photonics mast not only replaces the large opening in the submarine pressure hull necessary for the optics and hydraulics of a traditional periscope, but also can blend image data from several kinds of electro-optical sensors aboard the photonics mast, including visible-light and infrared cameras.

The ISIS system enables submarine crew members to manipulate a photonics mast with a joystick, while looking at digital video on a computer monitor, and share that video real-time with the submarine's combat team on various displays aboard the vessel. ←

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On this order Lockheed Martin will do the work in Manassas, Virginia Beach, and Arlington Va.; Orlando and Clearwater, Fla.; and Newport, R.I., and should be finished by September 2024. For more information contact Lockheed Martin Rotary and Mission Systems online at [www.lockheedmartin.com/en-us/who-we-are/business-areas/rotary-and-mission-systems.html](http://www.lockheedmartin.com/en-us/who-we-are/business-areas/rotary-and-mission-systems.html), or Naval Sea Systems Command at [www.navsea.navy.mil](http://www.navsea.navy.mil).





# Army orders infantry fire-and-forget anti-tank missiles with electro-optical guidance

BY John Keller

**REDSTONE ARSENAL, Ala.** — Missiles experts at Lockheed Martin Corp. and Raytheon Technologies Corp. (RTX) will build additional Javelin anti-tank missiles, which have achieved fame in the Russia-Ukraine war as one of the most lethal weapons used against invading Russian armored combat vehicles.

Officials of the U.S. Army Contracting Command at Redstone Arsenal, Ala., announced a \$13.5 million order to the Raytheon/Lockheed Martin Javelin Joint Venture based in Tucson, Ariz., to build Javelin weapon systems.

Javelin, which has electro-optical guidance, is an infantry fire-and-forget anti-armor weapon with lock-on before launch and automatic self-guidance designed to destroy main battle tanks, armored personnel carriers, and other armored combat vehicles. The missile also is effective against buildings and enemy helicopters.

Javelin has an imaging infrared-guided seeker to guide the warhead to its target. The tandem warhead has two shaped charges: a precursor warhead to detonate any explosive

▲ **The Army Lockheed Martin Javelin anti-tank missile features guidance from an infrared seeker and lock-on before launch capabilities.**

reactive armor, and a primary warhead to penetrate base armor.

Javelin offers lock-on before launch and automatic self-guidance that attacks the vulnerable tops of armored vehicles. A two-person infantry team typically carries the missile.

Raytheon produces the command launch unit, missile guidance electronic unit, and system software at Raytheon Missile Systems segment in Tucson, Ariz. Lockheed Martin, meanwhile, produces the missile seeker and the electronic safe, arm, and fire electronic module in Ocala, Fla., and performs missile all-up-round assembly in Troy, Ala. ◀

On this order the Raytheon/Lockheed Martin Javelin Joint Venture will do the work in Tucson, Ariz., and should be finished by July 2024. For more information contact the Raytheon/Lockheed Martin Javelin joint venture online at [www.rtx.com/raytheon/what-we-do/land/javelin-missile](http://www.rtx.com/raytheon/what-we-do/land/javelin-missile), or Lockheed Martin at [www.lockheedmartin.com/en-us/products/javelin.html](http://www.lockheedmartin.com/en-us/products/javelin.html), or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa/>.

# Raytheon to build 571 infrared-guided AIM-9X air-to-air missiles

BY John Keller

**PATUXENT RIVER NAS, Md.** – U.S. Navy aerial warfare experts are asking Raytheon Technologies Corp. to build 571 AIM-9X precision short-range infrared-guided air-to-air missiles for jet fighters and other combat aircraft under terms of a \$263.7 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 lot 23 AIM-9X block II air-to-air missiles. These anti-aircraft missiles are for the U.S. Air Force, Navy, and foreign allies.

The order is for 571 AIM-9X Block II missiles; captive air training missiles; missile containers; spare advanced optical target detectors; spare advanced optical target detector containers; spare Block II guidance units; captive air training missile guidance units; tactical sectionalization kits; captive air training missile anti-tank missile sectionalization kits; and spare parts.

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.

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 order Raytheon will do the work in Tucson, Ariz; North Logan, Utah; Linthicum Heights, Md.; Minneapolis; Murrieta, Calif.; Saint Albans, Vt.; Ann Arbor, Mich.; Warrington, Pa., and other U.S. locations, and should be finished by August 2026. For more information contact Raytheon Missiles & Defense online at [www.raytheonmissilesanddefense.com](http://www.raytheonmissilesanddefense.com), or Naval Air Systems Command at [www.navair.navy.mil](http://www.navair.navy.mil).



**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.**

### Leonardo DRS to supply shipboard displays for Future Surface Ship Combat Systems

U.S. Navy surface warfare experts are buying additional shipboard consoles, displays, and peripherals from Leonardo DRS (formerly DRS Laurel Technologies) in Johnstown, Pa., to promote maximum software reuse aboard Navy surface combatants. Officials of the Naval Sea Systems Command in Washington announced an \$30.7 million order to DRS for consoles, displays, and peripherals technical insertion 16 hardware in support of the Navy's Future Surface Ship Combat Systems, and the Consoles, Displays, and Peripherals (CDP) program. The CDP is composed of air-cooled and water-cooled variants of the Navy's Common Display System (CDS); consoles, portions of the Aegis weapon system Aegis Modernization Upgrade equipment, and peripheral equipment. The contract involves shipboard electronics equipment that is for vessels like the future Constellation-class frigate, future versions of the Arleigh Burke-class destroyer; the DDG 1000 Zumwalt-class surface-attack destroyer, as well as for Aegis modernization efforts aboard the Navy's Ticonderoga-class cruisers and Burke-class destroyers. On this order Leonardo DRS will do the work in Johnstown, Pa., and should be finished by September 2024. For more information contact the Leonardo DRS operation in Johnstown, Pa., online at [www.leonardodrs.com/locations/naval-electronics-laurel-technologies-johnstown-pa](http://www.leonardodrs.com/locations/naval-electronics-laurel-technologies-johnstown-pa), or Naval Sea Systems Command at [www.navsea.navy.mil](http://www.navsea.navy.mil).

### Near-infrared line-scan hyperspectral camera introduced by Specim Spectral Imaging

Specim Spectral Imaging Ltd. in Oulu, Finland, is introducing the Specim GX17 next-generation near-infrared line-scan hyperspectral camera for advanced machine vision in ruggedized and industrial applications. The Specim GX17 features a maximum frame rate of 800 Hz with 480 spatial pixels, which is 50 percent more than conventional QVGA sensor-based hyperspectral cameras. Operating in the near-infrared wavelength range from 950 to 1700 nanometers, the Specim GX17 can assess object details down to one-millimeter square flakes that are invisible to the human eye. The high spatial resolution and frame rate enable the detection of objects on conveyor belts and free-fall systems moving at high speed. The Specim GX17 camera can be controlled with the machine vision-compliant SpecimONE spectral imaging system that enables development of industrial sorting and inspection applications without in-depth knowledge of spectral imaging, and enables fast time-to-market. For more information contact Specim Spectral Imaging online at [www.specim.com](http://www.specim.com).

### Avalanche photodiode preamplifier modules offered by CMC

CMC Electronics in Montreal is introducing a series of high-response 1064-nanometer silicon avalanche photodiode preamplifier modules for laser rangefinders, as well as airborne and atmospheric light direction and ranging (lidar) applications. These avalanche photodiode receivers offer ultra-low light signals to improve laser applications, offer a high signal-to-noise ratio and can provide accurate and consistent readings under challenging conditions. Both receivers can detect long distances quickly, accurately, and consistently, and provide fast overload recovery that minimizes receiver damage and usage interruption from high laser burst. The ROHS-compliant avalanche photodiode receiver module provides a minimum of 1000 kilovolt amperes per Watt responsivity. Its optoelectronics provides nanosecond recovery from laser bursts without damage to enable the receiver to detect low optical signal powers in femtowatt range at high temperatures. This avalanche photodiode receiver is customizable to the customer's needs. For more information contact CMC Electronics online at <https://cmcelectronics.ca>.

### High-speed camera for near-ultraviolet and visible-light introduced by Teledyne DALSA

Teledyne DALSA in Waterloo, Ontario, is introducing the Linea HS 16k backside illuminated (BSI) TDI camera for near-ultraviolet and visible-light imaging applications such as wafer, flat panel display and electronic packaging inspection as well as photoluminescence and life science imaging. With its CLHS interface, this camera offers enhanced sensitivity, and uses Teledyne DALSA's charge-domain CMOS TDI 16k sensor with a 5x5-micron pixel size and delivers a maximum line rate of 400 kHz aggregate. Compared with front side illumination, the BSI model significantly improves quantum efficiency in the near-ultraviolet and visible wavelengths and boosts signal-to-noise ratio for imaging applications in light-starved conditions. Linea HS is for high-speed and high-sensitivity imaging, and provides performance based on multi-array charge-domain CMOS TDI technology, offering advanced capabilities including mono/HDR, color, multifield, and super resolution imaging for demanding machine vision. Linea HS 16k BSI has the same form factor as the Linea HS FSI, and uses a CLHS data interface that delivers 6.5 gigapixels per second data throughput in one cable. An active optical cable enables a long cable length to eliminate the need for a repeater to improve data reliability and reducing system costs. For more information contact Teledyne DALSA online at [www.teledynedalsa.com/en/home](http://www.teledynedalsa.com/en/home). ◀





## AIRPORT OPERATIONS

### ▲ SkyWest set to deploy CAE's next-generation flight operations solutions

Regional airline SkyWest, based in St. George, Utah, expressed a desire to modernize their digital operations ecosystem. They found their solution from CAE in Montreal.

SkyWest selected CAE's next-generation flight operations solutions. CAE's configurable and scalable operational software leverages the power of data and automation to enhance operational performance and profitability, the Canadian company says.

In addition to optimizing operations, SkyWest will benefit from CAE's experience in deploying mission-critical software that will modernize operations, and boost performance.

CAE's flight operations solutions are part of the company's "SkyWest is taking a leap forward in operations management with CAE's next generation flight operations solutions," said Pascal Grenier, senior vice president, flight services and global operations. "With our most advanced solutions at their fingertips, the team at SkyWest will be empowered to make the best decisions for its operations and its passengers."

"CAE's next generation software will help advance SkyWest's technology across our operations," said Robert Simmons, chief financial officer for SkyWest, Inc. "CAE's automation will reduce our manual workload and bring critical information to the forefront, helping ensure we continue to safely and efficiently coordinate thousands of flights each day."

CAE's portfolio of next generation solutions is a platform of choice for regional carriers in North America who rely on our technology to realize operational efficiencies and support them in managing their business in close coordination with their respective mainline partners.

## MISSILES

### ▼ Raytheon to build AIM-9X missiles that work with helmet-mounted displays

U.S. Navy aerial warfare experts are asking Raytheon Technologies Corp. to build 571 AIM-9X precision short-range infrared-guided air-to-air missiles for jet fighters and other combat aircraft under terms of a \$263.7 million order announced in December.

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 lot 23 AIM-9X block II air-to-air missiles for the U.S. Air Force, Navy, and foreign allies.

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 heat-seeking 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.

The order is for 571 AIM-9X block II all up round tactical missiles — 91 for the Navy, 257 for the Air Force, and 223 U.S. allies; 48 block II captive air training missiles — 38 for the Navy and 10 for the Air Force; 185 all-up-round containers — 62 for the Navy, 67 for the Air Force, and 56 for U.S. allies; 11 spare advanced optical target detectors — five for the Navy and six for the Air Force; eight spare advanced optical target detector containers — two for the Navy, and six for the Air Force; 31 spare block II live-battery guidance units — 21 for the Navy and 10 for the Air Force; 54 spare inert-battery block II captive air training missile guidance units — 41 for the Navy and 13 for the Air Force; two block I tactical sectionalization kits for the Air Force; seven block II tactical sectionalization kits — four for the Navy, two for the Air Force, and one for U.S. allies; 10 block II captive air training missile anti-tank missile sectionalization kits — nine for the Navy and one for U.S. allies; one support equipment for U.S. allies; three other lot spare assets for the Navy, Air Force, and one U.S. ally; and non-recurring engineering.



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 some of the latest versions of the AIM-9X, called the AIM-9X block II, with lock-on after launch capability for use with the F-35 Lightning II joint strike fighter and the F-22 Raptor advanced tactical fighter.

On this contract Raytheon will do the work in North Logan, Utah; Tucson, Ariz.; Linthicum Heights, Md.; Minneapolis; Murrieta, Calif.; Saint Albans, Vt.; Ann Arbor, Mich.; Warrington, Pa., and other U.S. locations, and should be finished by August 2026.

For more information contact Raytheon Missiles & Defense online at [www.raytheonmissilesanddefense.com](http://www.raytheonmissilesanddefense.com), or Naval Air Systems Command at [www.navair.navy.mil](http://www.navair.navy.mil).

### SHIPBOARD RADAR

#### ▲ Ultra Electronics moves forward on Navy software-defined surface-search radar

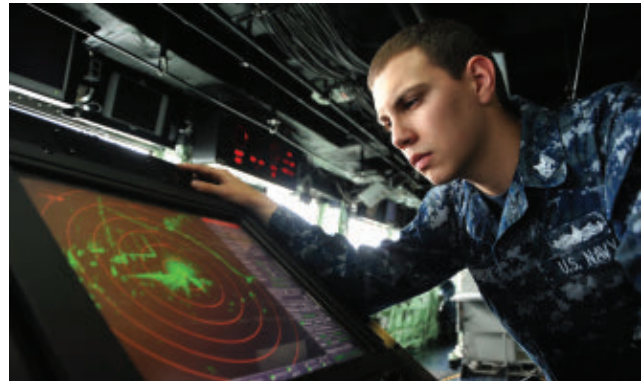
U.S. Navy Surface warship radar experts are moving forward with a project to build a new software-defined surface-search radar system to replace existing radars that suffer from obsolescent technologies or an inability to meet current threats.

Officials of the Naval Sea Systems Command in Washington announced a \$23.9 million order to the Ultra Electronics Ocean Systems segment in Braintree, Mass., for technical and field engineering of the Next Generation Surface Search Radar (NGSSR).

Navigation and situational awareness are basic functions of all surface warships and these seemingly routine tasks have become more difficult as the ocean becomes increasingly complex with the proliferation of inexpensive solid-state radar, Navy officials say.

In March 2019 Ultra Electronics won a \$28 million contract to develop NGSSR qualification systems. In July 2020 Ultra won a \$42.2 million order to acquire the first NGSSR production lot following a contract award for design and production of three qualification systems.

Major shipping channels are jammed with ship and radio traffic as well as debris like floating transport



containers. Even small fishing boat and pleasure craft operators today can afford navigation radar systems. Air traffic and land-based radar further crowd and confuse the radio spectrum.

To make matters worse, enemy ships, aircraft, and unmanned aerial vehicles (UAVs) can exploit this complex sensor picture to conduct surveillance or other operations undetected. The answer, experts say, will be the NGSSR.

This new radar uses of the latest digital technology and incorporate a software-based architecture at its core. NGSSR will have a suite of algorithms that extend, enhance, and optimize NGSSR's performance by exploiting the system's software-defined architecture.

The NGSSR's receiver and exciter are implemented in software to the maximum extent possible, Navy officials say. The bulk of the non-processor hardware is for A/D and D/A conversion, except for ancillary equipment like power supplies. Its software-defined capabilities are expected to enhance maintainability by reducing radar-specific hardware.

Its software-defined architecture also could implement functionality never before considered for such relatively simple rotating radar, such as extending the radar's range and navigation functions in bad weather; resisting enemy electronic warfare attempts to jam it; detecting UAVs, periscopes, floating debris, and floating mines; and improving collision avoidance in crowded waterways.

The new NGSSR software-defined radar ultimately will replace all variants of the Navy's current AN/SPS-67, AN/SPS-73, BridgeMaster E series, and commercial-of-the-shelf radar systems.

Ultra Electronics is helping to find a replacement for legacy systems due to current military threats and obsolescence issues. Last year the company outlined the requirements and approach for NGSSR development, testing, and manufacturing.

The AN/SPS-67 is a short-range, two-dimensional, surface-search and navigation radar system that provides surface and limited low-flyer detection and tracking. The AN/SPS-73(V)12 radar, likewise, is a short-range, two-dimensional, surface search and navigation radar system that provides contact range and bearing information, and helps determine own-ship position relative to nearby vessels and navigational hazards. The BridgeMaster E surface-search radar, meanwhile, provides navigation to commercial and military high speed crafts and vessels.

The AN/SPS-73(V)12 is installed on about 100 Navy ships like aircraft carriers, cruisers, destroyers, amphibious assault ships, and support ships. It was placed into caretaker Status in 2017 in preparation for its replacement by the NGSSR. Thousands of BridgeMaster E marine radars, meanwhile, have been sold to more than 50 navies and coast guards worldwide as well as civilian customers. It replaced the Navy SPS-64 surface-search radar on Arleigh Burke-class destroyers in 2001.

On this order Ultra Electronics Ocean Systems will do the work in Chantilly, Va.; Wake Forest, N.C.; and Braintree, Mass., and should be finished by May 2024. For more information contact Ultra Electronic Ocean Systems online at [www.ultra.group](http://www.ultra.group), or the Naval Sea Systems Command at [www.navsea.navy.mil](http://www.navsea.navy.mil).

## COMMUNICATIONS

### ► Raytheon to build satellite communications (SATCOM) terminals to control nuclear forces

U.S. Navy nuclear weapons experts needed communications terminals for the Air Force Family of Advanced Beyond Line-of-Sight Terminals (FAB-T) program to command nuclear forces. They found their solution from Raytheon Technologies Corp.

Officials of the Air Force Nuclear Weapons Center in Bedford, Mass., have announced an 11-year \$625 million contract to the Raytheon Intelligence & Space segment in Marlborough, Mass., for Force Element Terminals for the Air Force FAB-T program.

The Air Force FAB-T program provides secure and survivable satellite communications (SATCOM) during all phases of nuclear conflict by linking with Milstar and Advanced Extremely High Frequency (AEHF) satellite systems via AEHF waveforms.

This contract calls for Raytheon to buy equipment, as well as provide interim contractor support, depot activation, contractor logistics support, and studies for the FAB-T system.

FAB-T uses ground and airborne satellite terminals to provide presidential national voice conferencing, integrated tactical warning attack assessment, emergency action message dissemination, satellite telemetry, tracking, and control, and force reportback. The system must also operate through a nuclear event.

Raytheon was named the FAB-T production contractor in June 2014. The airborne terminals go aboard E-4B and E-6B aircraft, and the ground terminals offer a fixed and transportable variant for command posts.

FAB-T consists of ground and aircraft communication terminals with two terminal types: Command Post Terminals (CPTs) and Force Element Terminals (FETs). The FET is to be installed in the B-52 and RC-135 aircraft, while the CPT is for E-4B and E-6B aircraft.

The U.S. president, the secretary of defense, combatant commanders, and supporting Air Force units will use FAB-T to provide strategic nuclear and non-nuclear command and control with extremely high frequency wide-band protected and survivable communications terminals for beyond line-of-sight communications.

Air Force Space Command (AFSPC) uses the FAB-T for satellite telemetry, tracking, and commanding for the AEHF satellite constellation, including management of the satellites, communication networks, and cryptologic keys.

U.S. Strategic Command and U.S. Northern Command use the FAB-T for integrated tactical warning and attack assessment satellite communications of incoming missile threats to military forces from fixed and mobile sites.

On this contract Raytheon will do the work in Marlborough, Mass., and Largo, Fla., and should be finished by June 2034. For more information contact Raytheon Technologies Corp. online at [www.rtx.com/raytheon](http://www.rtx.com/raytheon), or the Air Force Nuclear Weapons Center at [www.afnwc.af.mil](http://www.afnwc.af.mil).







### ANTENNAS

#### ▲ BAE Systems to build shipboard antennas for radar, IFF, and air traffic control

U.S. Navy aerial warfare systems experts needed special circular shipboard antennas for identification-friend-or-foe, secondary surveillance radar, and air traffic control radar applications. They found their solution from the BAE Systems Electronic Systems segment in Nashua, N.H.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., has announced a \$22 million contract to BAE Systems last month for electronically steered OE-120/UPX antenna group for shipboard identification and air traffic management.

The BAE Systems OE-120 antenna group for shipboard radar is an electronically steerable antenna that shipboard operators can redirect within 50 microseconds to interrogate any target on the horizon. The antenna array supports IFF interrogator as well as air traffic control beacon systems, and is designed for surface ships and land-based installations.

This contract is for eight OE-120/UPX antenna group systems — seven for the Navy, and one for government of Canada; six OE-120 retrofit kits for the Navy; two OE-120 installation and checkout kits for the Navy; and two OE-120 delta installation and checkout kits — one for the Navy, and one for the government of Australia.

The OE-120B antenna groups offer instantaneous multiple-target identification for use against today's sophisticated air threats. It accommodates all standard IFF modes.

The antenna system adapts to land and sea applications to support a variety of mission environments, and its electronically steered system architecture offers increased reliability and reduced maintenance. Its array configuration allows for smooth performance degradation in the event of a failure.

The OE-120 electronically steerable antenna is suitable for the Navy's Ticonderoga-class cruiser (CG 47), the Arleigh Burke-class destroyer (DDG 51), the Wasp-class amphibious assault ship (LHD 1), the San Antonio-class amphibious

transport dock (LPD 17), aircraft carriers, and the Japanese Kongo-class destroyer (FMS DD 173) — a version of the U.S. Burke-class destroyer.

The AN/UPX-29(V) shipboard IFF interrogator, for which the OE-120B antenna is part, distinguishes friendly vessels and aircraft nearby during combat operations.

The AN/UPX-29(V) can process and store as many as 400 targets, provide instantaneous interrogation on a target within 25 microseconds, electronically evaluate Mode 4 replies, call up operator-designated target information, display IFF targets synchronized with as many as four radars at 22 displays, and interface with shipboard computers.

At the heart of the OE-120 system is the AS-3134/UPX antenna array, which consists of 64 vertical radiating dipole antenna element pairs arranged in a circle on the ship's mast. The system uses electronic beam steering to scan all areas around the ship. The dipole antenna element pairs can produce either directional or omnidirectional beam patterns.

The system can aim its RF energy at any target of interest located at any point on the horizon within microseconds. Operators also can scan the antenna's output rapidly over a designated sector of interest. During normal surveillance operations the antenna group scans the horizon at 90 revolutions per second.

The OE-120's CV-3372/UPX antenna positioner receives commands from the C-10063/UPX controller, distributes RF power to the radiators, and digitally controls the system's output mode and boresight direction. The system's C-10063/UPX antenna controller, meanwhile, is located below decks and translates synchronized data continuously from the ship's environmental sensors.

On this contract, BAE Systems engineers will do the work in Nashua, N.H., and should be finished by December 2025. For more information contact BAE Systems Electronic Systems online at [www.baesystems.com/en-us/our-company/inc-businesses/electronic-systems](http://www.baesystems.com/en-us/our-company/inc-businesses/electronic-systems), or Naval Air Systems Command at [www.navair.navy.mil](http://www.navair.navy.mil).

### POSITIONING, NAVIGATION, AND TIMING

#### Collins to provide PNT in vetronics to protect armored combat vehicles from GPS threats

U.S. Army land warfare experts needed a way to assure accurate positioning, navigation, and timing (PNT) for its fleet of combat vehicles when signals from Global Positioning System (GPS) satellites are blocked or jammed. They found their solution from the RTX Collins Aerospace segment in Cedar Rapids, Iowa.



Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., have announced a \$64 million contract to Collins Aerospace, a subsidiary of Raytheon Technologies Corp. (RTX), for Mounted Assured Positioning, Navigation and Timing Systems (MAPS).

The latest version of the Collins Aerospace MAPS, the MAPS Gen II system, keeps up with the pace of current and future enemy threats and technologies, Collins officials say.

The MAPS Gen II, composed of the Collins To reduce the number of changes aboard armored combat vehicles, Collins Aerospace also uses a smart, two Line-Replaceable-Unit (LRU) system that cleanly replaces the existing navigation system in the vehicle for easier upgrade and sustainability.

The MAPS Gen II system is composed of the Collins Aerospace NavHub-100 navigation system and Multi-Sensor Antenna System (MSAS-100), and is designed to boost protection against evolving GPS threats. It includes Military Code (M-Code) capability and improved levels of reliability through modernized signal tracking to enhance GPS integrity, Collins officials say.

NavHub-100 generates and distributes assured position, navigation and timing (APNT) information to all combat vehicle systems, and provides accurate navigation amid GPS threats by fusing data from several different sensors.

NavHub-100 offers modern signal tracking to ensure GPS integrity; supports the Defense Advanced GPS Receiver (DAGR) standard interface; includes an M-Code security-certified circuit card.

The MSAS-100 offers additional protection by using the ground-based MSAS-100 anti-jam antenna. It also provides simultaneous GPS L1 and L2 protection; delivers anti-jamming capability; supports Y-Code and M-Code anti-jamming. It also includes the AltNav single-patch antenna and barometer and orientation sensor for assured PNT.

On this contract Collins Aerospace will do the work in Cedar Rapids, Iowa, and

should be finished by September 2025. For more information contact RTX Collins Aerospace online at [www.collinsaerospace.com](http://www.collinsaerospace.com), or the Army Contracting Command at Aberdeen Proving Ground at <https://acc.army.mil/contractingcenters/acc-apg/>.

#### DESIGN AND DEVELOPMENT TOOLS

### ▼ Flexium selects Ansys software for 5G millimeter-wave antenna designs

Designers at Flexium Interconnect Inc. in Kaohsiung, Taiwan, needed simulation technology to help them develop test antenna modules for high-frequency signal transceivers. They found their solution from Ansys Inc. in Canonsburg, Pa.

Flexium experts are using Ansys simulation tools to help design printed circuit boards for advanced driver assistance systems (ADAS) and autonomous vehicle (AV) applications.

With support from Ansys tools, the circuit board manufacturer's research team also can test the durability and reliability of the company's circuit boards, as well as explore new design ideas through layout and material experimentation at a relatively low cost.

Within Flexium's circuit board layouts are flexible print circuits (FPCs) responsible for critical connections that enable 5G communication in ADAS and AV applications. Any design deficiencies within these layouts can negatively impact FPC transmission characteristics responsible for vehicle perception.

To address these challenges, Flexium uses Ansys simulation software for the electromagnetic, thermal, and mechanical optimization of its FPC designs through layout and material changes. Ansys tools also helped Flexium set specific parameters for board layout and materials, then create a reference library for future millimeter-wave design verification.

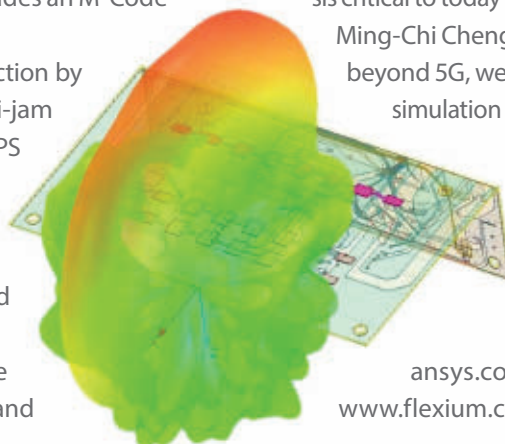
"Ansys delivers the greatest predictive accuracy and yields the strongest results for us during circuit board layout analysis critical to today's ADAS and AV applications," says

Ming-Chi Cheng, president of Flexium. "Looking beyond 5G, we will continue to reference Ansys

simulation to discover new methods for optical integration and communication that will help shape the future of our millimeter-wave antenna module designs."

For more information contact Ansys online at [www.ansys.com](http://www.ansys.com), or Flexium Interconnect at

[www.flexium.com.tw/?lang=en-US](http://www.flexium.com.tw/?lang=en-US).





### ELECTRONIC WARFARE

#### ▲ Lockheed Martin to build anti-radar EW systems for Apache helicopters

U.S. Army combat helicopter designers needed electronic warfare (EW) systems to enable the AH-64E Apache Guardian attack helicopter to detect and identify enemy radar threats. They found their solution from Lockheed Martin Corp.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., have announced a \$192.2 million contract to the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y., for production, sustainment hardware, and engineering for the Modernized-Radar Frequency Interferometer (MRFI).

The MRFI identifies intelligence, surveillance, and reconnaissance (ISR) emitters, and helps the AH-64E pilot to detect and engage an enemy radar threat long before the aircraft becomes vulnerable.

The system quickly detects, identifies, and locates enemy radar, and then ranks these hostile radars in order of priority for subsequent ground attack.

The MRFI is part of the AH-64E's digital receiver-based AN/APR-48B system, which performs target acquisition and cueing for the helicopter's fire-control radar system.

It also can deliver warning of radar directed antiaircraft threats and serve as the controller for an integrated aircraft survivability equipment. The system provides high sensitivity and precision angle of attack in a lightweight, modular configuration.

The AN/APR-48B system primarily operates on a dual-redundant MIL-STD-1553B databus. Other commercial I/O interfaces available for future growth include Gigabit Ethernet, RS-232, and RS-422.

On this contract Lockheed Martin will do the work in Owego, N.Y. For more information contact Lockheed Martin Rotary and Mission Systems online at [www.lockheedmartin.com](http://www.lockheedmartin.com), or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa>.

### SENSORS

#### ▼ Army to convert 155-millimeter artillery shells into GPS-guided smart munitions

U.S. Army explosives experts are asking Northrop Grumman Corp. to provide precision-guidance kits to transform conventional 155-millimeter artillery shells into GPS-guided smart munitions.

Officials of the Army Contracting command in Newark, N.J., has announced a \$69.7 million order to the Northrop Grumman Armament Systems and Ammunition segment in Plymouth, Minn., for M1156 precision guidance kits for the Army.

The Northrop Grumman Precision Guidance Kit (PGK) transforms existing 155-millimeter high-explosive artillery projectiles into affordable satellite-guided precision weapons.

The PGK conversion kit uses signals from the Global Positioning System (GPS) to guide artillery shells to their targets with accuracy of less than 10 meters.

The low-cost reliable, fuze-sized guidance kit installs in the artillery shell's fuze well and also provides traditional fuze functions for height-of-burst and point detonation.

The PGK conversion kit provides maneuver forces with an organic precision capability that works in all weather conditions, and fills a gap between conventional artillery and smart munitions capabilities.

On this contract modification Northrop Grumman will do the work in Plymouth, Minn., and should be finished by May 2028. For more information contact Northrop Grumman Armament Systems and Ammunition online at [www.northropgrumman.com/what-we-do/advanced-weapons/armament-systems](http://www.northropgrumman.com/what-we-do/advanced-weapons/armament-systems), or the Army Contracting Command at <https://acc.army.mil/contractingcenters/acc-nj>.





## REAL-TIME SOFTWARE

▲ **Astroscale selects Wind River's VxWorks to command ELSA-M Servicer spacecraft**

Astroscale Holdings Inc. in Tokyo needed command software for the on-board computer on company's ELSA-M Servicer spacecraft. They found their solution from Wind River Systems in Alameda, Calif.

Astroscale develops solutions to create sustainable space systems and mitigate the growing and hazardous buildup of debris in space. Astroscale's End-of-Life service line (ELSA-M) is designed to capture and retire several satellites in one mission.

The on-board computer will support the rendezvous between Astroscale's servicer spacecraft and the client satellite to be removed safely from orbit. Astroscale's software that runs on VxWorks handles computer vision processing that will command ELSA-M.

A high level of precision is necessary for robotic operations, including maneuvers during rendezvous between the ELSA-M servicer and retired satellites.

An in-orbit demonstration to capture an inactive satellite is scheduled for launch in 2025. This will be the first time a commercial active debris removal satellite will take a satellite out of orbit. The mission is part of Astroscale's partnership with OneWeb and the European Space Agency (ESA).

"Our ELSA-M service strives to solve satellite operators' end-of-life disposal challenges" says Stephen Wokes, director of engineering at Astroscale. "With increasing regulatory, industry, and public pressure to prioritize space sustainability, Astroscale's ELSA-M service presents a proactive way for satellite operators to protect the orbital environment and the services that they offer."

For more information contact Wind River online at [www.windriver.com](http://www.windriver.com), or Astroscale at <https://astroscale.com>.

## SOFTWARE ENGINEERING TOOLS

▼ **AROBS Engineering selected for software verification of ESA Space Rider project**

AROBS Engineering, part of AROBS Group in Cluj-Napoca, Romania is leading the technical specifications, architecture, code development, and validation for the Space Rider program, which aims to be Europe's first reusable space transportation system.

Space Rider aims to provide affordable, independent, and reusable space transportation for routine access and return from low-Earth orbit.

AROBS and its partners will ensure specification quality, design, coding, and testing of the Space Rider's central software modules for the AVUM Orbital Module (AOM) and the Re-entry Module (RM).

After landing, Space Rider Reentry Module will be refurbished for reuse, as it is designed to make at least five re-flights each lasting about two months. As much as 1,323 pounds of payload can fit inside the environmentally controlled cargo bay. The inaugural flight is expected towards the end of 2024.

Space Rider may enable free-flying applications such as experiments in microgravity for pharmaceuticals, biomedicine, biology, and physical science. In addition, Space Rider also may help with in-orbit technology demonstration and validation for exploration, Earth observation, and telecommunications, plus surveillance applications such as Earth disaster monitoring and satellite inspection.

AROBS Engineering also is one of the ClearSpace and the European Space Agency (ESA) industrial partners to deliver embedded software for the ClearSpace-1 program. In 2020, ESA commissioned ClearSpace to build, launch, and fly a deorbit mission to capture a large piece of debris in orbit, then safely pilot the object into Earth's atmosphere.

For more information contact AROBS Engineering online at <https://arobs.com/arobs-engineering>, or the European Space Agency at [www.esa.int/Enabling\\_Support/Space\\_Transportation/Space\\_Rider](http://www.esa.int/Enabling_Support/Space_Transportation/Space_Rider). ←



# NEW PRODUCTS

## RUGGED COMPUTERS

### ► Intel-based rugged computer for robotics and IoT introduced by AAEON

AAEON Technology in Taipei, Taiwan, is introducing the EPIC-ADS7-PUC peripheral unit controller computer, powered by the 12th Generation Intel Core processor. With a chassis that measures 10.2 by 6.3 by 2.1 inches, the chassis can host several high-speed interfaces, and is suited to applications in robotics, internet of things (IoT), and smart health care. Equipped with as many as eight performance cores and 20 threads with the efficiency of hybrid processor architecture, the EPIC-ADS7-PUC's 12th Generation Intel Core, and offers Gracemont efficient cores to manage projects that require a balance of efficiency and strength. Two DDR5 4800 MHz slots offer high-speed system memory and bandwidth speed for as many as six USB 3.2 Gen 2, two COM, and four LAN ports, which provide connections for peripheral devices such as cameras and sensors. The EPIC-ADS7-PUC also offers display interface of one HDMI 2.1 and two DP 1.4a ports for three simultaneous displays, and supports Intel Time Coordinated Computing (Intel TCC), which ensures the reliable execution of time-sensitive mission-critical operations. The EPIC-ADS7-PUC can integrate into existing projects, and lends itself to projects requiring discreet deployment. For more information contact AAEON Technology online at [www.aaeon.com](http://www.aaeon.com).



switching and data-center-grade protocols. The fabrics enable 2.5 times the bandwidth of similar 10/40 Gigabit Ethernet 3U VPX SOSA-aligned switches without a proportional increase in power consumption, increasing the efficiency of bandwidth

per Watt. The switch fabric combines with a dual-core ARM-based processor running OpenWare, Abaco's switch management software to manage the switches via serial console, SNMP, Telnet, SSH, or web interface. Overwriting onboard non-volatile storage for security purposes is simplified with a built-in sanitization capability. The SWE450S 3U VPX Ethernet switch, designed with a 2-terabit-per-second switch fabric, aligns with two SOSA switch profiles. It offers as many as 2x 100G-SR4 rugged front panel fiber ports with Multi-fiber Push On (MPO) connectors. All copper and fiber fat-pipe quad ports can be reconfigured to run as four thin-pipe discrete ports. Each copper channel supports speed downgrading from 25/100G to 10/40G to connect and switch between high- and low-speed endpoints. Options for the SWE450S include 1x or 2x 100GBASE-SR4 rugged front panel fiber modules with MPO connectors for connecting across distances. One rear in-band 1000BASE-T also is available with a 6F8U profile. For more information contact AMETEK Abaco Systems online at [www.abaco.com](http://www.abaco.com).

## NETWORKING

### ▼ Rugged SOSA-aligned 3U and 6U Ethernet switches introduced by AMETEK Abaco

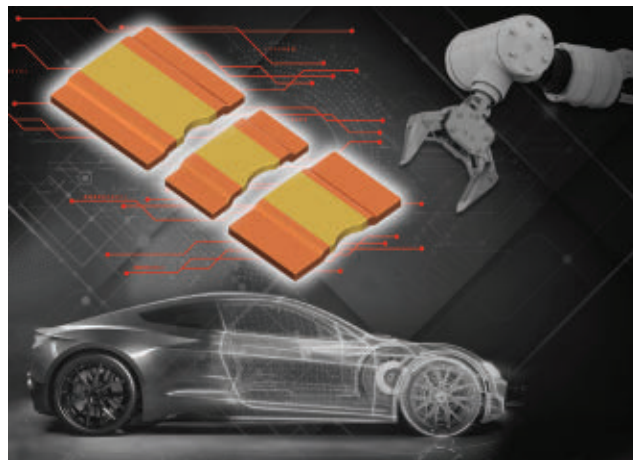
AMETEK Abaco Systems in Huntsville, Ala., is introducing the NETernity SWE450S and SWE550S managed layer 2/3 rugged 3U and 6U VPX Ethernet switches with 25-to-100-gigabit Ethernet connectivity for aerospace and defense embedded computing applications. Both SOSA-aligned Ethernet switches use a high-performance switch fabric, providing wire-speed



## POWER CONTROL

### ▼ 12-Watt-rated metal plate shunt resistor for high-power applications introduced by ROHM

ROHM Semiconductor USA in Santa Clara, Calif., is introducing the PSR350 12-Watt-rated metal plate shunt resistor for high-power industrial and automotive applications. The PSR350 uses ROHM's vertically integrated production





system with material and process optimization to achieve a thickness of 0.03 inches — about half

that of conventional power electronics products in the 12-Watt class. The same technology helps ROHM develop the 0.25-inch 15-Watt-rated PSR330 shunt resistor. This decreases size by about 65 percent compared to conventional products in the same class to reduce mounting area in a wide range of high-power applications. Shunt resistors have been used in power modules for industrial equipment for some time. Similarly in the automotive sector, the number of thin double-sided cooled power modules adopted in the main inverters of xEVs is rising, demanding incorporate power device chips (IGBTs and SiC MOSFETs) and shunt resistors to decrease housing size. Conventional metal plate shunt resistors reduce the cooling efficiency of power devices due to their relatively high profile. But decreasing height has proven difficult, as it is necessary to prototype and evaluate a variety of welding materials in different configurations. For more information contact ROHM Semiconductor USA online at [www.rohm.com](http://www.rohm.com).

#### MOTION CONTROL

##### ▲ Four goniometer stages for laser positioning, microscopy introduced by Optimal Engineering

Optimal Engineering Systems Inc. (OES) in Van Nuys, Calif., is introducing the AK160-30 series of four goniometer high-precision positioning stages for microscopy, crystallography, laser positioning, light measurement, and inspection. The stages feature precision-ground worm gears with a 400:1 ratio, and pre-loaded cross roller guides offer plus-or-minus 30 degrees of travel with 30 kilograms of load. This series of goniometer stages feature four motor options. The -01 option is stepper motor driven. The -02 option is three phase-servo motor driven with a quadrature optical encoder, the -03 version is DC servo motor driven with a quadrature optical encoder, and the -04 option is stepper motor driven with quadrature optical encoders for

position verification. This AK160-30 goniometer series of stages has a 160-by-160-millimeter table with a precision pattern of mounting holes. The center of rotation is 136 millimeters above the surface of the table and the radius of rotation is 203 millimeters. The size of these stages is 160 by 384 millimeters without the motor, and a load capacity of 30 kilograms. A calibrated indicator displays the angle of rotation. For more information contact OES online at [www.oesincorp.com](http://www.oesincorp.com).

#### ANTENNAS

##### ► Omnidirectional outdoor antennas for wireless networking introduced by KP

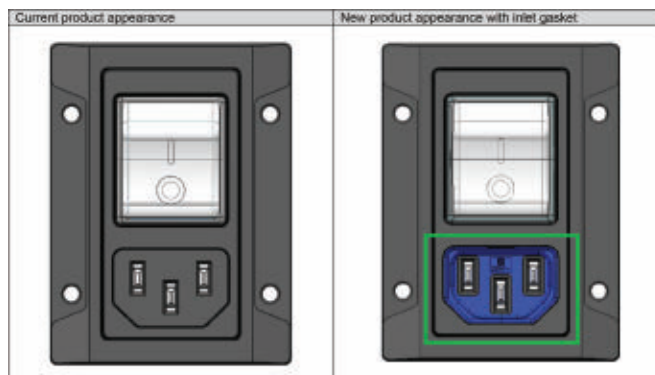
KP Performance Antennas in Lewisville, Texas, is introducing omnidirectional antennas with NMO mounts for improving wireless network performance in outdoor applications like IT, Zigbee, Bluetooth, and Wi-Fi. The omnidirectional antennas are available in several connector options, including RP SMA, N-female, N-male, SMA, RP TNC plug, and TNC male. They feature a magnetic NMO mount for easy installation. With gains ranging from 2.5 to 5.5 decibel isotropic (dBi), these omnidirectional antennas offer several connector options for the NMO mount, and their magnetic bases provide a strong and durable mount for vehicles and other structures. These omnidirectional antennas with NMO mounts are in-stock and available for same-day shipping. For more information contact KP Performance Antennas online at [www.kpperformance.com](http://www.kpperformance.com).



#### POWER ELECTRONICS

##### ▼ IP67-rated power entry modules for aerospace and defense introduced by SCHURTER

SCHURTER Inc. in Santa Rosa, Calif., is updating the company's series DG11 and DG12 power entry modules with ingress protection between the connector and mating V-Lock power cord for aerospace and defense electrical appliances. SCHURTER uses the





same sealing mechanism in the existing DG11 and DG12. The blue-colored latch of the V-Lock power cord and blue inlay of the appliance inlet indicate that the two can provide an IP54 rating under load. The unit is IP67 rated between the power entry module and the panel. The DG11 and DG12 are designed to combine as many as five functions in one component: a C14 or C18 inlet

for appliances, a circuit breaker that provides overcurrent protection and/or a recessed 2-pole ON/OFF switch, a mains filter (DG12), and ingress protection with the blue V-lock compatible power cords. The circuit breaker switch is available lighted or unlighted with a selection of colors and ON/OFF printing/embossing. The device is rated to 10 amps at 250 volts AC according to IEC and

15 amps at 250 volts AC according to UL/CSA. For more information contact SCHURTER online at [www.schurter.com](http://www.schurter.com).

## RF AND MICROWAVE

### ► Push-button RF and microwave attenuators for SATCOM introduced by Pasternack

Pasternack, an Infinite Electronics brand in Irvine, Calif., is introducing a series of push-button attenuators for applications like test, instrumentation, cellular, wireless, and satellite communications (SATCOM). Pasternack's line of continuously variable attenuators features power ratings of 5 and 10 Watts, an operating frequency range to 18 GHz, and attenuation levels to 50 decibels. The variable-phase shifters provide frequency ranges at 2 GHz, 4 GHz, and 8 GHz along with a 100-Watt power rating. These variable-phase shifters also have adjustable phases at 60, 90, and 180 degrees per gigahertz. The step attenuators are engineered for RF and microwave performance with frequency ranges at 6, 8, and 18 GHz. They feature attenuation levels including 10, 60, 70, and 99 decibels, and attenuation steps at 1 and 10 decibels depending on the model. Pasternack's push-button attenuators are in-stock and available for same-day shipping. For more information contact Pasternack online at [www.pasternack.com](http://www.pasternack.com).

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meets MIL-STD-461G, MIL-STD-1275E, and MIL-STD-810H military standards for high-reliability electronics. The sensor is ITAR-free, and is not restricted to export. Key features include low size, weight, power consumption, and cost (SWaP-C); performance in harsh environments; jamming and spoofing mitigation and detection; dead reckoning; built-in data logger and Ethernet connectivity; integration tools such as REST API, binary, and ASCII protocols; pre-configured motion profiles for land, air, and sea; single-antenna heading; and dual-antenna heading for low dynamics applications. Other features include 0.015 degrees of roll and pitch accuracy; heading accuracy of 0.05 degrees; 1 centimeter and plus-or-minus 2 parts-per-million horizontal accuracy; a built-in data logger; and Ethernet, serial, and CAN networking interfaces. For more information contact SBG Systems online at [www.sbg-systems.com](http://www.sbg-systems.com).

#### NAVIGATION AND GUIDANCE

##### ▼ **SWaP-optimized rugged inertial navigation system offered by SBG**

SBG Systems in Carrières-sur-Seine, France, is introducing the Ekinox Micro miniature GNSS-aided inertial navigation system for mission-critical applications like unmanned surface vessels, antenna pointing, mobile mapping, and hydrography. The Ekinox Micro combines a high-performance micro-electro-mechanical-system (MEMS) inertial sensor with a quad-constellation dual-band global navigation satellite system (GNSS) satellite navigation receiver. The rugged navigation and guidance system

#### CABLE AND CONNECTORS

##### ► **Fiber optic outdoor cable assemblies introduced by L-com**

L-com in North Andover, Mass. is introducing ODVA-compatible MPO fiber optic outdoor cable assemblies for outdoor uses like military communications, oil and gas, broadcast, transport, and renewable energy. These cable assemblies feature a bayonet-locking



system and are compatible with existing ODVA cable deployments for LTE, fiber to the antenna (FTTA), DAS, and mobile cell tower applications. Options are available for multimode fiber and single mode fiber. L-com's cable assemblies exceed the requirements for ODVA, and are outdoor-rated with an IP68 designation for reliability in harsh environments such as water immersion. They operate in temperatures from



## NEW PRODUCTS

-40 to 70 degrees Celsius, are chemical-resistant, and have a low-smoke, zero-halogen (LSZH) burn rating. These fiber optic cable assemblies offer low insertion loss and come in 12-strand fiber or 24-strand fiber and are as long as 98 feet. Also included fan-out assemblies as long as 16 feet and IP68 LC connectors with chemical resistance and pull force of 100 pounds. Connector configurations include MPO/UPC, MPO/APC and LC/APC. For more information contact L-Com online at [www.l-com.com](http://www.l-com.com).

### SOLDER

#### ► Lead-free solder paste for extended thermal cycling introduced by Indium

Indium Corp. in Clinton, N.Y., is introducing the Indium8.9HFRV air reflow no-clean solder flux vehicle to improve the voiding performance of next-generation lead-free high-reliability alloys.

Developed from the Indium8.9HF chemistry, the solder paste features low-voiding performance while providing stencil print transfer efficiency and response-to-pause performance. Applications that require extended thermal cycling performance may use lead-free tin-silver-copper-based alloys that contain antimony, bismuth, and indium. Indium8.9HFRV is a for high-reliability alloys, and provides voiding performance and electrical and process reliability. The flux also is compatible with standard tin-silver-copper alloy systems. Indium8.9HFRV offers low voiding when used with high-reliability alloys; high transfer efficiency through small apertures; excellent wetting; superior response-to-pause performance; and compatibility with Air and N2 reflow environments. For more information contact Indium Corp. online at [www.indium.com](http://www.indium.com). ◀



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The advertisement features a background image of a person in a military-style uniform sitting at a desk with multiple computer monitors. The monitors display various data visualizations, including maps and charts. The text is overlaid on this image.



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# Honeywell partners with Department of Energy on hydrogen fuel storage for UAVs

BY Jamie Whitney

**PHOENIX** - Honeywell in Phoenix is working together with the U.S. Department of Energy's (DOE's) National Renewable Energy Laboratory (NREL) on a yearlong collaboration to prototype and support to commercialize cartridge-based hydrogen fuel storage for uncrewed aerial vehicles (UAVs).

Honeywell will provide technological expertise, testing for fuel cartridge technology, supply chain support, prototyping and fuel cell evaluation to qualify for the "Fuel Additives for Solid Hydrogen (FLASH) Carriers in Electric Aviation" project.

The FLASH project will mature a new hydrogen carrier technology developed at NREL as part of the HyMARC (Hydrogen Materials Advanced Research Consortium) project. The program is funded by a partnership of the DOE's Hydrogen and Fuel Cell Technologies Office, NREL, and Honeywell.

Electric UAVs are seeing rapid adoption in industrial applications such as surveying, infrastructure inspection and security.

Many of these applications previously required inefficient ground-based vehicles or hazardous use of piloted helicopters.

For short-range applications, UAVs have the potential to offer greater efficiency, reliability and precision compared with conventional combustion-driven aircraft. For long-range and heavy-payload applications, however, battery-powered electric UAVs today fall short. The NREL and Honeywell collaboration seeks to prove that hydrogen can help address these longer-duration, high-payload challenges.

"Today's long-range drones are typically powered by internal combustion engines. While they provide the required range that battery-powered electric UAVs lack, these engines have issues with excessive noise, vibration and emissions, including carbon emissions," said Katherine Hurst, NREL senior scientist and group manager. "This is an exciting opportunity to demonstrate the performance of hydrogen storage materials that we developed in our laboratory together with Honeywell to fuel a real-life flying vehicle."

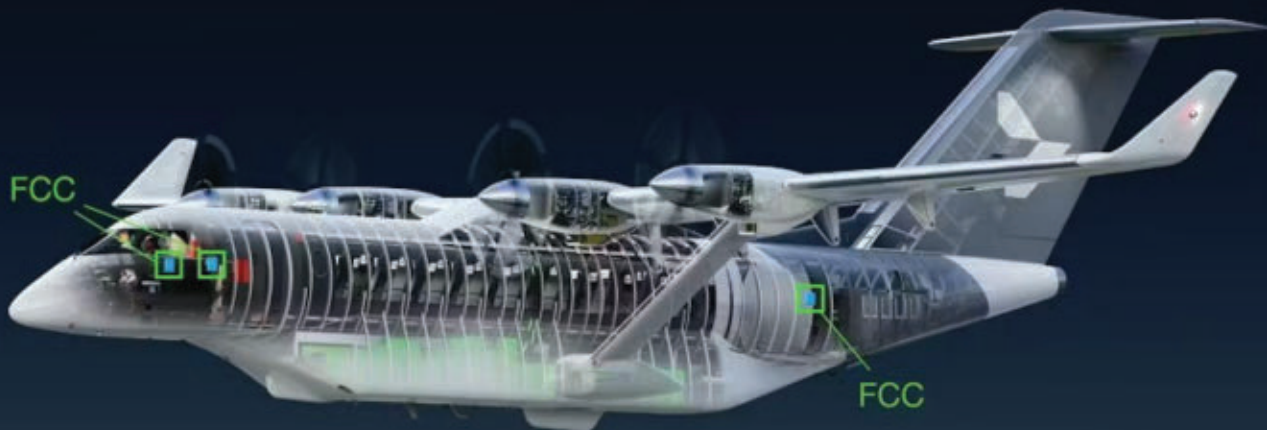
The FLASH project seeks to deliver an alternative approach in which efficient and long-lasting hydrogen storage is coupled to a fuel cell that converts hydrogen to electricity to power electric UAV flight. The resulting system will enable long-range flights, but without the noise and tail-pipe emissions of combustion engines. It will also enable sensitive drone applications like atmospheric monitoring, where exhaust gases and rumbling engines would reduce performance.

The FLASH project is focused on a solid material that can rapidly release hydrogen gas for use by the fuel cell. The material has a high hydrogen capacity and can operate at low temperatures (approximately 100°C). This class of materials is highly versatile to industrial hydrogen delivery requirements. ◀



**Electric UAVs are seeing rapid adoption in industrial applications such as surveying, infrastructure inspection and security.**





# Honeywell and Heart Aerospace eye flight controls for ES-30 electric plane

BY Jamie Whitney

**GOTHENBURG, Sweden** - Heart Aerospace in Gothenburg, Sweden, and Honeywell in Phoenix are collaborating to integrate Honeywell flight controls into Heart's ES-30 regional electric plane.

The ES-30 is a regional electric airplane with a 30-passenger standard seating capacity and is driven by electric motors powered by batteries. It will have a fully electric zero-emissions range of 200 kilometers, an extended hybrid range of 400 kilometers with 30 passengers, and flexibility to fly up to 800 kilometers with 25 passengers, all with typical airline reserves. Heart Aerospace has 250 firm orders for the ES-30, with options and purchase rights for an additional 120 planes.

Heart is also working with BAE Systems in Falls Church, Virginia to develop power storage for the ES-30. That collaboration was announced earlier this year.

The ES-30 will also have a scalable upgrade path as future battery technology matures. The battery upgrade roadmap allows for increased usable energy at the same weight, resulting in longer flight durations and expanded route options.

▲ **The Heart ES-30 electric regional passenger aircraft is to use flight controls designed by Honeywell Aerospace.**

"Our industry-leading solution builds on decades of expertise delivering technologies and systems needed to progress sustainable transportation," said Ehtisham Siddiqui, vice president and general manager of Controls and Avionics Solutions at BAE Systems. "We are delighted to collaborate with Heart Aerospace on the innovative battery system for its electric airplane."

Honeywell was selected by Heart Aerospace for the Joint Definition Phase of Heart's ES-30 airplane, and the goal, once the phase has been completed successfully, is to fully integrate Honeywell's compact fly-by-wire system into development for production.

Honeywell's next-generation compact Fly-by-Wire system is in an advanced stage of development on multiple aircraft, and its functions are adaptable to the ES-30, allowing Heart to bring its airplane to market. ◀



# Boom Supersonic's technology demonstrator readies for flight

BY Jamie Whitney

DENVER - Boom Supersonic in Denver has completed several key milestones for XB-1, Boom's technology demonstrator aircraft. XB-1 employs technologies like carbon fiber composites, advanced avionics, and digitally optimized aerodynamics to enable sustainable supersonic travel.

Earlier this year, XB-1 was moved from the company's hangar in Centennial, Colorado to the Mojave Air & Space Port in Mojave, Calif., to continue preparations for flight. The aircraft has undergone extensive ground testing since arriving, including taxi testing this week.

In addition to the testing, XB-1 has received an experimental airworthiness certificate from the U.S. Federal Aviation Administration (FAA), following a detailed aircraft inspection. Boom has also is authorized to allow Chief Test Pilot Bill "Doc" Shoemaker and test pilot Tristan "Gepetto" Brandenburg to fly XB-1.

XB-1 has provided the company with lessons that include the development of a robust safety culture. In preparation for flight, Boom's test pilots have completed hundreds of hours in the simulator for aircraft evaluation, operations development, training, and human factors assessments.

▲ **The Boom Scientific XB-1 experimental aircraft is expected to demonstrate supersonic flight without potentially damaging sonic booms.**

The test pilots also maintain flight proficiency in the T-38 supersonic jet trainer aircraft, the same aircraft that will be used as a chase plane for all flight tests of XB-1. To further increase safety, the test pilots will use the T-38 to practice formation flying.

XB-1 features a 71-foot carbon composite and titanium fuselage, and an ogive (modified delta) wing for safe takeoffs, supersonic cruising, and landings. The three General Electric J85 engines that power XB-1 produce a combined maximum thrust of 12,300 pounds of force.

The supersonic demonstrator aircraft rolled out of Boom's hangar in Centennial, Colo., in October 2020. Since then, rigorous testing of all of XB-1's internal subsystems has been completed. Upgraded landing gear and supersonic engine intakes were also installed on XB-1, both of which increase performance and safety.

Across its development, XB-1 has validated Boom's approach to airplane design and enabled engineers to leverage advanced tools like computational fluid dynamics (CFD) which are critical components of Overture's development. Overture is the sustainable supersonic airliner from Boom that will fly at Mach 1.7, or about twice the speed 100 percent sustainable aviation fuel (SAF). ◀



# NASA seeks integrated circuits for extreme environments for Venus missions

BY Jamie Whitney

**WASHINGTON** - The National Aeronautics and Space Administration (NASA) is developing integrated circuits capable of withstanding extremely hot temperatures as part of landers for future missions to Venus.

The NASA Glenn Research Center Smart Sensing and Electronics Systems Branch in Cleveland is developing silicon carbide (SiC) for intelligent sensing and control of electronic subsystems that will operate in temperatures as hot as 600 degrees Celsius, which is beyond the physical capabilities of silicon technologies.

In particular, NASA is seeking fabrication of integrated SiC electronic device structures like junction field effect transistor (JFETs) and resistors via a particular fabrication process flow to specifications on NASA-provided 100-millimeter-diameter 4H-SiC epilayered wafers using NASA-provided device-layout design files in Graphic Database System II (GDS) format.

After the SiC device structures are completed, the wafers will be delivered back to NASA for additional processing of bondpads and the back-side contact that will complete the formation of integrated circuits needed for NASA missions. The resulting chips will implement prototype extreme-environment electronic systems and demonstrations.

Information regarding the layers, layout feature dimensions, and layout rules for device pattern features is available

▲ **NASA is asking industry for SiC integrated circuits able to withstand demanding temperatures on the surface of Venus. NASA illustration.**

online at <https://www1.grc.nasa.gov/research-and-engineering/silicon-carbideelectronics-and-sensors/jfet-ic-tech-guide/>.

The agency also asks that the contractor e-mail the data/documentation listed in each major step to the NASA's technical monitor so that NASA can verify and quantify contractor progress and workmanship during the performance of this process.

The contractor also shall note any off-nominal observations and processing detected and provide accompanying relevant data. Examples of off-nominal observations include larger than 10 percent non-uniformities in deposited film thicknesses, or etch depths, de-lamination, buckling, or peeling of metal films, cracking or peeling of dielectric films, etc. in any wafer regions farther than 4 millimeters from a wafer edge. ←

More information, including diagrams and specifications, is available at <https://sam.gov/opp/5aa1d634239747a58a985cd5d934d368/view>. Email questions to NASA's Lindsey McLellan at [lindsey.m.mclellan@nasa.gov](mailto:lindsey.m.mclellan@nasa.gov). Companies were asked to respond by late September.