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NOVEMBER/DECEMBER 2025

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AI AND MACHINE LEARNING in electronic warfare

Computer and software boost capabilities in cognitive electronic warfare to detect threats and launch counter-attacks.

PG. 12

Newsletter

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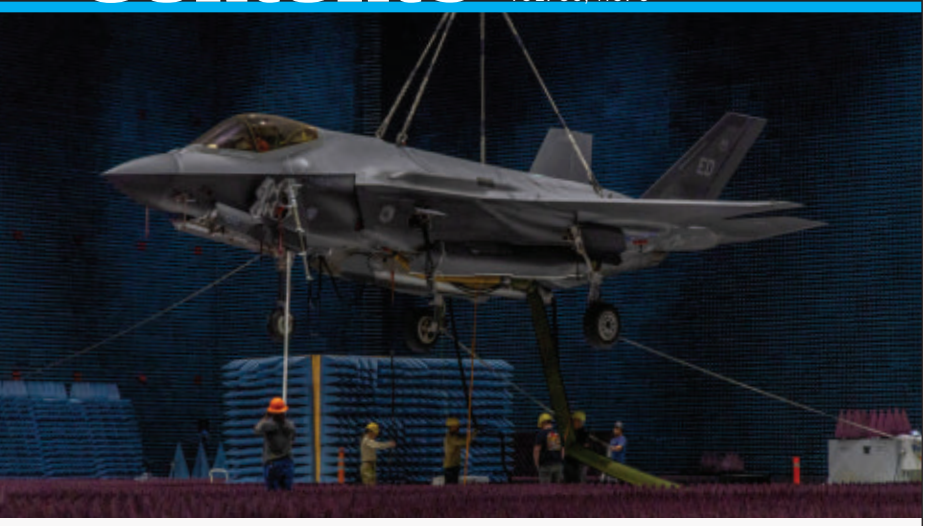

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Blending biology and robotics to get the most from warfighters

BY **John Keller**
EDITOR IN CHIEF

American military researchers are increasing their emphasis on technologies that combine biological and robotic components to enhance the effectiveness and survivability of warfighters on the battlefield.

Two recent projects of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., focus on blending cellular properties with robotics where it has to do with human blood.

The first project is called the Smart Red Blood Cells (Smart-RBC) program, and seeks to create smart red blood cells that enhance human performance under austere military conditions; support quick recovery; and improve the chances of survival during combat.

The other is called the Medics Autonomously Stopping Hemorrhage (MASH) program, which seeks to help battlefield medics who aren't qualified surgeons to stabilize torso bleeding quickly on the battlefield by finding and stopping bleeding autonomously. MASH seeks solutions to stop bleeding for more than hours — a crucial step to stabilize torso wounds and provide extra time for evacuation to higher levels of care.

These projects are part of a wider long-term emphasis on the U.S. Department of Defense (DOD) to combine cells and robotics to enhance the strength of human warfighters to persevere and survive on the battlefield.

Smart-RBC seeks to enable human blood not only to carry oxygen, but also to sense extracellular biomarkers in the bloodstream; decide on the correct response based on these signals; and act by releasing effector molecules that can modify metabolism or other aspects of human physiology.

This capability could lend itself to creating universal blood types, rapid acclimation to high altitudes, thermal regulation, and even on-demand therapeutic delivery for diseases using red blood cells as carriers.

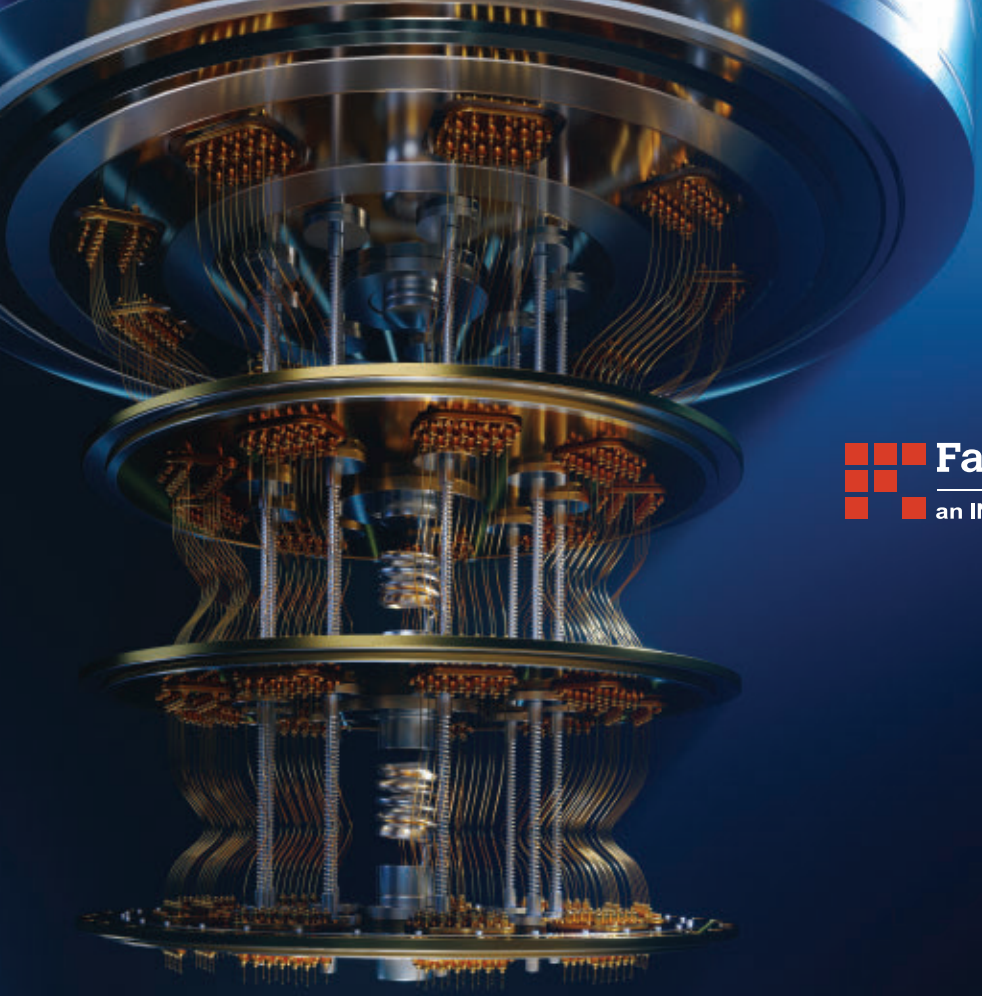
The goal of the Smart Red Blood Cells project hinges on modifying stem cells such that mature red blood cells retain new programmable functions. It aims to engineer red blood cells to contain biological features that can safely, temporarily, and reliably alter human physiology.

Smart blood will be engineered to contain additional biological circuits consisting of three layers: sensing extracellular biomarkers; deciding next steps; and acting by creating effector molecules that can alter metabolism or physiology. This program does not include clinical trials or direct human testing.

The MASH program seeks to help battlefield medics who aren't qualified surgeons to stabilize torso bleeding quickly on the battlefield by finding and stopping bleeding autonomously. It focuses on finding and stabilizing abdominal bleeding via external, laparoscopic, endovascular, or hybrid approaches that use machine autonomy, signal processing, existing sensor suites, surgical or endovascular maneuvers, and robotics to find and treat abdominal bleeding on the battlefield. The goal is to treat battlefield abdominal bleeding that can involving hard-to-find internal damage and even mangled internal organs.

The program's first phase will integrate or retrofit effectors into autonomous devices, provide access to a robotic surgical device for the life of the project, and then incorporate phase-two software and sensors. Companies interested were asked to email MASH@DARPA.mil to join a list for future program updates. More information is online at https://sam.gov/opp/7b87175548d34dedaaaaae4c07d253be/view.

It's the beginning of a new world that takes the best of robotics and biology to extract the best the humans can offer.



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2025 innovation awards announced for enabling technologies in aerospace and defense applications

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Awards for innovation in aerospace and defense enabling technologies are in three tiers — ranging from platinum, the highest, to the gold awards, and finally to the silver awards — and are based on the recommendations of an independent panel of industry judges.

Innovators awards span a range of enabling technologies for aerospace and defense applications ranging from avionics, communications and networking, embedded computing, sensors, power electronics, connectors, software, RF and microwave, chassis and enclosures, and more.

PLATINUM HONOREES

The IQSat from Aitech Systems in Chatsworth, Calif., is an artificial intelligence (AI)-enabled picosatellite (PicoSat) constellation system for detecting and providing insight on patterns and anomalies for applications like military and defense, public safety, agriculture, climate, and biology. It brings AI capabilities in a low-cost commercial off-the-shelf (COTS) system for low Earth orbit (LEO) missions by powering rapid actionable data and insights.

The EM-6841 antenna from EM Antennas in Johnstown, N.Y., is rugged and compact for military communications. The passive omnidirectional antenna covers frequencies from 20 MHz to 43.5 GHz, and can replace several legacy antennas with one unit to reduce size, weight, and complexity, while improving reliability and connectivity. Designed and manufactured in the USA, the EM-6841 is MIL-STD-810H certified for harsh conditions, enabling mission-critical operation across land, air, sea, and space.

Sabertooth AI from VersaLogic Corp. in Tualatin, Ore., is a compact rugged embedded computer defense, aerospace, medical, smart security, and energy applications, and supports AI and 3D rendering workloads in harsh environments. The Sabertooth AI system is powered by the hex-core Intel Xeon-E CPU and the NVIDIA RTX 2000 ADA GPU for high-performance AI inferencing, and features TPM 2.0 security, 32 gigabytes error-correcting memory, high-speed solid-state NVMe data storage, and computing power in a 90-by-96-by-63-millimeter package.

The AxIO16 radiation-hardened I/O expander from Apogee Semiconductor in Plano, Texas, is a 16-bit radiation-hardened I/O expander that extends a processor's digital interface over an I2C or SPI bus. It provides 16 configurable I/O pins that support push-pull or open-drain modes and can monitor or drive digital signals such as power enables, fault flags, or sensor states.

The V60653U VPX Versal Premium ASoC FPGA optical I/O module with XMC site from New Wave Design in Eden Prairie, Minn., is a heterogeneous embedded computing 3U VPX module featuring the AMD Versal Premium Adaptive System-on-Chip (ASoC), rugged optical and electrical high-speed I/O, XMC site, and SOSA-aligned profile options. The V6065 provides options for Versal Premium VP1502 or VP1702 part selection.

The Tactical Edge Network Targeting in a Contested Long-Range Environment (TENTaCLE) from Fuse Integration Inc. in San Diego can enable the U.S. military and Joint forces to

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exchange intelligence, surveillance, and communications data in contested environments. Its integrated IP and tactical data link (TDL) architecture is open, agile, and adaptable to changing global requirements.

The INTEGRITY-178 tuMP Secure Virtualization real-time operating system (RTOS) software from Green Hills Software in Santa Barbara, Calif., can run applications on a guest operating system while maintaining a high level of security. Compared to traditional hypervisors that run entirely in privileged kernel mode, secure virtualization for INTEGRITY-178 tuMP takes a hybrid approach that separates the isolation and virtualization functions of a hypervisor.

The Radio Frequency Artificial Intelligence (RFAI) from DroneShield in Warrenton, Va., capitalizes on DEEP LEARNING to classify RF signals in real-time on software-defined radio (SDR) hardware. By learning its own representation of the hidden features in the SoI dataset (invisible to a human), RFAI outperforms hand-engineered algorithms, especially in challenging scenarios like high-RF-interference environments. The strength of RFAI lies in its SoI classification accuracy and resilience against the RF interference inevitably present in the target RF bands or frequency spectrum of interest.

The VPX3-536 from the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is a SOSA-aligned 3U VPX FPGA plug-in card designed for high-performance sensor processing applications like radar, electronic warfare (EW), and SIGINT digital signal processing. It supports 100 Gigabit Ethernet and PCI Express Gen 4 interfaces. Its AI-enabled compute architecture with AMD Versal Premium VP2502 Adaptive SoC (ACAP), integrating a large 3.7M logic cell FPGA, two dual-core Arm processors, and DSP engines (7,392 slice).

The Cape cellular network from Cape in Arlington, Va., provides device and network solutions to government, consumers, and enterprises to ensure that mobile communications are private, secure, and resilient. It is for organizations that are at elevated risk of digital attacks, such as public figures, executives, and journalists. Cape operates as a mobile virtual network operator (MVNO), but runs its own mobile core software to control and secure sensitive subscriber data. This offers significantly greater protection than typical privacy apps or VPNs, addressing both device and network-level vulnerabilities.

The VITA 48.4 liquid-flow-through test and development chassis from Elma Electronic in Fremont, Calif., is a rugged, lab-deployable chassis designed to test and validate high-power 6U OpenVPX payloads that require liquid-flow-through (LFT) cooling. Built for engineers developing SOSA-aligned systems, this 6-slot system enables full-speed board bring-up in a benchtop environment. The system supports an external CDU (Coolant Distribution Unit) for fluid circulation, giving customers the flexibility to pair it with high-performance cooling infrastructure from preferred vendors.

The 100 V JANS radiation hardened gallium nitride (GaN) transistor from Infineon IR HiRel in El Segundo, Calif., is an internally manufactured radiation hardened GaN device to earn certification of reliability from the U.SD. Defense Logistics Agency (DLA), meeting the Joint Army Navy Space (JANS) Specification MIL-PRF-19500/794. The 100 V, 52 A GaN transistor offers high power density in a small and lightweight package with radiation performance.

The 3 Slot VNX+ Test and Development Chassis from Elma Electronic in Fremont, Calif., is a compact SOSA-aligned VNX+ development system for rapid board bring-up, validation, and test of VITA-90 plug-in cards (PICs). Tailored for early-stage VNX+ developers and system integrators, this

2+1 slot chassis provides a streamlined solution to accelerate time-to-market for mission-critical small form factor (SFF) systems. Supporting 400-pin and 320-pin payload slots with complete user I/O breakout and mezzanine-mapped expansion, the chassis simplifies system testing with features like a maintenance port aggregator, airflow-optimized card cage, and flexible power configurations (AC or 28VDC).

GOLD HONOREES

Milpower Source in Belmont, N.H., Miltech 918TSN; Fractal Antenna Systems Inc., ARM—Acoustic Resonance Mitigation; Milpower Source; Miltech 9020; Parallel Works ; ACTIVATE High Security Platform; OSL Technology FACE AI-powered sensor fusion and decision-support system; Inventive Resources Inc.; Enclosure Protector Attachment; D-Fend Solutions, EnforceAir2; Curtiss-Wright Defense Solutions, Motion Control Stabilization System; PIC Wire & Cable, Single Pair Ethernet (SPE) Cable; General Micro Systems, Triple-Domain Cross Domain System; Real-Time Innovations (RTI), RTI Connext.

SILVER HONOREES

Durabook Americas Inc. Durabook S14I rugged laptop; Neousys Technology; Rugged IP66 Edge AI Computer Powered by NVIDIA Jetson NRU-230V-AWP; Curtiss-Wright Defense Solutions, PacStar Modular Radio Center (MRC); LCR Embedded Systems, Dual System SAVE Compliant Innovation; AirBorn, a Molex Company, verSI high density interconnect system; Getac Technology Corp. Getac B360 Pro rugged laptop; Curtiss-Wright Defense Solutions Fortress HUMS; Elma Electronic, AI Enabled Test and Development Chassis; General Micro Systems, X9 AI Virtual Router with Cisco NFV; and General Micro Systems, X9 Venom 3U OpenVPX Mission Computer.

Don't see your company's name? Start thinking about submitting entries for the 2026 Military & Aerospace Electronics Innovators Awards, which should be announced in October 2026, with submissions starting in April 2026. More information is online at https://designengineering.endeavorb2b.com/military-aerospace-electronics-innovators-awards/.

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▶ **Technicians from the Air Force 412th Electronic Warfare Group position an F-35A combat jet in the Benefield Anechoic Facility at Edwards Air Force Base last May. Air Force photo.**

AI AND MACHINE LEARNING take center stage in electronic warfare

Advanced computer and software technologies create new capabilities in cognitive electronic warfare to detect threats and launch counter-attacks more quickly than ever before.

BY John Keller

Military electronic warfare (EW) stands on the precipice of a major revolution in capability, as enabling technologies like artificial intelligence (AI) and machine learning prepare to transform electronic combat on the airwaves.

AI and machine learning algorithms have the potential to provide capabilities crucial to EW, such as autonomous threat detection, adaptive countermeasures, and real-time decision-making, and EW systems designers are banking heavily on these technologies to bring about the next generation of EW, called cognitive EW.

AI and machine learning are transforming EW technology by enabling faster, smarter, and more adaptive systems now and in the future. These capabilities have the potential to analyze the radio frequency spectrum in real time; analyze enemy jamming and spoofing attempts automatically; and deploy countermeasures without human intervention.

Put together, AI and machine learning are expected to enable much faster responses to electronic threats. For example, drones equipped with AI targeting systems can identify and strike targets autonomously, even in heavily jammed environments.

AI also can automate fusion and interpretation of sensor data to improve situational awareness and help military commanders respond quickly to emerging threats.

What is electronic warfare?

EW describes using RF and microwave energy to control the RF spectrum, attack an enemy, or impede disrupt enemy operations, while ensuring friendly forces maintain unimpeded access to RF spectrum. It disables or disrupts enemy communications, radar, navigation, and other electronic systems.

EW has three major parts. Electronic attack involves jamming enemy radar and communications to degrade their effectiveness. Electronic protection involves protecting friendly forces from electronic attack with counter-jamming and RF emission control. Electronic support involves gathering intelligence by intercepting and analyzing enemy RF emissions for situational awareness and targeting.

EW can be conducted from air, sea, land, or space, using crewed or uncrewed systems, and involves techniques like radar jamming, deception, electronic masking, and reconnaissance.

Key capabilities include electromagnetic sensing and signal processing for detecting, identifying, and locating enemy emissions; high-performance embedded computing and open-system architectures for rapid processing and system modularity; network-enabled EW for integrating RF monitoring and cyber security; crewed and uncrewed to conduct real-time electronic combat and protection; and spectrum management and emission control to optimize and protect RF and microwave resources.

Among the most influential enabling technologies in EW operations are AI and machine learning algorithms that provide autonomous threat detection, adaptive countermeasures, and real-time decision-making to overcome the complexity and chaos of the electromagnetic environment.

▲ U.S. Army Soldiers observe a radio frequency detector during an exercise in Hohenfels, Germany, last June to help deter electronic warfare threats. Army photo

The role of AI in electronic warfare

Artificial intelligence and machine learning are transforming EW capabilities by enabling fast, intelligent, and adaptive systems now and in the future. Today AI

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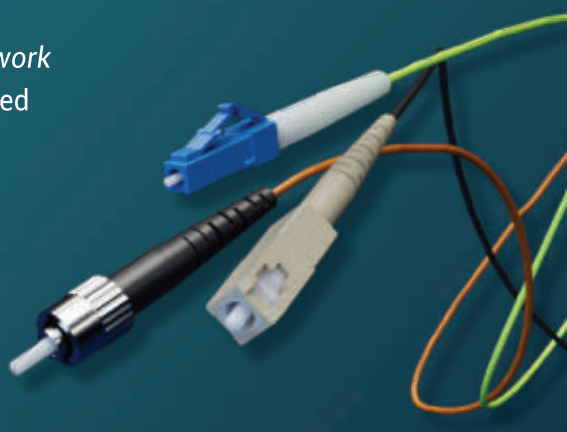

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and machine learning can help analyze the RF spectrum in real time to detect enemy jamming and spoofing attempts automatically and deploy countermeasures without human intervention.

Uncrewed aircraft with AI-based targeting systems, for example, can identify and strike targets autonomously, even amid heavy enemy jamming.AI also automates fusing and interpreting sensor data for improved situational awareness and fast command decision-making.

For the future, AI-enabled autonomy is expanding into operations on and under the oceans, in space, and in missile defense for battlefield reconnaissance, targeting, and EW based on real-time data.

The next generation of EW likely will involve coordinated control of uncrewed systems with AI to enable systems to adapt to battlefield conditions dynamically. AI also is expected to improve EW by generating tailored signals to mislead or disrupt adversaries, rather than simply defending against attacks.

Integrating EW enabling technologies with emerging technologies like quantum computing and 5G networks is expected to enhance data processing capabilities drastically, and support predictive analytics and securing communication channels that are essential for EW operations.

Future capabilities in cognitive EW

Cognitive electronic warfare is expected to employ AI and machine learning to enable electronic systems to perceive, analyze, learn, and adapt autonomously in real time within the electromagnetic spectrum.

Unlike traditional EW, which relies heavily on human analysis and pre-programmed responses, cognitive EW uses AI-driven cognitive processes to recognize, classify, and respond rapidly to complex and evolving electronic signals such as RF emitters, pulsed radars, and low-probability-of-detection signals.

Cognitive EW will provide rapid situational awareness of the electromagnetic spectrum, adaptive countermeasures, signal fingerprinting, and real-time intelligence without human intervention.

It will operate at millisecond or microsecond speeds to outpace human decision-making, and enable military forces to outmaneuver and deceive

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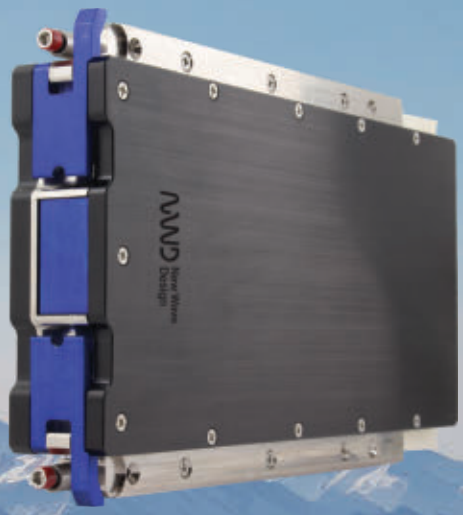

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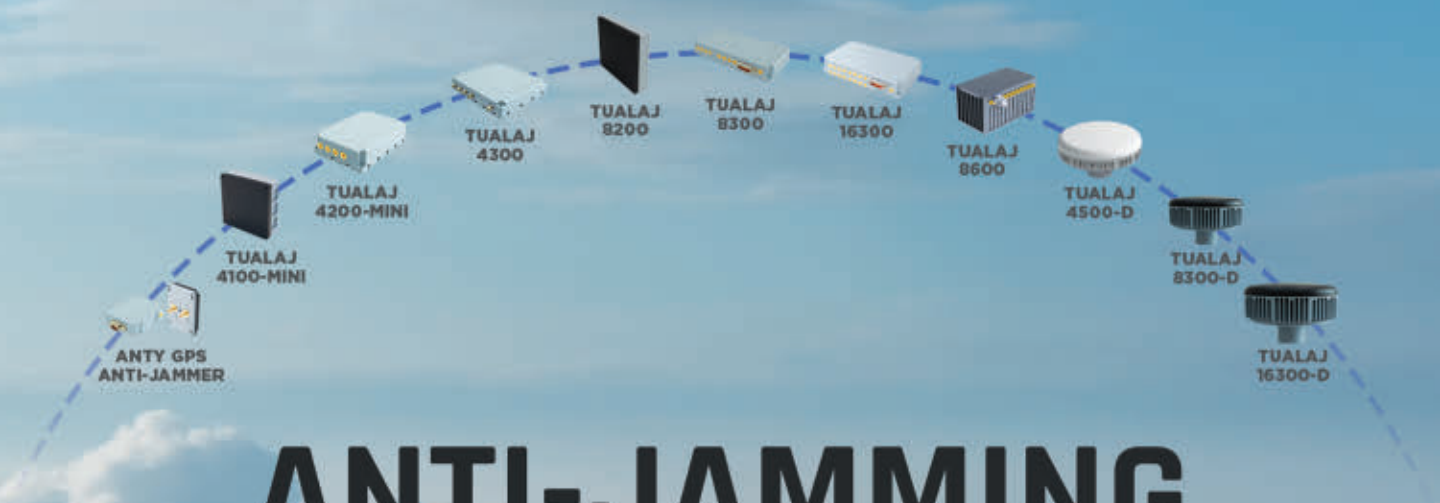

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enemy sensors and communications, and optimize resource usage.

Cognitive EW will work using sophisticated machine-learning algorithms deployed close to the sensors that perform rapid signal recognition, and integrate components such as sensing and data-collection units detecting signals; processing signals, and converting analog signals into digital.

AI and machine learning engines will analyze patterns, classify signals, predict threats, and learn from new encounters. Decision engines will be able to choose optimal electronic attack or protection responses, and carry out electronic jamming, spoofing, or deception. These systems will be able to adapt over time and improve their effectiveness dynamically to enhance situational awareness.

Electronic jamming systems will be aware of EW threats and adapt their jamming behavior dynamically by synthesizing the most appropriate jamming program in real time.

Cognitive EW are expected to produce systems that adapt quickly to changing enemy tactics by rapidly sensing, identifying, and countering new or unexpected electronic threats, such as neutralizing swarms of uncrewed aircraft with wide-beam jamming that adapts to the threat moment by moment.

Initial cognitive EW efforts

While the term cognitive EW is somewhat new, foundational research has been in progress for at least the past 15 years. A 2010 project of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., called Behavioral Learning for Adaptive Electronic Warfare (BLADE) sought to push the bounds of machine learning to counter enemy threats from wireless adaptive communications such as battlefield radios, command and control networks, and RF triggers like cell phones used to detonate improvised explosive devices (IEDs).

▲ An Air Force airman installs a countermeasure firing pulse tester into a U.S. Air Force F-15E Strike Eagle at RAF Lakenheth, England, last May to assess EW defensive system readiness. Air Force photo

The project pursued adaptive communications that automatically adjusts to conditions that degrade its performance, such as environmental conditions, or from intentional or inadvertent EW signals jamming.

BLADE sought to develop a networked electronic attack system that jams new wireless communications threats automatically by detecting and characterizing the new threat, learning to jam the new threat effectively and efficiently, and assessing the effectiveness of RF jamming in the field.

The goal was the ability to operate as one node or as a network of distributed BLADE nodes, with performance improving as nodes are added to the network. Companies interested in participating should use existing networking capabilities to enable information sharing among several BLADE nodes. Lockheed Martin Corp. handled the original BLADE research.

Two years later, DARPA kicked-off a project called Adaptive Radar Countermeasures (ARC) to find ways to detect and counter digitally programmable radar systems that have unknown behaviors and agile waveform characteristics.

The program involved the BAE Systems Electronic Systems segment in Nashua, N.H., which worked on developing cognitive electronic warfare technologies, adaptive algorithms, and testing for airborne electronic warfare systems. Leidos handled developing electronic warfare adaptive radar countermeasures, while Exelis (now L3Harris) worked with Leidos to implement Leidos-developed software processing to protect airborne platforms with electronic warfare (EW) systems.

Today's cognitive EW

There are a few implementations of cognitive electronic EW today, which

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integrate AI and machine learning to detect, analyze, and respond to threats autonomously more quickly than traditional methods.

The U.S. Air Force awarded a $6.4 million contract in 2024 to Southwest Research Institute (SwRI) in San Antonio, Texas, to develop cognitive EW algorithms to analyze the electronic environment similarly to how a human pilot interprets signals and threats, but with greater speed and accuracy. The project involves AI and machine learning to extract features from threat radar signals and identify new, previously unknown signals that are not in traditional threat libraries.

The approach includes two phases: feature extraction using AI and machine learning to identify signal characteristics, and grouping millions of radar pulses to highlight vulnerabilities and lethal signals.

Neuromorphic processing hardware emulates brain-like memory and processing to boost efficiency and speed beyond the capabilities of conventional systems to transform EW from a reactive to a proactive and adaptive capability.

Northrop Grumman also is advancing algorithms using machine learning to detect hard-to-detect threats like low-power radio frequency signals near noise floors, enhancing threat detection in GPS and navigation warfare contexts. While some cognitive EW tools have been deployed for testing and evaluation, full integration and operational use has not happened yet.

Big EW programs

Although AI, machine learning, and cognitive technologies play heavy roles in EW today, traditional EW design approaches are still major players, and are at the forefront of many large U.S. military EW programs. Among the largest and most influential EW) programs in the U.S. Department of Defense are several key initiatives led mainly by the U.S. Army and focused on rapid-response EW capabilities.

One example is the U.S. Army Multifunction Electronic Warfare – Air Large (MFEW-AL) program, which focuses on airborne electronic attack capabilities and capitalizes on commercial off-the-shelf (COTS) technology for rapid capability delivery.

The Lockheed Martin Corp. MFEW-AL airborne EW system seeks to detect, identify, locate, deny, disrupt, and degrade enemy communications and radar systems. It's a self-contained airborne EW pod for the MQ-1C Gray Eagle uncrewed aircraft, and provides battlefield commanders with electronic attack capabilities. It uses modular, open-system architecture based on the C5ISR/EW Modular Open Suite of Standards (CMOSS), and seeks to fill a gap in organic electronic attack capabilities for Army combat aviation brigades. No clear deployment date is set, however, because of a change in approach and strategy.

Lockheed Martin also is involved in the Army Terrestrial Layer System (TLS) for Brigade Combat Teams (BCTs) program, which focuses on providing extended-range SIGINT and cyber warfare at the brigade level. TLS BCT has variants tailored for different BCT types: Stryker Brigade Combat Teams (SBCT), Armored BCTs (ABCT), and Infantry BCTs (IBCT). The SBCT variant integrates onto the Stryker Medical Evacuation Double-V Hull vehicle, the ABCT variant onto an

An Army electronic warfare specialist plots points on a map during a training competition last August. Army photo

Armored Multi-Purpose Vehicle, and the IBCT variant is a man-portable system called TLS BCT Manpack.

The TLS BCT Manpack handles RF surveying, signals collection, direction finding, and electronic attack, and has been fielded on a limited basis since 2024. A broader assessment for all BCTs is planned for June 2026, with full deployment expected by 2028. The Army separates SIGINT and EW capabilities for the Stryker variant. Prime contractors are Mastodon Design LLC, a subsidiary of CACI International, which is building the TLS-BCT Manpack system. Lockheed Martin is working on EW SIGINT, and cyber capabilities, and is supporting the TLS Brigades and Echelons Above Brigade (EAB) variants.

The Army's Vehicle Mounted Multi-mission Electronic Warfare System (VMEWS) is designed to protect military vehicles from RF threats like jamming, deception, and electronic attacks aimed at disrupting vehicle systems, sensors, and communications. The system helps to identify, respond to, and counter these RF threats to ensure vehicle survivability.

The system uses rapid reprogramming through AI and advanced analytics to react quickly. VMEWS, from Pacific Defense in El Segundo, Calif., encompasses electromagnetic warfare capabilities to protect wheeled and tracked vehicles. Pacific Defense partners on VMEWS include Thales Defense & Security; BAE Systems; Palantir; MAXISIQ; Regal Technology Partners; and STC, an Arcfield company.

The Navy Surface Electronic Warfare Improvement Program (SEWIP) Block 3 seeks to surface ships defenses against anti-ship missiles through early threat detection and electronic countermeasures. It is an upgrade to the legacy AN/SLQ-32 electronic warfare system, and protects surface ships from anti-ship missiles by providing early

detection, signals analysis, threat warning, and soft-kill defense. The SEWIP Block 3 prime contractor is Northrop Grumman Corp.

The Digital Radio Frequency Battlespace Emulator (DRBE) from Cerebras Systems in Sunnyvale, Calif., is sponsored by the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va. It seeks to develop a large-scale, virtual RF environment to help develop, provide training, and test for advanced RF systems like radar and EW systems. It enables several RF systems to interact to replicate dense responsive real-world RF conditions.

The core of DRBE is real-time high-performance wafer-scale computing that delivers massive computational throughput with microsecond latency. DARPA is enhancing DRBE with optical interconnects and scalable wafer-scale computers to increase bandwidth to enable larger and more complex RF scenarios and expand into battlespace autonomy and digital twins.

Among the most influential EW companies in the world are Lockheed Martin Corp.; Northrop Grumman Corp.; RTX Raytheon; L3Harris Technologies; the Boeing Co.; General Dynamics Corp.; CACI International; BAE Systems; Thales Group; Saab AB; Leonardo SpA; Elbit Systems; and HENSOLDT.

Key enabling technologies

EW systems rely on several enabling technologies to enhance RF and microwave detection, interception, disruption, and protection across the electromagnetic spectrum. They involve hardware, software, and AI-driven elements.

Among the most important EW enabling technologies are high-power RF amplifiers; digital signal processing hardware and software; frequency management and frequency hopping; stealth technologies and signals hardening; cognitive radio and cognitive processing; electromagnetic deception and jamming; and distributed mesh networks.

▲ **An Army electronic warfare specialist uses a Mastodon Beast+ system at an exercise last month. Mastodon Beast+ system is a multi-channel electronic warfare device designed for detection, direction finding, and attack of adversary signals. Army photo**

High-power RF amplifiers and antennas boost and transmitting signals, and expand operating ranges. Signal processors and software enable real-time analysis of intercepted signals to support rapid decision-making and adaptive responses to threats. Frequency management and frequency hopping help mitigate jamming and interference by varying signal frequencies dynamically. Stealth technologies and signal hardening can involve radar-absorbent materials and cryptographic techniques that protect friendly signals from enemy detection and disruption. Cognitive radio and processing involve adaptive systems that learn and respond autonomously to enemy RF signals. improving resilience and countermeasure sophistication. Electromagnetic deception and jamming involve signal jamming and spoofing to disrupt enemy sensors and communications. Thermal signature management and radar-absorbent coatings: advanced materials science enabling stealth in harsh environments such as space. Distributed mesh networks reduce vulnerability to centralized command disruption.

The role of embedded computing

Among the most crucial enabling technologies for EW — besides AI and machine learning — is embedded computing. These technologies are responsible for real-time processing, machine autonomy, and the adaptability necessary for electronic attack, defense, and surveillance, and plays a central role in jamming, spoofing, signals detection, and countermeasures.

Embedded systems offer fast computation necessary to detect and respond to threats in milliseconds in missile defense, radar signal processing, and applying electronic countermeasures quickly. Certain kinds of embedded computing also are designed to be rugged and function reliably under extremes in temperature, vibration, radiation, and electromagnetic interference.

Sophisticated algorithms run on embedded systems enable system agility and stealth, and enable EW systems to process data locally at the edge to reduce latency and bandwidth loads, and can enable autonomous operation even when communications links are jammed. Embedded computing in EW systems also integrates hardware-level encryption and anti-tamper mechanisms to secure sensitive military communications and data against cyber threats and espionage.

Embedded computing refers to specialized computing systems designed to perform dedicated functions within larger systems, often operating in real-time with low power, small size, and optimized reliability. These are typically compact computers integrated into devices to carry out specific tasks without user interaction.

Yet there's another branch of embedded computing called high-performance embedded computing (HPEC) that plays an equally important role in today's and tomorrow's EW systems. HPEC extends embedded computing by delivering significantly higher computational power, comparable to data center-level or supercomputing performance, within rugged, compact, and power-constrained applications.

HPEC is designed for mission-critical applications that need real-time processing for vast amounts of data from sensors like radar, video, and SIGINT. They combine processing elements like central processing units (CPUs), general-purpose graphics processing units (GPGPUs), and field-programmable gate arrays (FPGAs) through open-systems high-throughput interconnects, to enable edge computing with advanced workloads like AI inference and sensor fusion, and maintain a balance between performance, size, weight, and power consumption.

HPEC provides real-time processing, high-speed data analysis, and the ability to perform complex electronic countermeasures like jamming, spoofing, and radar deception. They process large volumes of data from radar, infrared sensors, and signals intelligence to help detect and disrupt enemy communications and surveillance. HPEC platforms bring data center-level computing power into rugged, compact systems suitable for harsh battlefield environments.

HPEC-enabled real-time processing is essential for intercepting and responding to electromagnetic signals within milliseconds for electronic support, attack, and defense. It can enable jamming and deception via digital radio frequency memory (DRFM) jammers, which rely on embedded digital signal processors. Increasingly, HPEC integrates AI and machine learning to enhance signals recognition, threat identification, and decision-making in EW.

Combining GPGPUs, FPGAs, and high-bandwidth I/O supports the heavy computational and communication demands typical of EW systems. This approach helps provides rugged, compact computing with supercomputing performance for deployment in rugged and

space-constrained applications. It also can help integrate several EW functions like surveillance, jamming, and electronic support in one system.

Embedded computing leaders

Among the most influential high-performance embedded computing companies involved in EW are Intel Corp.; Advanced Micro Devices Inc. (AMD); Curtiss-Wright Corp. Defense Solutions; NVIDIA Corp.; Abaco Systems; Aitech Systems; NXP Semiconductors; Mercury Systems; Ecrin Systems; Toyon Research Corp.; Pacific Defense; General Micro Systems Inc. (GMS); EIZO Rugged Solutions; Extreme Engineering Solutions (X-ES); Systel; LCR Embedded Systems; Elma Electronic; General Dynamics Corp.; and BAE Systems.

▲ U. S. Space Force personnel conduct training and maintenance with the Counter Communications System (CCS) last July CCS is a tactical electronic warfare system designed to detect, identify, and disrupt adversary communications systems. Space Force photo

Intel provides CPU and FPGA processors designed for EW; NVIDIA provides rugged GPGPUs.; Abaco, Curtiss-Wright, Aitech, Mercury, GMS, EIZO, X-ES; and LCR provide rugged high-performance embedded computing modules; Elma provides rugged embedded computing chassis and enclosures for EW applications. ←

The evolution of test and measurement instruments

The increasing use of digital electronics in military operations, and the rise of artificial intelligence (AI) and machine learning are pushing test technology forward.

BY **Jamie Whitney**

The next evolution of test and measurement in the military and aerospace sector lies in the convergence of digital twins, artificial intelligence (AI) and machine learning, and embedded computing. These technologies are transforming how engineers simulate, evaluate, and sustain critical systems across their entire life cycle.

Modern defense and aerospace systems are more complex, compact, and connected than ever before. The demand for high-frequency, software-defined, and mixed-signal electronics has reshaped how engineers verify performance and ensure mission readiness. Traditional lab-based testing is giving way to data-driven, continuous validation processes that extend from the factory floor to the field.

"Testing is no longer the end of the process," says Jeff Miner, product line manager for advanced integrated systems at Spectrum Control in Fairview, Pa. "It's the heartbeat of mission performance."

High-frequency and mixed signals

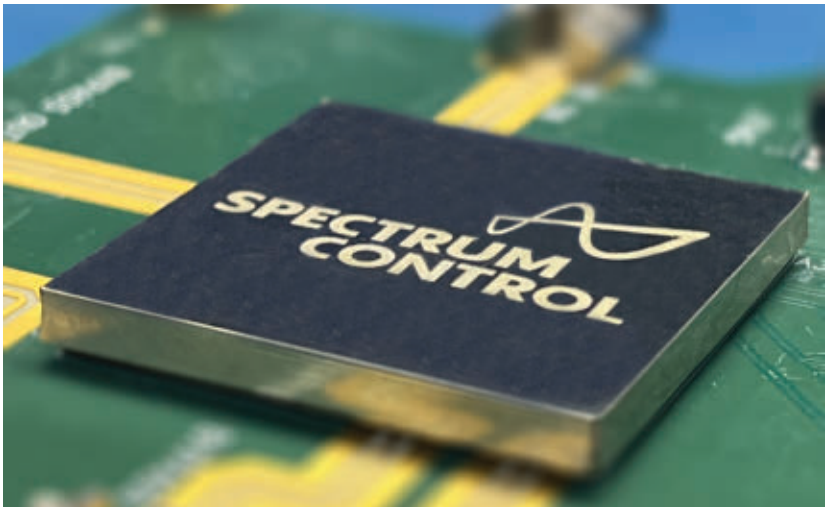
As radar, communications, and electronic warfare (EW) systems move into higher-frequency domains, testing must account for the nuances of signal

▲ A U.S. Air Force instructor loadmaster guides a U.S. Marine Corps High Mobility Artillery Rocket System into a C-130J Super Hercules. Modern test equipment enables technology to be serviced while deployed rather than being sent back to the home front. Air Force photo

integrity, environmental variation, and electromagnetic compatibility.

"The demand for higher-frequency operation is no longer theoretical; it's here," Spectrum Control's Miner says. "As missions push into the millimeter-wave spectrum, range still limits some applications, but the rapid availability of commercial chipsets, system-in-package (SiP) solutions, and SMT-based assemblies is accelerating adoption across the mil-aero ecosystem. These technologies are opportunities and threats, requiring new validation approaches."

Spectrum Control is redefining testing approaches to address the market trend, Miner says. "Traditional connectorized brassboard setups can't scale to these frequencies or levels of integration. Instead, we're moving toward compact, digitally controlled RF assemblies with embedded calibration, configuration, and self-diagnostic capabilities down to the component level," Miner says. "FPGAs and onboard memory now store environmental compensation data, enabling long-term adaptability, even in the field."



▲ **The Spectrum Control miniaturized, high-performance system-in-package (SiP) are targeted at advanced defense and electronic warfare applications. Spectrum Control photo**

Embedded computing in test and measurement

Beyond high-frequency and mixed-signal testing, embedded computing increasingly is playing an central role in modern military and aerospace validation processes. Engineers are leveraging embedded systems not only to control and monitor devices under test but also to create realistic, high-fidelity simulations of devices under test. This approach enables testing to move closer to actual operational conditions, and improving confidence in performance before deployment.

"Years ago, a variation of the VMEbus standard called VXI was used extensively in test and measurement," says Chris Ciufo, president and chief technology officer of General Micro Systems (GMS) in Rancho Cucamonga, Calif. "Today, it is commonplace to either use similar embedded systems to test the actual embedded systems or use commercial-temperature versions of the 'flyable' embedded system. This approach lets engineers exercise the deployable system using the same processing horsepower and I/O, and it enables evaluation of early prototypes or first-article units before low-rate initial production - eliminating the need for a separate, third type of test environment."

Ciufo says that by using embedded computing in this way, test engineers can replicate mission-like conditions, provide controlled forcing functions, and capture precise performance data. This capability dovetails with the broader trend toward continuous, data-driven testing, bridging the gap between laboratory evaluation and field operations.

AI in test

As artificial intelligence and machine learning capabilities continue to improve, industry experts are able to take advantage of where these technologies shine: recognizing patterns and automating processes.

"The next wave is AI-assisted testing," says Spectrum Control's Miner. "Generative AI will bridge data from the test bench to the device under test (DUT) to identify flaws and optimize calibration in real time. Artificial intelligence and machine learning are reshaping how test systems process and interpret data. Instead of static, sequential testing, AI-enhanced tools adapt dynamically based on previous results, identifying anomalies, predicting failures, and even optimizing calibration in real time."

Spectrum Control's engineers are embedding digital control and calibration logic directly into these devices, allowing them to self-adjust for factors such as temperature drift, vibration, and radiation exposure.

Digital twins enhance this process by simulating real-world signal behavior before hardware is ever fabricated. Engineers can validate RF and mixed-signal designs virtually, then use embedded test modules to confirm those predictions during live operation.

This integration of modeling and measurement shortens design cycles while improving field reliability.

"We're developing a family of RF SiP components that embody these concepts. Our flagship millimeter-wave up- and down-converters, housed in compact BGA packages, integrate embedded digital subsystems and memory for calibration, adaptability, and performance monitoring during acceptance testing and in operation," Miner says. "They are more than components. They enable responsive, intelligent systems. Our SiP don't just pass tests - they participate in them. Every insight we've discussed, including miniaturization, digital control, and AI readiness, has been shaped by the development of this SiP family, bringing us closer to truly responsive mission systems that adapt in real time."

Field testing

The growing use of rugged high-performance embedded computers (HPECs) has bridged the gap between laboratory test systems and deployed systems.

"Field-deployable systems increasingly mirror what's used in the lab," explains GMS's Ciufo. "Rugged embedded computing enable test and measurement systems to travel with the aircraft, the vehicle, or the sensor suite itself. That's how you get real-time, mission-relevant data. One notable key benefit to rugged, compact, and high-performance computing is the ability to test deployed systems at the forward depot or in the field without having to send units back CONUS or back to the original rugged system supplier."

Ciufo notes that the GMS X9 Spider modules are capable of built-in self-test and continuous health monitoring, offering a path toward on-platform diagnostics and real-time test data collection. When integrated with a digital twin, these systems create a continuous feedback loop - allowing engineers to model performance, analyze operational conditions, and push updates or optimizations remotely.

Ciufo says that industry has added Joint Test Action Group - a standardized interface (IEEE 1149.1) used for testing and debugging integrated circuits and boards - as a way to test very complex integrated circuits (ICs).

▲ The aircraft carrier USS Gerald R. Ford (CVN 78) operates in the Norwegian Sea above the Arctic Circle. Advanced test and measurement equipment supports real-time diagnostics on naval aircraft to ensure reliable performance under extreme conditions. Navy photo

"This was a necessary step as the ICs got so complex that they out-power any test equipment not based upon the same IC or better. Similarly, in the embedded space, the growth of more sophisticated built-in self-test (BIT), continuous BIT, and initiated BIT provides an opportunity for an embedded system to test and diagnose itself. All of GMS's X9 Spider family modules, for example, include extensive on-board sensors that work in parallel with intelligent ICs - such as Ethernet controllers or the CPU(s) themselves - in the systems to report functional status such as real-time health and/or I/O availability. Our ReliHealth initiative, for example, builds a useful API for our system users to access key sensors and functional blocks as a way of testing and predicting the state of GMS hardware."

Software solutions

The proliferation of software-defined architectures in avionics, autonomous systems, and weapons has made software verification and validation (V&V) an integral part of test and measurement.

"Software reliability now defines mission success," says Jim McElroy, vice president of sales and marketing at LDRA in Wirral, U.K. "Verification can't wait until late-stage testing - it must be automated, continuous, and standards-driven from the start."

He continues, "As we all see in the market, software complexity is accelerating, while at the same time, the demands on functional safety and security compliance are also increasing. As a result, software V&V is critical to overall 'system' assurance just like hardware testing, flight test, etc."

LDRA's tools enable developers to perform static and dynamic analysis, unit testing, and HIL or SIL testing against standards such as DO-178C for avionics and DO-326B for cyber security. The test data these tools generate also supports AI-driven analytics, helping identify failure patterns or vulnerabilities early in development.

"For example, we have a team of experts in LDRA certification services that have helped customers number one understand the current status of these standards, analyze any gaps in their current process, and establish a plan for addressing compliance going forward," McElroy says.

▲ The GMS X9 Spider features fully sealed, submersible, and conduction-cooled enclosures with a stackable, modular design.

Digital twins play a key role in the meshing of embedded systems and software. A digital twin is a virtual replica of a physical system that mirrors its behavior, configuration, and operational conditions. Engineers can feed test data from embedded systems into the digital twin, allowing them to simulate complex scenarios, predict failures, and evaluate design changes without physically stressing the hardware. This virtual modeling enables safer, faster, and more cost-effective testing, while providing insights that inform both software and hardware improvements.

When combined with a digital twin, automated V&V environments can validate software updates against simulated hardware before deployment — reducing risk and improving compliance with safety and airworthiness standards.

Machine learning algorithms trained on sensor and test data also can recognize performance degradation long before it becomes a failure, supporting predictive maintenance and improved mission availability. When integrated with a system's digital twin, these models can simulate potential fault scenarios, evaluate system responses, and optimize performance parameters before they're implemented in the field.

"From the tooling perspective, teams should look at solutions that can help them throughout the entire development and verification process, automating wherever possible in terms of software requirements traceability, code analysis, test generation and execution, results capture, and compliance evidence reporting," explains McElroy.

Continuous testing

Modern test systems are designed not just for qualification but also for continuous life cycle support. The combination of embedded diagnostics, AI analytics, and digital twins enables military operators to maintain a real-time understanding of system health.

Ciufo says this shift blurs the traditional line between design validation and operational maintenance. "With today's compute power and data pipelines, test and measurement have become a living process," he says. "You're always verifying, always improving, whether the system is on a test stand or in flight."

Miner adds that Spectrum Control's adaptive RF modules are designed to perform continuous self-calibration and interference mitigation, even in contested

electromagnetic environments — a growing priority for modern defense systems.

"Defense contractors are now designing for a battlefield that's as much electromagnetic as it is physical," says Miner. "As systems become more connected and spectrum-aware, the volume and velocity of test data have exploded. Modern test environments must capture vast amounts of measurement data, as well as process and interpret it fast enough to be actionable. That need for data richness and speed is reshaping how testing is structured. It is evolving from long, discrete validation steps to more continuous, adaptive processes."

He continues, "Reliability remains non-negotiable, especially in the harsh environments where these systems operate. What's changing is the balance: defense programs are looking for faster, lower-cost test cycles without compromising ruggedness or mission assurance. To address the change, testing must now be inherently digital, scalable, and ready for AI ingestion. For example, datasets generated during qualification can feed learning systems that improve future designs."

▲ The General Micro Systems X9 Spider mission computer features patented RuggedCool technology provides four-sided cooling for balanced heat transfer, enabling full operation at temperatures to 85 degrees Celsius. GMS photo

A digital future

Digital twins and AI-driven analytics are no longer emerging concepts - they're fast becoming the backbone of next-generation test and measurement. By linking hardware, software, and data throughout the life cycle, these technologies allow engineers to model, predict, and validate system behavior with reliable accuracy.

The convergence of these technologies enables test and measurement to

become an intelligent, connected, and predictive function. Continuous data capture, automated analysis, and virtual modeling provide actionable insights that inform design, deployment, and maintenance. In this new paradigm, the value of test and measurement lies not only in verifying system performance but in enabling mission assurance, resilience, and operational readiness across the life cycle.

A Navy operations specialist helps identify vessels using radar aboard the Arleigh Burke-class guided-missile destroyer USS William P. Lawrence (DDG 110). Rugged electronics enable rapid configuration and testing of shipboard radar and communication systems. Navy photo

As military and aerospace systems continue to integrate RF, digital, and software elements at higher levels of complexity, the value of intelligent, connected test and measurement will only grow.

The future of test and measurement is not just about capturing data - it's about making it meaningful, actionable, and increasingly automated. Across the defense and aerospace ecosystem, the marriage of digital twins, embedded computing, and AI-enabled analytics is reshaping testing from a checkpoint into a continuous, predictive, and mission-critical capability.

▶ The captain of the Arleigh Burke-class guided-missile destroyer USS Rafael Peralta (DDG 115) monitors the Royal Thai Navy warship HTMS Rattanakosin (FSGM 441) during a transiting exercise in June 2023. Navy photo

Navy focusing on C4ISR and cyber warfare for operations from seabed to space

BY **John Keller**

SAN DIEGO – U.S. Navy researchers are preparing to approach industry for new enabling technologies for information warfare; command, control, communications, computers, intelligence, surveillance, reconnaissance (C4ISR); offensive and defensive cyber warfare; and space systems.

Officials of the Naval Information Warfare Center (NIWC) Pacific in San Diego have issued a notice (N66001-26-R-0019) for the upcoming Intelligence, Surveillance, and Reconnaissance (ISR) Systems and Information Operations (IO) from Seabed to Space (S2ISR) project.

NIWC Pacific intends to issue a request for proposal (RFP) for the S2ISR project that involves enabling the Navy to develop enabling technologies in communications, surveillance, and security to accommodate advances in technology and counter enemy threats.

NIWC Pacific is responsible for research and development in information warfare that involves integrated C4ISR systems, offensive and defensive cyber warfare; and life cycle management of fielded systems such as uncrewed underwater, surface, and aerial systems; large data management, antenna design, and renewable energy.

The S2ISR project will ask several different contractors to develop algorithms; data processing; hardware and software development; testing; repair; engineering; configuration management;

maintenance; training; ISR analysis; and cyber security systems.

ISR activities may involve developing uncrewed systems to detect and potentially neutralize chemical, nuclear, biological, and radiological (CNBR) threats. They also will involve surveillance, networks, and tactical data communications like automated radio communications, satellite terminals, and autonomous or non-autonomous ISR systems for use in space, in the air, on land, and on the ocean.

NIWC Pacific officials say they expect the final RFP for N6600126R0019 was to be released by late November, and will be available electronically under Notice ID N6600126R0019 via the Solicitation Module within the Procurement Integrated Enterprise Environment (PIEE) website online at https://piee.eb.mil/.

Email questions or concerns to the Navy's Carl Odom at carl.n.odom.civ@us.navy.mil. More information is online at https://sam.gov/workspace/contract/opp/46552c058b83402ca318fc8629e2e9ec/view.

Air Force wants cognitive radio intelligent waveform generation and network control

BY **John Keller**

ROME, N.Y. – U.S. Air Force researchers are asking industry for new ways to design cognitive radio waveform generation and network control to enable RF communications that are fast, efficient, and able to adapt to environmental conditions.

Officials of the U.S. Air Force Research Laboratory Information Directorate in Rome, N.Y., have reissued a broad agency announcement in late September (FA8750-22-S-7006) for the Adaptive Waveform Generation for Extreme RF (AWGER) project.

The program seeks new kinds of cognitive radio techniques that enable wireless communications that autonomously find open radio frequencies and choose the most efficient RF waveform to avoid interference, achieve necessary range, and send data quickly.

Cognitive radio describes an RF transceiver that intelligently can detect which communication channels are in use, which ones are not, and instantly move into vacant channels. The same principles could apply to radar, electronic warfare (EW) and other RF and microwave applications.

The AWGER program aims at effective design tradeoffs between RF spectral efficiency, linearity, and power efficiency. One of the major issues in cognitive radio is obtaining an adaptive transmitting waveform based on environmental measurements.

The Air Force Research Laboratory is soliciting white papers that describe technologies for cognitive waveform generation; machine learning or other cognitive techniques for building waveforms from fundamental digital processing blocks; adjusting to waveforms based on varying RF environments and interference; simulate RF environments and physical layers for waveform evaluation; and resiliency to adversarial attacks.

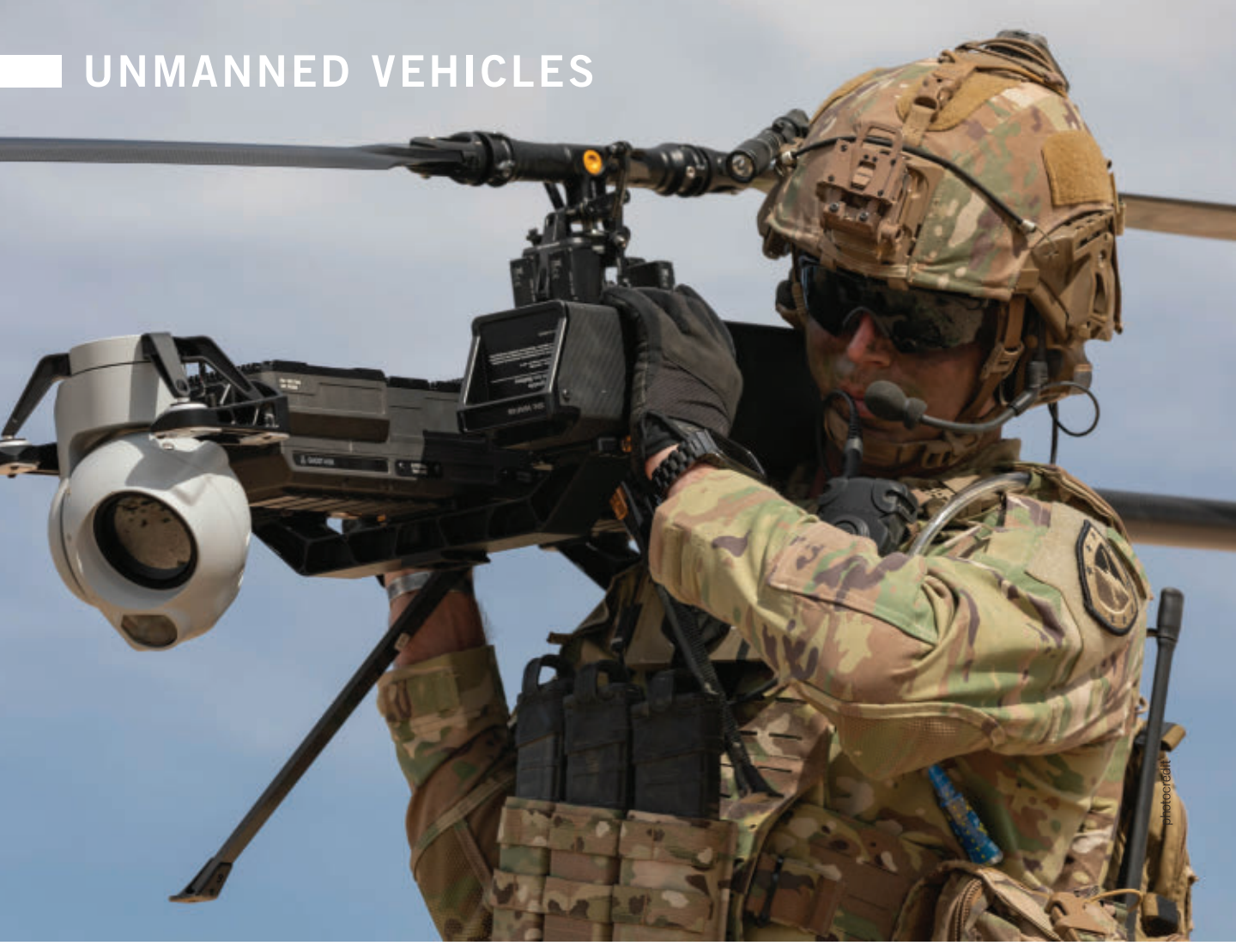
A U.S. Marine Corps expeditionary fuel technician establishes communications using a radio as part of an exercise at Ie Shima, Okinawa, Japan, last May. Marine Corps photo

Finally, the AWGER project seeks to create a unified scenario evaluation environment with over-the-air demonstrations consisting of virtual nodes from emulation and physical nodes; and integrated demonstration of network control and waveform generation. The AWGER project should be worth nearly $50 million through 2027, split among several different contractors.

Companies interested were asked to email white papers to the Air Force's Gerald Wohlrab by 15 Sept. 2026 at gerard.wohlrab@us.af.mil. Email technical questions or concerns to the Air Force's Gerald Wohlrab at gerard.wohlrab@us.af.mil, and business questions to Amber Buckley at Amber.Buckley@us.af.mil. More information is online at https://sam.gov/workspace/contract/opp/78c6cc9659774f40a64a528f641571a6/view.

Army asks Northrop Grumman to turn 155-millimeter artillery rounds into precision-guidance smart munitions

U.S. Army explosives experts are asking Northrop Grumman Corp. to provide additional 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., announced an $40.5 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. 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 https://www.northropgrumman.com/what-we-do/advanced-weapons/armament-systems, or the Army Contracting Command-New Jersey at https://acc.army.mil/contractingcenters/acc-nj/



Army eyes small uncrewed aircraft for company-level reconnaissance and surveillance

BY **John Keller**

ROCK ISLAND ARSENAL, Ill. – U.S. Army uncrewed aircraft experts are searching industry to find viable company-level small uncrewed aircraft systems for a flight demonstration next spring as part of an urgent requirement to acquire small uncrewed air vehicles (UAVs) for small Army maneuver units.

Officials of the Army Contracting Command at Rock Island Arsenal, Ill., issued a solicitation (PM-UAS-sUAS) for the Company Level Small Uncrewed Aircraft System (sUAS) project to inform industry of emerging Army requirements, and speed integration of agile, cutting-edge sUAS technologies.

The Army Contracting Command issued this solicitation on behalf of the Program Manager-Unmanned Aircraft Systems-Small Unmanned Aircraft Systems at Redstone Arsenal, Ala., which will use the One Nation Innovation industry consortium in Columbia, S.C., to conduct the industry survey.

Army company-level small unmanned aircraft systems (sUAS)

The Anduril Ghost X small uncrewed aircraft is intended to provide Army maneuver units as small as companies with intelligence and reconnaissance data in real time on the battlefield. Army photo

are drone systems designed to enhance reconnaissance and surveillance at the company maneuver level within Brigade Combat Teams. An Army company consists of between 100 and 250 soldiers, and falls between battalion- and platoon-sized units.

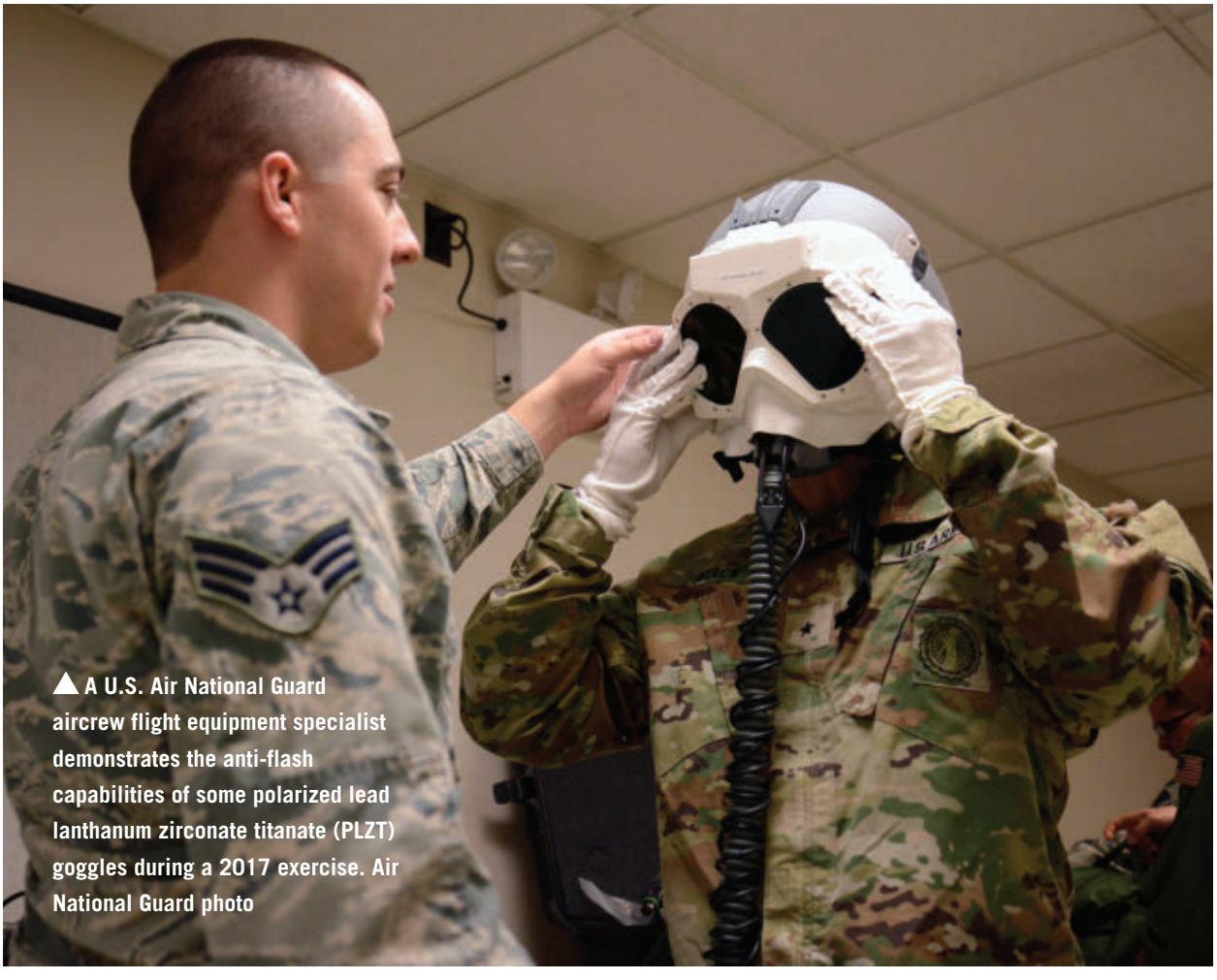
Company-level sUAS will be commercially available small drones with rapidly reconfigurable, modular, and attritable payloads that help enable maneuver companies to conduct several different kinds of missions with immediate deployable drone designed to operate contested environments to gather real-time intelligence.

Examples of company-level sUAS are the Ghost X from Anduril Industries in Costa Mesa, Calif.; and the C-100 UAS from Performance Drone Works in Huntsville, Ala. The company-level sUAS typically includes at least two uncrewed aircraft per system, with modular mission payload capabilities and a ground-control station.

These small drones should be expendable easily reconfigurable for different missions to support infantry or maneuver companies without saturating commanders with the complexities of drone operations.

The Army will use this challenge to ensure industry remains informed of evolving requirements to encourage continued investment and innovation in sUAS technologies for future opportunities.

Companies interested were asked to submit white papers by 17 Dec. 2025 online at https://marketplace.gocolosseum.org/public/challenges/532b267a-f8c6-4438-bee5-783aac08f884. Submit questions or concerns to the One Nation Innovation online at https://marketplace.gocolosseum.org/public/challenges/532b267a-f8c6-4438-bee5-783aac08f884. More information is online at https://sam.gov/workspace/contract/opp/c930003cc58c4d7bbe4d-2c4c45aa3ac1/view.



▲ A U.S. Air National Guard aircrew flight equipment specialist demonstrates the anti-flash capabilities of some polarized lead lanthanum zirconate titanate (PLZT) goggles during a 2017 exercise. Air National Guard photo

Intellisense to build auto-darkening goggles to protect against nuclear flash blindness

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio – U.S. Air Force vision safety experts needed protective eyewear for the flight crews of nuclear-capable aircraft to protect their eyes from the intense flash of nuclear explosions. They found a solution from Intellisense Systems Inc. in Torrance, Calif.

Officials of the Air Force Life Cycle Management Center's Combat Readiness Human Systems Division at Wright-Patterson Air Force Base, Ohio, announced a $7.7 million contract to Intellisense for Next-Generation Nuclear Flash Blindness Protection (NGNFBP) systems.

This contract involves engineering and manufacturing development, and low-rate initial production of NGNFBP systems. Intellisense engineers are focusing on improved sensor speed, integration with aircraft systems, and a move to initial production.

This contract provides for ensuring aircrews can carry out their missions safely and effectively amid nuclear explosions by replacing EEU-2A/P and protecting against flash blindness and retinal burn. EEU-2A/P is an advanced version of the lead lanthanum zirconate titanate (PLZT) anti-flash blindness goggles used by bomber crews of the B-52, B-1, FB-111, and other nuclear-capable aircraft.

Intellisense is developing next-generation nuclear flash blindness protection for military aircrew and personnel, building on technologies such as advanced auto-darkening goggles and sensor-driven systems to detect the intense light pulse of a nuclear detonation and rapidly darken protective eyewear to prevent flash blindness for pilots and aircrew.

Intellisense's nuclear flash blindness protection systems involve integrating sensors capable of ultra-fast detection of nuclear events that trigger auto-darkening within milliseconds, which is much faster than human reflexes allow.

The company's NGNFBP research involves multi-sensor fusion, infrared imaging, deep-learning algorithms, and augmented intelligence to enable decision-making and increased reliability in intense battlefield environments. These systems are to provide eye protection without interfering with critical mission tasks.

PLZT goggles have been the standard for nuclear flash eye protection. This material instantly goes black within microseconds via electric charge upon detecting a nuclear flash to block harmful light and preserve pilot vision.

Intellisense is seeking to enhance existing PLZT technologies and explore new sensor designs like neuromorphic vision chips and multi-spectral detection to improve responsiveness and reduce false positives.

Intellisense will take-on manufacturing liquid crystals cells and lenses with optical performance capable of a switching time from the triggering flash and the lens of 150 microseconds or less.

This project includes research, test, and evaluation of aircrew equipment that balances nuclear flash eye protection, mission compatibility, and flight safety. These devices will use modern technology for faster and darker switching following a nuclear event, and should be faster and darker than most commercial-off-the-shelf solutions.

These devices should have a curved design that accommodates prescription eyeglasses, and compatible with the AN/AVS-9 helmet-mounted night-vision display and color helmet mounted display.

The goggles will be suitable for nuclear-capable aircraft, and should be usable during the day and at night. Goggles must be compatible with aircrew flight equipment, and enable the wearer to see the correct shape ad colors of cockpit displays, lights, phosphors, exterior aircraft lights, and airfield lights.

On this contract Intellisense will do the work in Torrance, Calif., and should be finished by March 2027. For more information contact Intellisense Systems online at www.intellisenseinc.com, or the Air Force Life Cycle Management Center at https://www.aflcmc.af.mil/.

◀ A BQM-177 subsonic target drone launches from the Marine Corps Medium Range Intercept Capability system during Live Fire 2 as part of a quad-launch event at White Sands Missile Range, N.M., in September 2022. Marine Corps photo

Raytheon starts full-rate production of anti-air system with radar and infrared sensors

BY **John Keller**

QUANTICO MARINE BASE, Va. – The U.S. Marine Corps is pouring more money into a medium-range anti-air weapon system that can detect, track, identify, and destroy enemy cruise missiles and unmanned aircraft in and around attack beaches.

Officials of the Marine Corps Systems Command at Quantico Marine Base, Va., announced a potential $380 million to the RTX Corp. Raytheon segment in Tucson, Ariz., for full-rate production of the Medium Range Intercept Capability (MRIC) program.

MRIC is for mobile attacking forces and fixed sites in contested environments like the Indo-Pacific theater. It is a rapid prototyping program to develop short-to-medium range air defenses. This order brings the total value of the MRIC contract to $412.5 million.

RTX Raytheon won a $32.5 million quick-turnaround contract in late July for 44 sets of long-lead items for MRIC full-rate production, spare parts and upgrades to earlier prototype systems. Long-lead items either are difficult and time-consuming to obtain, and are funded early to keep overall production on schedule.

The medium-range MRIC integrates with the Marine Corps Ground/Air Task-Oriented Radar (G/ATOR) and the Common Aviation Command and Control System (CAC2S), and borrows technology from Israel's Iron Dome — particularly a U.S. version of the Tamir missile interceptor called SkyHunter, which has a 43-mile range, with possible extended versions in development.

The MRIC guidance systems consist of the G/ATOR radar for 360-degree coverage for detecting and tracking targets; the CAC2S for command, control, and communications; the SkyHunter interceptor with radar and infrared sensors for guidance.

MRIC fires the Raytheon SkyHunter surface-to-air missile, which is the American version of the Israeli Tamir Iron Dome missile. The SkyHunter missile has a range of 2.4 to 43.4 miles, and can shoot down cruise missiles, rockets, artillery shells, mortars, drones, and other aerial threats.

The SkyHunter surface-to-air missile is manufactured through a joint venture between Raytheon Technologies (RTX) and Rafael Advanced Defense Systems.

MRIC relies heavily on digital signal processing (DSP) for its radar and

infrared sensor to detect and track several aerial threats at once. DSP enables MRIC to filter, analyze and synthesize radar signals to identify threats, and is critical for target discrimination, threat identification, and real-time situational awareness.

The DSP capabilities in MRIC are part of what makes it capable of responding quickly to complex fast-moving threats in contested environments.

MRIC can defend against several kinds of aerial threats launched simultaneously and from different angles. It is trailer-mounted and can carry as many as 20 missiles in four levels of missile pods.

The Marines are moving forward with fielding MRIC to re-establish mid-range defense capabilities they have been without since retiring the MIM-23 Hawk missile batteries in 1997.

MRIC initial operating capability was last year; now comes full-rate production, and the Marines will outfit an initial platoon with MRIC later this fall. All three of the Marine Corps Low Altitude Air Defense Battalions will receive MRIC launchers, missiles, and support equipment between 2026 and 2028.

On this order, RTX Raytheon will do the work in Tucson, Ariz., and should be finished by August 2028. For more information contact RTX Raytheon online at www.rtx.com/raytheon/news/2022/05/03/med-range-interceptor-capability-proves-effective, or Marine Corps Systems Command at www.marcorsyscom.marines.mil.

RTX Raytheon to upgrade shipboard air defense gun with infrared sensors

U.S. Navy shipboard air defense experts are asking RTX Corp. to upgrade the MK 15 Close-In Weapon System (CIWS) with stabilized infrared sensors under terms of a $205.1 million order. Officials of the Naval Sea Systems Command in Washington are asking the RTX Raytheon segment in Tucson, Ariz., to carry out CWIS upgrades, conversions, overhauls, and provide related equipment to bring CIWS up to the latest CIWS block 1B variant. The Phalanx CIWS — also known as "sea-wiz," is a fast-reaction radar-guided Gatling gun system installed on U.S. Navy surface combatants and allied nations' ships for defense against anti-ship missiles, aircraft, drones, and asymmetric threats such as small fast surface craft and helicopters. Block 1B variants of this shipboard air-defense system add a stabilized electro-optical infrared sensor to enhance the system's capability to counter fast attack boats, helicopters, and uncrewed aircraft. CIWS retains the M61A1 20mm Gatling gun. CIWS is installed on all major U.S. Navy surface combatants, as well as aboard the surface warships of 24 allied nations. The system has undergone several upgrades since it first went to sea in 1980. Overhauls and conversions include MK 15 Mod 31 SeaRAM upgrade kits, which integrate missile defense capabilities into the system. On this order, RTX Raytheon will do the work in Louisville, Ky.; El Segundo, San Diego, Pomona, and Palo Alto, Calif.; Tucson and Tempe, Ariz.; Andover, Mass.; Colchester, Vt.; Mason, Ohio; Grand Rapids, Mich; Norcross, Ga.; Ottobrunn Germany; Joplin, Mo.; Hauppauge, N.Y.; Grantsburg, Wis.; Exeter, N.H.; Galena, Kan.; and other locations, and should be finished by by January 2029.

Laser-detection to reveal concealed optics and lasers offered by Sentinel

Sentinel Photonics in Farnborough, England, is introducing the ECHO and LASERD MAX laser-detection systems to expose covert lasers and optics in contested environments. ECHO is a rugged handheld laser-detection system that exposes concealed hostile optics and lasers that use magnified optics of any kind, for military, law enforcement, and high-security operations It can detect optics at distances as far as three kilometers even under harsh environmental conditions. ECHO uses advanced retro-reflection to uncover surveillance threats, and operates across the wide spectrum to enable operators to identify concealed optics without compromising their own position in surveillance, counter-surveillance, VIP protection, sniper scope detection, and border operations. The LASERD MAX advanced laser intelligence (LasINT) system gives operators real-time situational awareness of unknown laser threats. Designed for high-tempo high-threat operations, LASERD MAX delivers persistent, autonomous laser detection from as far away as 10 kilometers across the visible and non-visible laser spectrum. These electro-optical sensors enable users to map, log, and analyze laser activity passively in real time, even in complex or contested electronic warfare (EW) environments. Threat types include laser directed-energy weapons, rangefinders, beamriders, LIDAR, and covert illuminators. It has a compact size and several camouflage options. For more information contact Sentinel Photonics online at www.sentinelphotonics.co.uk.

Lockheed Martin to provide electro-optics parts for combat aircraft search and track

BY **John Keller**

PATUXENT RIVER NAS, Md. – U.S. Navy air combat experts are asking electro-optics engineers at Lockheed Martin Corp. to build components for infrared search and track (IRST) sensors on the F/A-18E/F Super Hornet jet fighter-bomber to enable the aircraft to detect, track, and attack enemy aircraft in a stealthy way without making its presence known.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $233 million contract to the Lockheed Martin Missiles and Fire Control segment in Orlando, Fla., for infrared receivers, inertial measurement units, and processors for Infrared Search and Track (IRST) Block II full-rate production.

The Super Hornet IRST Block II is a long-wave infrared detection sensor that targets enemy aircraft in conditions where the Super Hornet cannot or should not use its radar. The system uses infrared search and track technology to detect and provide weapons-quality track solutions on potentially hostile aircraft.

This contract includes 59 infrared receivers — 51 for the Navy and eight for the Air National Guard (ANG); 20 inertial measurement units for the Navy; and 45 processors — 37 for the Navy and eight for the ANG.

The Navy and Boeing first flew the IRST Block II pod on an F/A-18E/F Super Hornet in late 2019. IRST is a passive, long-range sensor blends infrared and other sensor technologies.

The IRST Block II gives the F/A-18 improved optics and processing power, significantly improving pilot situational awareness. The Block II variant first was delivered to the Navy in 2021, reaching initial operational capability shortly thereafter.

The Infrared Search and Track (IRST) mounted on a F/A-18F Super Hornet jet fighter-bomber at China Lake Naval Air Weapons Station, Calif. Navy photo

The IRST Block II is part of the Super Hornet Block III upgrades to keep the F/A-18 in active service for decades to come. Block III upgrades also include enhanced network capability, longer range with conformal fuel tanks, an advanced cockpit system, signature improvements, and an enhanced communications system.

The IRST fits on the front of the Super Hornet's centerline fuel tank. The IRST passive search system consists of a passive longwave infrared receiver, a processor, inertial measurement unit, and environmental control unit. The infrared receiver, processor, and inertial measurement unit fit inside the sensor, which attaches to the front of the fuel tank mounted to the aircraft on the BRU-32 bomb rack.

Infrared sensors like the IRST detect the heat from an aircraft's engine exhaust or even the heat generated by the friction of an aircraft as it passes through the atmosphere. Unlike radar, infrared sensors do not emit electronic signals, and do not give away their presence to adversaries.

This ability can enable Super Hornet pilots to identify enemy aircraft at long ranges, and enable them to fire their air-to-air missiles at their maximum ranges.

Data from the IRST system can stand alone or fuse with the Super Hornet's other on-board sensor data situational awareness.

On this contract Lockheed Martin will do the work in Orlando and Ocala, Fla.; Santa Barbara, Calif.; and Archbald, Pa., and should be finished by September 2029. For more information contact Lockheed Martin Missiles and Fire Control online at https://www.lockheedmartin.com/en-us/products/irst21-sensor-system.html, or Naval Air Systems Command at https://www.navair.navy.mil/.

AVIONICS

▲ Navy asks Northrop Grumman for avionics upgrade for secure communications

U.S. Navy airborne communications experts are asking Northrop Grumman Corp. for an avionics upgrade to the E-2D Advanced Hawkeye for the latest in NATO-standard secure communications.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced plans to award a sole-source contract to the Northrop Grumman Aeronautics segment in Melbourne, Fla., to update the E-2D's flight management computer to accept the Second Generation Anti-Jam Tactical UHF Radio for NATO (SATURN) secure radio.

The E-2D is the newest model in the E-2 Hawkeye carrier-based airborne early warning and command and control aircraft. It has the AN/APY-9 advanced surveillance radar for 360-degree all-weather surveillance, and can track more than 3,000 aircraft and missiles simultaneously.

Its main role includes airborne command, tactical battle management, surveillance, air defense coordination, and multi-mission command and control for carrier strike groups and joint operations.

SATURN is NATO's next-generation standard UHF communications system for designed for secure, reliable military voice and data transmission. SATURN can resist jamming and interference, and is the successor to the HAVEQUICK radio waveform, which was the previous NATO standard for secure military communications.

The avionics upgrade to accommodate SATURN will give the E-2D fast frequency hopping and digital modulation to resist the effects of electronic warfare (EW) jamming and improve communication clarity and reliability. The SATURN radio is compatible with military cryptographic units for enhanced communication security.

SATURN is widely adopted within NATO and allied forces, replacing older systems like HAVE QUICK II, and is implemented across various platforms including naval, air, and selected ground units. The waveform complies with NATO STANAG 4372. Radio manufacturers like Rohde & Schwarz and BAE Systems are key players in developing and deploying SATURN radios.

The Northrop-Grumman E-2D avionics flight management computer (AFMC) is undergoing continual upgrades, including a cockpit technical refresh that replaces and modernizes the current integrated navigation, controls, display, and tactical mission computer systems with newer, more capable technology.

The value of the Navy's upcoming contract to Northrop Grumman has yet to be negotiated.

For more information contact Northrop Grumman Aeronautics online at www.northropgrumman.com/what-we-do/aircraft/e-2d-advanced-hawkeye, or Naval Air Systems Command at www.navair.navy.mil.

RADAR

▶ Navy taps Ultra for next-generation surface-search radar with digital signal processing to combat clutter

Radar experts at Ultra Electronics Ocean Systems segment in Braintree, Mass., will provide AN/SPS-73(V) Next Generation Surface Search Radar (NGSSR) systems under terms of a $13.7 million order.

Officials of the Naval Sea Systems Command in Washington are asking Ultra Electronics to provide these next-generation surface-search radar systems to replace existing radars that suffer from obsolescent technologies or an inability to meet current threats.

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 AN/SPS-73(V)18 NGSSR uses the latest digital signal processing technology and incorporates a software-based architecture at its core. NGSSR has software algorithms that extend, enhance, and optimize NGSSR's performance by capitalizing on the system's software-defined architecture.

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 AN/SPS-73(V)18 NGSSR software-defined radar is replacing all variants of the Navy's current AN/SPS-67, AN/SPS-73, BridgeMaster E series, and commercial-of-the-shelf radar systems.

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. Older versions of the AN/SPS-73 are short-range, two-dimensional, surface search and navigation radar systems 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 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 AN/SPS-73(V)18 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.

This contract has options that could bring its cumulative value to $420.5 million, and extend contract's duration until September 2031. On this contract Ultra will do the work in Braintree, Mass.; Wake Forest, N.C.; and Chantilly, Va., and should be finished by February 2026.

For more information contact Ultra Electronic Ocean Systems online at https://umaritime.com/radar-electronic-warfare/, or the Naval Sea Systems Command at www.navsea.navy.mil.

BIOMICROELECTRONICS

▶ DARPA taps four to control biological functions using microsystems and molecular

U.S. military researchers have hired three more organizations for a project that seeks to control biological functions using microsystems and molecular catalysts.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced contracts in August to SRI International Menlo Park, Calif.; CFD Research Corp. in Huntsville, Ala.; and the University of California at Berkeley for the Microsystem Induced Catalysis (MICA) project.

Military researchers may use this kind of research in future hopes of designing nonliving artificial cells able to carry out functions of living cells for sensing, information processing, and self-repair to create machines that combine electronic, mechanical, and biological properties that ultimately could sense, reason, upgrade, and repair themselves.

SRI won a $10.7 million contract on 28 Aug. 2025; CFD Research won a $6.6 million contract on 19 Aug. 2025; and UC Berkeley won a $3.2 million contract on 26 Aug. 2025. They join Battelle Memorial Institute in Columbus, Ohio, which won a $10.3 million MICA contract in July.

Electron flow in transistors sometimes are similar to molecular flows in biochemical reactions in living cells, and their similarities suggest that cells and electronic components could interact in a predictable and controllable way.

The MICA program focuses on using microsystems to control biological functions, and will seek hardware demonstrations of molecular catalysts immobilized to microsystem surfaces and controlled by physical forces generated by the microsystem.

Additionally, the program focuses on modeling and simulation of such integrated molecular microsystems, with an emphasis on biomolecular catalysts.

The MICA program's design and simulation portion will include ways to predict the dynamic performance of molecules integrated with microsystems. The project's fabrication portion will include ways to place and immobilize molecules at microsystem interfaces to help the microsystem control catalyst activity.

A major thrust is placing and attaching catalytic molecules to microsystems to drive biological function. The program will emphasize compatibility with standard microelectronics manufacturing.

The MICA contractors will determine how to predict molecule structure and function, and how to couple to a field-programmable gate arrays (FPGAs) and CMOS digital logic circuits.

The MICA program involves companies with expertise in molecular design, microsystem design, and fabrication to integrate molecules with microsystems to control molecular function; and companies with expertise in modeling and simulating the performance of microsystem and molecule performance to develop tools for predicting integrated system performance.

For more information contact SRI International online at www.sri.com, CFD Research at www.cfd-research.com, Battelle at www.battelle.org, or DARPA at www.darpa.mil/news/2025/closing-integration-gap.

MARITIME ELECTRONICS

▼ Military orders stealthy boats with advanced electronics for special forces

U.S. clandestine special forces experts needed technologically advanced stealthy boats for insertion, extraction, and support of Navy SEALs and other special operations units. They found a solution from Fincantieri Marine Group LLC in Washington.

Officials of U.S. Special Operations Command at MacDill Air Force Base, Fla., announced a $22.1 million contract option to produce the Combatant Craft Heavy V (CCH V) stealthy special operations boats, designed primarily for use by Naval Special Warfare teams.

The CCH V is the fifth iteration in the Combatant Craft Heavy program, and is known for being among the largest and most technologically advanced boats in the U.S. Special Operations Command. It offers low observability,

modularity, and improved capability for high-risk and covert missions, and uses advanced stealth and electronic technologies to evade detection.

Also called the SEAL Insertion, Observation, and Neutralization craft (SEALION), the CCH V is enclosed, semi-submersible, and provides enhanced crew and operator protection against detection and small arms fire. The boat is 80 feet long, 14.5 feet wide, and 9.5 feet high.

The boat can be transported by C-17 aircraft or sling-loaded by heavy-lift helicopters for deployment. It replaces earlier generations like the Mark V Special Operations Craft.

CCH V has advanced electronics designed for stealth, command, control, intelligence, surveillance, reconnaissance, and modular mission support.

Its main electronic subsystems include command, control, communications, computers, cyber-defense, and combat systems (C6ISR); reconnaissance and surveillance sensors; navigation systems; communications equipment; electronic warfare (EW) and passive detection systems; launch and recovery interfaces; and sensor mast systems.

C6ISR electronics enables command and communication with other naval assets, including robust cyber-defense and computer systems. Reconnaissance and surveillance sensors include retractable sensor masts with high-resolution cameras; electronic sensors for surface and underwater surveillance; and Forward Looking Infrared (FLIR) sensors for enhanced night and low-visibility operations.

Communications equipment includes underwater telephones, UHF radios, encrypted low-probability-of-intercept links, and data transmission for joint operations. EW and passive detection systems detect, classify, and evade enemy radar, while passive electronic and cyber warfare measures improve survivability in contested environments.

Launch and recovery interfaces integrate with uncrewed surface and underwater vehicles, plus specialized payload control systems for munitions and mission packages. Modular masts offer mission-specific sensors for reconnaissance, navigation, or communications. CCH V boats also can accommodate pop-up missile launchers with stand-off munitions.

On this contract option, Fincantieri Marine will do the work in Green Bay, Wis., and should be finished by November 2027.

For more information contact Fincantieri Marine Group online at https://fincantierimarinegroup.com/, or U.S. Special Operations Command at www.socom.mil.

AIRBORNE COMMUNICATIONS

▼ RTX Collins Aerospace to build 9,859 AN/ARC-210(v) avionics voice and data radios

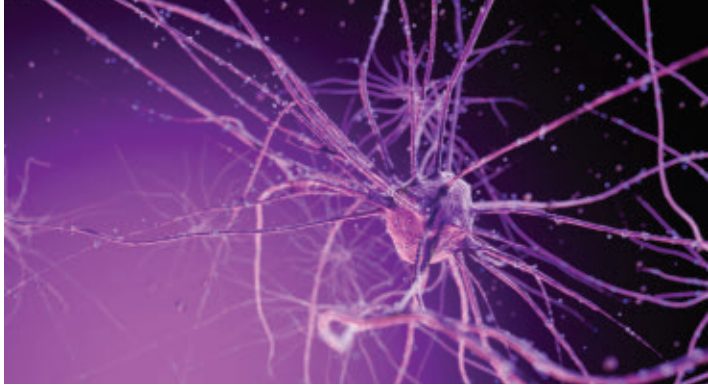
Military aircraft communications experts at Collins Aerospace in Cedar Rapids, Iowa, will provide the U.S. Navy with thousands of avionics radios under terms of a $351.2 million order.

Officials of the Naval Air Warfare Center Aircraft Division at Patuxent River Naval Air Station, Md., are asking the RTX Corp. Collins Aerospace segment to provide 9,859 AN/ARC-210(v) avionics radios and related equipment.

These radios are for installation in more than 400 military aircraft, ships, submarines, land vehicles, and fixed-site applications for the Navy, Marine Corps, Army, Coast Guard, other government agencies and U.S. allies.

The AN/ARC-210 Gen V programmable digital aircraft radio from Collins Aerospace provides two-way, multi-mode voice and data communications over frequencies from 30 to 512 MHz, covering UHF and VHF bands with AM, FM, and satellite communications capabilities.

The ARC-210 radio also includes embedded anti-jam waveforms, including Have Quick and SINCGARS, and



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other data link and secure communications features for battlefield interoperability and transfer of data, voice, and imagery. The radios communicate with other avionics over a MIL-STD-1553 data bus.

The ARC-210 aircraft radio provides VHF close air support radio communications on 30-88 MHz frequencies; navigation on 108-118 MHz; air traffic control on 118-137 MHz; land mobile communications on 137-156 MHz; and maritime communications on 156-174 MHz. The radios also provide aircraft with UHF military and homeland defense communications on 225-512 MHz frequencies; and public-safety communications on 806-824, 851-869, 869-902, and 935-941 frequencies.

The AN/ARC-210 Gen V programmable digital communications system conforms to software-defined radio (SDR) tenets and architectures, and transfers networked or point-to-point data, voice, and imagery.

Collins Aerospace engineers also have added a connector in the back of the radio for an Ethernet input for network-centric warfare. Collins Aerospace has supplied more than 30,000 AN/ARC-210 radios worldwide on more than 180 different kinds of aircraft for multiband, multimode communications.

The ARC-210 also provides embedded, programmable trusted computing and information security encryption per the U.S. National Security Agency (NSA) Cryptographic Modernization Initiative.

On this order Collins Aerospace will do the work in Cedar Rapids, Iowa, and should be finished by September 2026.

For more information contact RTX Collins Aerospace online at www.collinsaerospace.com/what-we-do/industries/military-and-defense/communications/airborne-communications/vhf-uhf-l-band/arc-210-rt-2036-c, or the Naval Air Warfare Center Aircraft Division at www.navair.navy.mil/nawcad.

BIO-ELECTRONICS

▶ RTX BBN to use microsystems and molecular catalysts to create artificial cells for sensing

U.S. military researchers have hired a fifth organization for a project to control biological functions using microsystems and molecular catalysts.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a $10.3 million contract to the RTX Corp. BBN segment in Cambridge, Mass., for the Microsystem Induced Catalysis (MICA) project.

Military researchers may use this kind of research in future hopes of designing nonliving artificial cells able to carry out functions of living cells for sensing, information processing, and self-repair to create machines that combine electronic, mechanical, and biological properties that ultimately could sense, reason, upgrade, and repair themselves.

RTX BBN joins SRI International Menlo Park, Calif.; CFD Research Corp. in Huntsville, Ala.; the University of California at Berkeley; and Battelle Memorial Institute in Columbus, Ohio, on the MICA project.

SRI won a $10.7 million contract; CFD Research won a $6.6 million contract; UC Berkeley won a $3.2 million contract; and Battelle won a $10.3 million MICA contract.

The MICA program focuses on using microsystems to control biological functions, and will seek hardware demonstrations of molecular catalysts immobilized to microsystem surfaces and controlled by physical forces generated by the microsystem.

A major thrust is placing and attaching catalytic molecules to microsystems to drive biological function. The program will emphasize compatibility with standard microelectronics manufacturing. The MICA contractors will determine how to predict molecule structure and function.

The MICA program involves companies with expertise in molecular design, microsystem design, and fabrication to integrate molecules with microsystems to control molecular function; and companies with expertise in modeling and simulating the performance of microsystem and molecule performance to develop tools for predicting integrated system performance. ←

For more information contact RTX BBN online at www.rtx.com/who-we-are/we-are-rtx/transformative-technologies/bbn; SRI International online at www.sri.com; CFD Research at www.cfd-research.com; UC Berkeley at www.berkeley.edu/research; Battelle at www.battelle.

EMBEDDED COMPUTING

▶ SOSA-aligned 3U VPX embedded computing for aerospace and defense offered by BittWare

BittWare, a Molex company in Concord, N.H., is kicking-off an early access program to jump start development of embedded systems that use the company's 3U VPX embedded computing cards with next-generation AMD Ryzen processors, AMD Versal RF series, and AMD Versal adaptive systems on chip (SoCs). BittWare's 3U VPX cards can help improve performance and optimize size, weight,

and power consumption (SWaP) for mission-critical aerospace and defense applications. The BittWare 3U VPX cards are for data acquisition and multi-sensor processing for multi-channel real-time digital signal processing for radar, sensor fusion, electronic warfare (EW), signals intelligence (SIGINT), unmanned aerial vehicles (UAVs), and image processing. The cards align with the Sensor Open Systems Architecture (SOSA) and VITA 48, which defines the mechanical requirements for building and cooling ruggedized electronic modules for embedded systems. Companies chosen for early access to BittWare's 3U VPX embedded computing cards will receive product details, roadmap information, and opportunities to engage with experts on next-generation product designs. For more information contact BittWare online at www.bittware.com.

ARTIFICIAL INTELLIGENCE (AI)

▶ GPGPU- and AI-based embedded computing card introduced by Concurrent and Eizo

Concurrent Technologies in Colchester, England, is introducing the Bragi rugged 3U OpenVPX general-purpose graphics processing unit (GPGPU) card for deployment in space-constrained and thermally challenging environments. Developed in partnership with EIZO Rugged

Solutions Inc. in Orlando, Fla., Bragi combines the latest NVIDIA RTX PRO 4000 and 5000 graphics processing units (GPUs) that are based on the Blackwell architecture. Bragi is designed for demanding applications in command, control, computers, communications, cyber, intelligence, surveillance, and reconnaissance (C5ISR) and high-performance embedded computing (HPEC) that require high-performance artificial intelligence (AI) processing at the edge. The card aligns with the Sensor Open Systems Architecture (SOSA) open-systems standard, and supports conduction-cooled and air-flow-through cooling. Bragi delivers up to 1,824 FP4 artificial intelligence (AI) tera-operations per second (TOPS), enhanced video encoding and decoding, and high-bandwidth memory access via PCI Express Gen 5 and GDDR7 ECC memory. The card offers 16 or gigabytes of GDDR7 graphics memory with ECC; as many as 10,496 CUDA cores, 320 Tensor cores, 80 RT cores; H.265, H.264, and AV1 codec support; and conformance to MIL-STD-810 for shock, vibration, and temperature. For more information contact Concurrent Technologies online at https://concurrent.tech/products/bragi.

CONNECTORS

▶ High-reliability Omnetics micro-circular connectors for rugged uses offered by Powell

Electronics distributor Powell Electronics Inc. in Logan Township, N.J., is offering micro-circular connectors from Omnetics Connector Corp. in Minneapolis for high-reliability military, aerospace, and industrial applications. Micro-circular connectors from Omnetics feature a 0.050-inch pitch. The components are QPL approved for MIL-DTL-32139 and MIL-DTL-83513 and are designed for new-generation electronic rugged and portable systems. The mated length is less than 12.4 millimeters, and the micro-circular connectors use the Omnetics rugged Flex-Pin contact. The gold-plated beryllium copper pins provide for more than 2,000 mating cycles. Plastic insulators shroud the male and female contacts to protect them during mating and unmating, while 5, 7, 12, 16, 27, and 39 position housing sizes are available in pre-wired

solder cup and solid straight tail versions. Several different shell and housing designs are available in inline, front, rear, and protruding-panel-mount configurations. Mating options include twist lock; threaded; and new breakaway formats. Wire harnesses, flex termination, over molding, and custom shells are available. The connectors can withstand high shock and vibration and maintain their electrical integrity, the micro-circular connectors from

Omnetics are ideal for demanding applications. For more information contract Powell Electronics online at www.powell.com/powell/en/USD/manufacturer/Omnetics/Micro_Circular_Connectors, or Omnetics at https://www.omnetics.com/.

BOARD PRODUCTS

▶ GPGPU XMC card for graphics and AI introduced by Concurrent

Concurrent Technologies in Colchester, England, is introducing the Narvi rugged Switched Mezzanine Card (XMC) general-purpose graphics processing unit (GPGPU) and graphics processing card for demanding military and aerospace applications. Developed in collaboration with EIZO Rugged Solutions, the Narvi XMC card is powered by the latest NVIDIA RTX PRO 2000 and 500 Blackwell GPUs, and delivers cutting-edge artificial intelligence (AI) acceleration, real-time video capture, and advanced display processing. Engineered for military, aerospace, and intelligence, surveillance, and reconnaissance (ISR) applications, The Narvi XMC offers next-generation GPU power for real-time sensor processing, situational awareness, and AI workloads at the edge. The embedded computing cards align with the Sensor Open Systems

Architecture (SOSA) standard; are built on NVIDIA RTX PRO 2000 or 500 GPUs (Blackwell architecture); has as much as 8 gigabytes GDDR7 ECC graphics memory; as much as 3,328 CUDA cores, 5th Gen Tensor Cores, 4th Gen RT Cores; PCI Express Gen 5 and 256-bit memory interface; as many as 3x DisplayPort++/DVI outputs; 9th Gen NVENC encoders and 6th Gen NVDEC decoders; H.265, H.264, and AV1 codec support; NVIDIA GPUDirect RDMA for high-bandwidth, low-latency transfers; and meets MIL-STD-810 for shock, vibration, temperature extremes. For more information contact Concurrent Technologies online at https://concurrent.tech/products/narvi.

POWER ELECTRONICS

▶ Capacitors for harsh environments like satellites and missiles offered by KYOCERA AVX

KYOCERA AVX Components Corp. in Fountain Inn, S.C., is introducing the DSCC 25007 miniature, high-CV stacked X7R capacitors for high-reliability military, aerospace, and space applications subjected to extreme operating conditions and harsh environments. The DSCC 25007 Mini BME Stacks deliver a combination of high-reliability, high-CV performance, substantial space and weight savings, and standard 100 percent Group A testing to satisfy military and aerospace industry demands. The DSCC

25007 Mini BME Stacks feature two horizontally stacked X7R multilayer ceramic chip capacitors (MLCCs) in an EIA 2220 package that conserves board space, exhibits high-CV performance, and enables design engineers to downsize from currently available components. They also exhibit low ESR, low impedance, high current handling, and higher shock and vibration resistance than larger, heavier stacked capacitors. Additional features include standard two-foot J and L styles and paddle, or single bar foot, J and L styles optimized for improved vibration resistance–all equipped with tin/lead plating. The initial release of the DSCC 25007 Mini BME Stacks is rated for operating temperatures extending from -55 to 125 degrees Celsius; three available voltage ratings; 25, 50, and 100 volts; and nine capacitance values extending from 8.2 to 47 microfarads at plus-or-minus 20 percent tolerance. Applications include satellites and satellite launchers, military missiles and aircraft, and input/output filtering circuits in power supplies. Parts ship in waffle pack, tape and reel, or two-chip packaging. For more information contact KYOCERA AVX online at www.kyocera-avx.com/news/dscc-25007-stacked-caps.

INDUSTRY-STANDARD COMPUTING

▶ SOSA-aligned single-board computer for embedded computing introduced by Acromag

Acromag Inc. in Wixom, Mich., is introducing the rugged VPX7600 3U OpenVPX single-board computer for high-performance embedded computing (HPEC) applications. The processor board aligns with the Sensor Open Systems Architecture (SOSA) open-systems standard, provides a broad range of I/O interfaces for rugged embedded systems, and is powered by Intel's 11th Generation Tiger Lake-H Xeon W-11000E processor. An XMC mezzanine site and I/O peripherals offer embedded computing flexibility, while the Intel E810 Ethernet controller supports 100 Gigabit Ethernet on the data plane and 10 Gigabit Ethernet on the control plane. An NVMe solid-state drive provides as much as 1 terabyte of M.2 data storage. Backplane I/O includes 2.5 Gigabit Ethernet, DisplayPort, USB 3.2, SATA III, RS232/422, and GPIO. Conduction-cooled and air-cooled with front I/O versions are available. The high-performance 8-core processor supports as much as 32 gigabytes of dual-channel, soldered-down DDR4 ECC memory with data rates as fast as 3200 megatransfers per second. For more information contact Acromag online at www.acromag.com.

VETRONICS

▶ Military-grade vetronics communications router introduced by Sundance and Etion

Sundance Multiprocessor Technology Ltd. in Chesam, England, and Etion Create in Irene, South Africa, are introducing the military-grade Cheetah tactical router for military vehicles and other harsh-environment edge applications. The tactical communications router with built-in interconnects is a managed level 2/3 switch/router with support for VNX+ (VITA 90) — an emerging hardware standard that speeds the design of small lightweight defense and aerospace applications. The

Cheetah military-grade router features an expandable design for cryptographic security, video camera processing, and Ethernet. Key interfaces include intra-vehicle data link; inter-vehicle data link; tactical data link (TDL); radio interface and radio fill management; intercom interface; health and usage monitoring system (HUMS); multiple-camera sensor fusion; and Power-over-Ethernet (PoE). Platform customization is available through Sundance. For more information contact Sundance online at https://www.sundance.com/?s=Cheetah, or Etion Create at https://etioncreate.co.za/wp-content/uploads/2025/09/cheetah-tactical-router-rev0G.pdf.

ADVERTISERS INDEX

Military+Aerospace Electronics®

GROUP EDITORIAL DIRECTOR Keith Larson
630-809-2064 / klarson@endeavorb2b.com

EDITOR-IN-CHIEF John Keller
603 891-9117 / jkeller@endeavorb2b.com

SENIOR EDITOR Jamie Whitney
603 891-9135 / jwhitney@endeavorb2b.com

ART DIRECTOR Meg Fuschetti

PRODUCTION MANAGER Sheila Ward

AD SERVICES MANAGER Shirley Gamboa

AUDIENCE DEVELOPMENT MANAGER Debbie Bouley
603 891-9372 / dbouley@endeavorb2b.com

ENDEAVOR BUSINESS MEDIA
www.endeavorbusinessmedia.com

EDITORIAL OFFICES

Endeavor Business Media, LLC
Military & Aerospace Electronics
61 Spit Brook Road, Suite 401, Nashua, NH 03060
603 891-0123 / www.milaero.com

SALES OFFICES

EASTERN US & EASTERN CANADA & UK
Samantha Nelson, Sales Executive
760-840-1703
snelson@endedavorb2b.com

WESTERN CANADA & WEST OF MISSISSIPPI
Maureen Elmaleh, Sales Manager
7475 Miller Street, Arvada, CO 80005
303 975-6381 / Cell 212 920-5051
melmaleh@endeavorb2b.com

DIRECTOR LIST RENTAL Kelli Berry
918 831-9782 / kberry@endeavorb2b.com

FOR ASSISTANCE WITH MARKETING STRATEGY OR AD CREATION, PLEASE CONTACT MARKETING SOLUTIONS

SR. MANAGER PROGRAM MANAGEMENT Steve Porter
sporter@endeavorb2b.com

ENDEAVOR BUSINESS MEDIA, LLC

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EVP MANUFACTURING & ENGINEERING GROUP Lisa Paonessa

VP OF CONTENT STRATEGY, MANUFACTURING & ENGINEERING GROUP Robert Schoenberger

SUBSCRIPTION INQUIRIES

Phone: 1-877-382-9187 / International Callers: +1-847-559-7598
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Airbus forecasts $311 billion global aviation services market by 2044

BY **Jamie Whitney**

TOULOUSE, France–Airbus in Toulouse, France, released its latest aviation Global Services Forecast (GSF), projecting a 10 percent year-on-year increase in total demand for services in 2025 and continued growth alongside expanding air traffic, reaching an estimated $311 billion by 2044 with a compound annual growth rate (CAGR) of 3.6 percent.

Global passenger traffic is expected to reach five billion passengers in 2025, and airlines are under pressure to maintain high fleet availability, reliability, and operational efficiency.

The GSF identifies five key service segments driving growth as the global commercial fleet nearly doubles to more than 49,000 aircraft by 2044, with annual passengers expected to double to 10 billion:

- Off-wing maintenance–The largest aftermarket sector, growing from $107 billion in 2025 to $218 billion by 2044, driven by more shop visits from an expanding and aging fleet.
- On-wing maintenance–Rising from $21 billion to $34 billion, covering inspections and heavy checks tied to fleet expansion.
- Modifications and upgrades–Increasing from $12 billion to $17 billion, focused on cabin and systems improvements to enhance passenger experience and aircraft life.
- Digital and connectivity–The fastest-growing segment, expanding from $9 billion to $26 billion, emphasizing predictive maintenance, optimized flight paths and improved passenger connectivity.
- Training–Climbing from $10 billion to $17 billion, addressing demand for 2.35 million new aviation professionals by 2044, including 633,000 pilots, 705,000 technicians and 1.01 million cabin crew.
- Airbus is also exploring two additional segments: maintenance operations support, including engineering and inventory management, and ground operations, focusing on aircraft turnaround efficiency.

The services market is expected to support more than 28,000 aircraft in 2025 with a total value of $159 billion. By 2044, Airbus projects that off-wing maintenance will double, digital and connectivity will expand at a CAGR of 5.6 percent, and ground operations and maintenance support will grow to $74 billion and $100 billion, respectively.

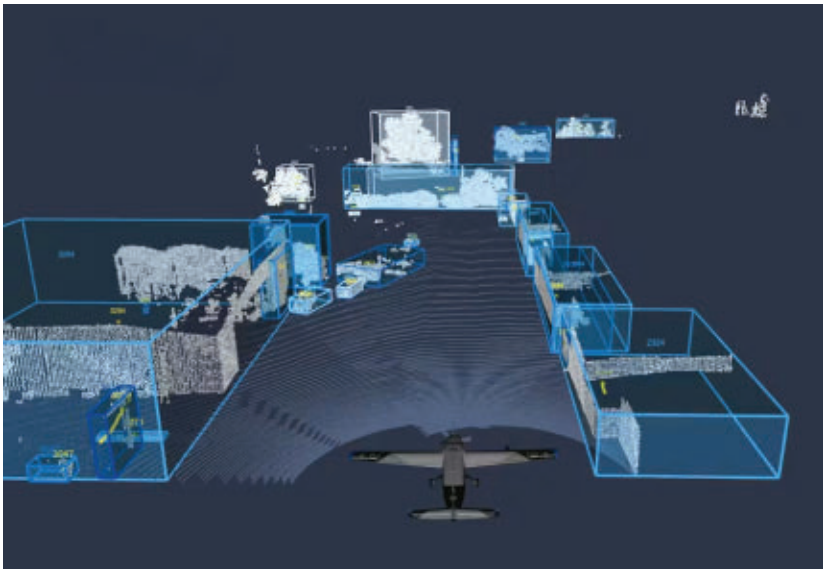
Joby Aviation collaborates with NVIDIA to advance autonomous flight with IGX Thor platform

BY **Jamie Whitney**

SANTA CRUZ, Calif.–Joby Aviation Inc. in Santa Cruz, Calif., announced a collaboration with NVIDIA in Santa Clara, Calif., naming Joby as the only aviation launch partner for the new NVIDIA IGX Thor platform. Powered by NVIDIA's Blackwell architecture, the industrial-grade platform is designed to support the next generation of physical AI applications. The collaboration aims to advance Joby's Superpilot autonomous flight technology across military and civil platforms.

"The autonomous systems under development at Joby are poised to complement human intelligence by providing speed, precision, and stamina beyond what a person alone is capable of," said Gregor Veble Mikic, flight research lead at Joby. "To achieve this, an aircraft needs a powerful onboard computer that can interpret extraordinary amounts of information to make decisions in real time. Combining NVIDIA's compute power with our world-class aircraft design, certification, and rigorous flight testing capabilities, we're enabling a new era of safety-first autonomy in aviation."

Joby is developing Superpilot to interact with the world through a continuum of autonomous functions. NVIDIA's support for industry-recognized functional safety standards on the IGX Thor platform enables Joby to pursue certifiable autonomy for near-term defense and long-term civil applications as the Federal Aviation Administration advances autonomous flight integration into national airspace.



▲ **Joby's autonomy test aircraft analyzes its environment through a range of perception sensors. Joby image**

Integrating this level of onboard compute can enhance operational safety and mission capability through real-time capabilities such as:

Autonomous mission management: Enables the aircraft to determine, request, and follow optimal flight paths, adapting to changes in weather, air traffic control instructions, or unexpected events, with intuitive human-machine teaming to ensure mission success.

Radar and perception processing: Onboard compute processes high-rate data from radar, LiDAR, and vision sensors to provide environmental awareness, object perception, and localization for safe navigation in all conditions.

Sensor fusion: High-performance processing combines data from multiple sensors to deliver accurate aircraft state estimation and situational awareness in complex environments.

The system also provides a foundation for features that improve operational insight, reliability, and performance:

Predictive system health monitoring: The aircraft refines models of its own function and reliability, predicting when components may need attention and alerting crews before a failure occurs.

Digital twin modeling: With reliable compute capabilities, an aircraft can host a digital twin of itself and its environment, collecting flight data to improve fidelity and integrating this information into mission control systems to optimize performance and efficiency.

FAA seeks industry input on modernization of radio range systems

BY **Jamie Whitney**

WASHINGTON–The U.S. Federal Aviation Administration (FAA) is seeking input from industry as it moves to modernize its Very High Frequency (VHF) Omnidirectional Radio Range (VOR) network, a critical component of the nation's ground-based air navigation infrastructure.

The agency issued a market survey to identify qualified vendors capable of delivering next-generation VOR systems that meet newly established performance specifications.

The FAA's effort is focused on replacing or upgrading legacy VOR systems that face sustainment challenges due to aging components, parts obsolescence, and diminishing manufacturing sources. The new VOR systems will need to comply with the FAA-E37012 performance specification, finalized on 24 June 2025, which was recently made public under the FAA DVT Sustainment Program Contract Opportunity.

The agency is requesting detailed input from vendors offering fully developed Conventional (CVOR) and Doppler (DVOR) systems. Respondents are asked to describe how their products align with the FAA's technical and performance requirements and to explain interoperability with existing collocated systems such as the Tactical Air Navigation (TACAN) Antenna/Distance Measuring Equipment (DME) FA-9996, the FA-10391 third-generation DME, and Indra's FA-30600 and FA-30601 DME systems.

Responses also should address potential modifications or replacements necessary to ensure compatibility with other FAA infrastructure, including the Facility Central Processing Unit (FCPU), Remote Status Control Equipment (RSCE), and the Remote Monitoring and Logging System (RMLS). Vendors are encouraged to include information about any ancillary components–such as counterpoises, transmit antennas, and monitor antennas–needed for full system functionality.

According to the FAA, this market survey is being conducted under the agency's Acquisition Management System (AMS) Section 3.2.1.2.1 and will be used for planning purposes only. The agency has not yet determined the acquisition strategy for the future procurement, but intends to use responses to assess available technologies, identify potential competition, and determine whether a small business or unrestricted competition approach is appropriate. Interested companies were asked to respond by early November.

Boeing launches Virtual Airplane Procedures Trainer to modernize pilot training

The Boeing Company in Arlington County, Va., announced the launch of its new training technology, the Virtual Airplane Procedures Trainer (VAPT), at the European Aviation Training Summit in Cascais, Portugal. Powered by Microsoft's Azure cloud computing platform and Microsoft Flight Simulator, the new platform provides pilots and flight training teams with immersive, accessible, and customizable tools to enhance learning and readiness. The Procedures Trainer is the first application in Boeing's Virtual Airplane product suite. It enables flight training teams to conduct realistic flight-deck practice through high-fidelity, three-dimensional simulations on lightweight devices. Boeing says these simulations help standardize training, reduce simulator familiarization time, and improve pilot readiness before working with full-flight training devices. Training operators can use an intuitive, self-service authoring tool to create and manage content. The tool allows instructors to author, customize, and distribute training lessons instantly across programs, ensuring that all pilots train with up-to-date, validated procedures.

DLR demonstrates airborne quantum communication link

The German Aerospace Center (DLR) has demonstrated the ability to transmit photons from multiple quantum channels between an aircraft and a ground station, sending photons to an ion trap, and testing several methods for quantum key distribution (QKD) as part of its research

into airborne quantum communications. The experiment was part of the QuNET initiative, a national program focused on developing quantum-secure communication. By using photons–particles of light–scientists can create quantum encryption keys that could make future communications resistant to eavesdropping. The same technologies may also form the foundation for a quantum internet capable of linking quantum computers around the world. The research team included experts from the German Aerospace Center, the Max Planck Institute for the Science of Light (MPL), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), the Fraunhofer Institute for Applied Optics and Precision Engineering (IOF), and the Fraunhofer Heinrich-Hertz-Institut (HHI).

Cessna Citation Ascend earns FAA type certification

The Cessna Citation Ascend, designed and manufactured by Textron Aviation Inc. in Wichita, Kan., a Textron Inc. company, announced that the Federal Aviation Administration (FAA) awarded type certification for the aircraft. Entry into service is expected later this year. The midsize business jet introduces an all-new cockpit, improved performance, and a flat-floor cabin designed for greater passenger comfort and operational flexibility. Two flight test aircraft completed more than 1,000 flight hours and numerous certification tests to meet FAA requirements. The Citation Ascend's cockpit is equipped with the Garmin G5000 avionics suite, featuring three large 14-inch ultra-high-resolution displays with split-screen capability and dual flight management systems. Autothrottle technology reduces pilot workload and provides flight-envelope protection, while synthetic vision technology renders terrain and obstacle data for enhanced situational awareness. The flight deck also includes a cockpit voice and data satellite transceiver for in-flight communications, as well as Garmin's advanced weather detection and avoidance systems. Operators can optionally equip a second Iridium data radio and controller-pilot data link communications (CPDLC) capability to enable more direct routing between North America and Europe.

Airbus, Leonardo and Thales sign MOU to form new European space company

Airbus in Toulouse, France; Leonardo in Rome; and Thales in Paris have signed a memorandum of understanding to combine their respective space activities into a new company. The companies say the joint effort aims to strengthen Europe's strategic autonomy in space, supporting critical infrastructure and services related to telecommunications, navigation, earth observation, science, exploration, and national security. The company will combine and develop a portfolio of complementary technologies and end-to-end solutions, from space infrastructure to services, excluding launchers. Officials said the merger aims to accelerate innovation and establish a unified, integrated, and resilient European space organization with the scale to compete globally and expand into export markets. The new company will unite investments in future space products and services, leveraging the expertise of all three partners. This collaboration is expected to deliver mid-triple-digit million euros in annual operating income synergies within five years of closing. Officials stated that the project aims to unlock new revenue opportunities by expanding the portfolio of end-to-end products and services, providing a more competitive and globally integrated platform.

Star Catcher claims new record for wireless optical power transmission at Kennedy Space Center

Star Catcher Industries, Inc. a Jacksonville, Fla.-based space energy company developing an orbital power grid, has set a new record for wireless optical power transmission, surpassing a benchmark established by the U.S. Defense Advanced Research Projects Agency (DARPA). In testing at the National Aeronautics and Space Administration's (NASA) Kennedy Space Center, the company delivered more than 1.1 kilowatts of electrical power to commercial off-the-shelf solar panels using multi-wavelength laser technology. The previous record of 800 Watts was set by DARPA in May 2025. Over the course of the test campaign, Star Catcher transmitted more than 10 megajoules of energy at Space Florida's Launch and Landing Facility. The demonstrations were part of efforts to validate technologies for the company's planned orbital energy network, the Star Catcher Network. The company's space-based optical power beaming system collects and concentrates sunlight in orbit, converts it into optimized wavelengths for spacecraft solar panels, and transmits it wirelessly to satellites. The process enables client spacecraft to generate two to ten times more power without requiring retrofits. During testing, Star Catcher delivered between one and ten Suns of optical energy to multiple commercial solar panel.

▼ A SpaceX Falcon 9 rocket carrying NASA's IMAP (Interstellar Mapping and Acceleration Probe), Carruthers Geocorona Observatory, and the National Oceanic and Atmospheric Administration's (NOAA) Space Weather Follow On-Lagrange 1 (SWFO-L1) missions launches from the agency's Kennedy Space Center in Florida on 25 Sept. 2025. NASA photo

NASA and NOAA launch three missions to study the Sun and protect against space weather

BY **Jamie Whitney**

CAPE CANAVERAL, Fla.–The National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) launched three missions on 24 September to study the Sun's influence across the solar system and improve protection against space weather hazards.

A SpaceX Falcon 9 rocket lifted off from Launch Complex 39A at NASA's Kennedy Space Center carrying NASA's Interstellar Mapping and Acceleration Probe (IMAP), the Carruthers Geocorona Observatory, and NOAA's Space Weather Follow On-Lagrange 1 (SWFO-L1) spacecraft.

Each mission will examine a different aspect of the Sun's activity and its impact on Earth. NASA's IMAP will study the boundary of the heliosphere, the solar wind's protective bubble against cosmic rays, using 10 scientific instruments. These include particle detectors to measure solar wind ions and electrons, as well as imagers to map energetic neutral atoms from the edge of the solar system.

The Carruthers Geocorona Observatory will be the first mission dedicated to imaging the geocorona, the ultraviolet glow from Earth's exosphere. The spacecraft carries two ultraviolet cameras capable of detecting changes in the geocorona during solar storms. Data from Carruthers will provide a new understanding of how Earth's upper atmosphere interacts with solar radiation.

NOAA's SWFO-L1 is designed as the first continuous operational space weather observatory. Its instruments include a magnetometer to monitor solar magnetic fields, particle sensors to measure solar wind and high-energy proton flux, and coronagraphs to track coronal mass ejections. By operating at Lagrange point 1, the spacecraft can provide advance warnings of solar storms before they reach Earth.

IMAP is led by David McComas of Princeton University in New Jersey with 27 partner institutions. The spacecraft was built by Johns Hopkins University Applied Physics Laboratory in Laurel, Md. The Carruthers mission is led by Lara Waldrop of the University of Illinois Urbana-Champaign, with spacecraft development by BAE Systems in Broomfield, Colo. SWFO-L1 is managed by NOAA with support from NASA Goddard Space Flight Center in Greenbelt, Md., and commercial partners. ←