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Contents

JANUARY/FEBRUARY 2024
VOL. 35, NO. 1

Features

16 SPECIAL REPORT
Technology trends in autonomous vehicles
Unmanned vehicles have come a long way since post-World War I, but enabling technologies are reaching into the latest processors and data networking to put true machine autonomy within reach.

24 TECHNOLOGY FOCUS
Rugged computing for the military stands up to heat, shock, and vibration
Today's designers are under pressure to move advanced capabilities like artificial intelligence to the edge, and look forward to big advantages in additive manufacturing in the future.

D1 DIGITAL EXCLUSIVE
Commercial Aerospace
www.militaryaerospace.com/subscribe

Columns

2 TRENDS
4 NEWS
15 IN BRIEF
31 RF & MICROWAVE
34 UNMANNED VEHICLES
37 ELECTRO-OPTICS WATCH
41 PRODUCT APPLICATIONS
45 NEW PRODUCTS

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Military+Aerospace Electronics®, USPS Permit 5901, ISSN 1046-9079 print, ISSN 2688-366X online, is published 6 times a year in January/February, March/April, May/June, July/August, September/October, November/December by Endeavor Business Media, LLC. 201 N Main St 5th Floor, Fort Atkinson, WI 53538. Periodicals postage paid at Fort Atkinson, WI, and additional mailing offices. **POSTMASTER:** Send address changes to Military+Aerospace Electronics, PO Box 3257, Northbrook, IL 60065-3257. SUBSCRIPTIONS: Publisher reserves the right to reject non-qualified subscriptions. **SUBSCRIPTION PRICES:** U.S. $171 per year; Canada $198 per year; All other countries $224 per year. All subscriptions payable in U.S. funds.

TSN Ethernet could become the next time-critical switch fabric for embedded computing

BY **John Keller**
EDITOR IN CHIEF

One of the biggest complaints about Ethernet as a high-speed switch fabric in high-performance embedded computing (HPEC) systems is its lack of determinism. Sure, 10- and 100-gigabit Ethernet links are fast, but it's difficult for systems designers to know exactly how fast they are. The high speed of today's Ethernet typically makes its lack of determinism irrelevant.

Previous generations of fast embedded computing required deterministic high-speed switch fabrics with names like Serial RapidIO, InfiniBand, and StarFabric. Most of those names have passed into history, except for niched applications, in favor of the latest iterations of Ethernet. The Sensor Open Systems Architecture (SOSA), in fact, requires the use of Ethernet to align to the standard and help with future compliance.

So what about those applications that require closely controlled determinism. Some embedded computing vendors, such as Concurrent Technologies Plc in Colchester, England, are offering Time-Sensitive Networking (TSN) Ethernet to meet the needs of hard determinism in high-speed embedded computing applications.

Nigel Forrester, director of strategy at Concurrent Technologies, outlined the company's TSN Ethernet strategy in January at the VITA the Embedded Tech Trends (ETT) 2024 conference in Fort Lauderdale, Fla.

TSN is an extension to the standard Ethernet protocol that enables real-time synchronization and deterministic low-latency communications by adding features for applications that need high availability, robustness, and reliability.

These features include time-aware shapers, schedulers, and guard bands that allow for deterministic and bounded communication latency. TSN also supports redundancy and failover mechanisms to ensure high availability, and includes queuing disciplines and traffic scheduling algorithms that help systems designers rank time-critical traffic on the Ethernet network in order of priority.

"TSN guarantees you can synchronize at less than 1 microsecond," Forrester told ETT attendees. He pointed out that the U.S. Department of Defense (DOD) is beginning to push for TSN Ethernet -- particularly for optionally manned fighting vehicle development.

One major benefit of future implementations of TSN Ethernet will be to ensure the long-term availability of the switch fabric, which some refer to as "future-proofing," Forrester says. "It will be easy to deploy best-in-class capability," he says. In addition, TSN Ethernet has the potential to simplify cabling throughout aerospace and defense electronics designs.

Is TSN Ethernet a viable option for today's aerospace and defense electronics systems, or even those in the near future? Probably not, Forrester cautions. "It's decades away, but we are starting the journey," he says.

To help begin the move to TSN Ethernet, Concurrent Technologies is offering two processing with TSN on the control plane, and a TSN Ethernet switch. "Our customers are asking about it," Forrester says.

New and existing systems designs are unlikely candidates for TSN Ethernet, but those on the horizon may find a need for such an approach. The future Northrop Grumman B-21 Raider strategic stealth bomber, and perhaps even the future Columbia-class ballistic missile submarine are likely to see implementations of TSN Ethernet.

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Researchers seek to boost manufacturing for 3DHI microelectronics

BY **John Keller**

ARLINGTON, Va. – U.S. military researchers are asking industry to develop manufacturing capability for three-dimensional heterogeneously integrated (3DHI) microelectronics in attempts to spur the next major wave of microelectronics innovation.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a solicitation (DARPA-PA-24-03) for the Next-Generation Microelectronics Manufacturing (NGMM) Phase 1 and Phase 2 project.

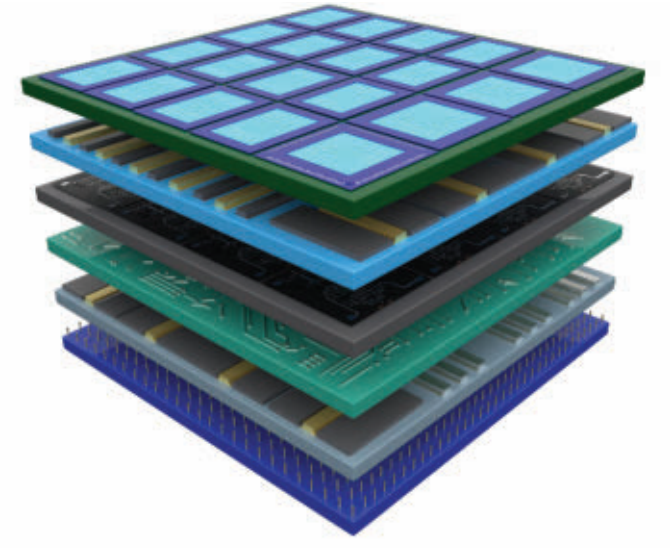
The DARPA Microsystems Technology Office seeks to establish a domestic capability for research, development, and production of 3DHI microelectronics, with the goal of sustaining U.S. leadership and innovation in microelectronics manufacturing.

The next major wave of microelectronics innovation is likely to come from integrating heterogeneous materials, devices, and circuits through advanced packaging to produce a tightly coupled system that extends into the third dimension with performance that exceeds what is available from today's monolithic approach.

The NGMM program will advance the state-of-the-art in 3DHI microelectronics by forming a domestic open-access prototyping and pilot line center accessible to users in academia, government, and industry.

The first and second phases of the NGMM program will take five years. The first phase will focus on establishing baseline fabrication processes, a three-dimensional assembly design kit (3D-ADK), and electronic design automation (EDA) and simulation software tailored to 3DHI.

The second phase will create hardware prototypes, automate processes, and develop emulation and digital twin capabilities. The goal is to create a non-federal self-sustaining 3DHI manufacturing center that is accessible to users in academia, government, and industry to help design high-performance 3DHI microsystems quickly and at reasonable cost.



▲ **The NGMM program will advance the state-of-the-art in 3DHI microelectronics by forming a domestic open-access prototyping and pilot line center.**

Industry leaders today use 3D integration of modestly dissimilar silicon digital technologies for a narrow range of commercial products, from stacked dynamic random-access memory (DRAM) to complementary metal-oxide-semiconductor (CMOS) imagers to high-performance computing.

Today's mature integration techniques, even those often referred to as 3DHI, focus primarily on low-power leading-edge CMOS, legacy CMOS, and silicon-based memory. Still, the opportunity to improve defense systems relies on expanding the types of microelectronics that can be integrated and assembled. Advancing digital integration requires increasing interconnect densities well beyond today's state-of-the-art.

The U.S. today has no open-access center with capacity for sustained 3DHI research *Continued on page 7*

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Axiom Electronics

Intelligence researchers search for similarities in software to pinpoint cyber attacks

BY **John Keller**

WASHINGTON – U.S. intelligence researchers are asking industry to find new ways of analyzing software code to uncover characteristics that will help reveal the identities of cyber attackers.

Officials of the U.S. Intelligence Advanced Research Projects Agency (IARPA) in Washington have issued a broad agency announcement (IARPA-BAA-24-02) for the Securing Our Underlying Resources in Cyber Environments (SoURCE CODE) program. IARPA is the research arm of the U.S. Office of The Director of National Intelligence.

The SoURCE CODE trusted computing program seeks to create scientifically validated forensic similarity and analytic technologies that measure similarity of code and binaries to help analyze hidden information on groups, countries, or individuals, and then provide evidence to help forensic experts find those responsible for cyber attacks.

▲ Intelligence researchers are looking for new forensic methods of analyzing software that could uncover the identities of cyber hackers.

Cyber attacks on companies and infrastructure has grown significantly and will continue to evolve over time, IARPA researchers warn. Worse, there is a shortage of cyber-forensic experts to help attribute these attacks.

Attribution of these malicious cyber attacks can work to disrupt criminal cyber capabilities and improve law enforcement and intelligence community responses to attacks.

The SoURCE CODE program is a 30 month effort in two phases. The first phase seeks to develop new methods and explore the feature space between source code to source code and binary to binary representations of software. The second phase is to extend the capabilities developed in the first phase.

Continued from page 4

and development. With very few exceptions, U.S. companies engaged in 3DHI research rely on offshore facilities.

An open-access domestic center for 3DHI research could promote an expansive wave of innovation, promote shared learning, and ensure that start-ups, academia, and defense companies could engage in 3DHI research for low-volume products. DARPA researchers say they expect to select one contractor for the $420 million first phase, and for the $420 million second phase.

Companies interested were asked to submit full proposals by 5 March 2024 to the DARPA BAA website at https://baa.darpa.mil. Email questions or concerns to DARPAPA-24-03@darpa.mil. More information is online at https://sam.gov/opp/aaf4e3022be14cdf98425a3beae20327/view.

Companies participating are to address three focus areas: feature space generation and extraction; similarity and demographic analytic algorithms; and system explainability.

Feature space generation and extraction may involve neural network approaches, hand-crafted, or a combination of features that predict similarities and information on suspect countries, groups, or individuals.

Similarity and demographic analytic algorithms seeks to develop a system to identify similar binaries to determine similarities to uncover specific authors, groups, or countries. System explainability will help explain why a cyber attack may or may not have come from specific countries, groups, or individuals.

SoURCE CODE has one unclassified technical area and two classified technical areas. Details of the classified technical areas are available to qualified providers.

Companies interested were asked to email unclassified responses by January 2024 to IARPA at DNI-IARPA-BAA-24-02@iarpa.gov. Email questions, concerns, or requests for classified details to Kristopher Reese, the SoURCE CODE program manager, at DNI-IARPA-BAA-24-02@iarpa.gov. More information is online at https://sam.gov/opp/2dfa458e47de4480bd1e2cdfc5eb1de7/view.

Wanted: digital signal processing automation for signals intelligence (SIGINT)

BY **John Keller**

ROME, N.Y. – U.S. Air Force researchers are asking industry to develop cyber security and signals intelligence (SIGINT) real-time digital signal processing for the intelligence community.

Officials of the Air Force Research Laboratory's Information Directorate in Rome, N.Y., have released a broad agency announcement (FA875023S7005) for the Signals Intelligence (SIGINT) Solutions for Evolving Scenarios (SSES) project.

SSES seeks to improve tactical information collection, geolocation, extraction, identification, analysis, simulation, and reporting in support of the intelligence community.

Goals include providing situational awareness for worldwide signals and network intelligence sources; sensor data collection and digital signal processing with a network-centric approach; multi-platform/multi-intelligence support to protect and increase the blue coalition warfighting capabilities; and understanding the adversarial battlespace.

▲ SSES seeks to improve tactical information collection, geolocation, extraction, identification, analysis, simulation, and reporting.

A key objective is to advance state-of-the-art real-time tools to assess and pinpoint the right decision quickly to mitigate threads and ensure battlespace dominance. The SSES project first was announced in 2022, and extends through 2028.

SSES enabling technologies are to support the command, control, communications, computers, and intelligence (C4I) and cyber, science, technology, research and development vision, protect blue coalition forces with command, control, computer and intelligence applications, and support battlespace awareness for the warfighter.

The Air Force is particularly interested in multi-agency systems that rely on open architectures with scalable technologies for quick-reaction capabilities and heretofore undemonstrated technical capabilities based on warfighter needs.

Information extraction for SIGINT focuses on new processing techniques to provide decision-makers with C4I information in as near real-time as possible.

Solutions should be able to operate in low-signal-to-noise ratio environments against targets where the noise types and channel conditions are frequently varying from message to message, with a goal of automating SIGINT collection, processing, and exploitation in tasking and training. SSES has three broad technology areas: information extraction, signal processing, and automation.

Information extraction seeks to identify and catalog signals of interest. Signal processing seeks to remove noise and interference. Automation seeks to automate signal-processing tasks to manipulate the signals of interest for storage and transmission.

Another focus is to develop algorithms to identify, collect, process, and exploit electronic communication signals in a moderate-to-dense co-channel environment with potentially significant Doppler effects.

Goals are to detect, identify, and locate emerging communications and low-power signals of interest; provide systems and waveforms; develop new software and hardware architectures for standoff collection; and characterize cognitive, software-defined radios from aircraft and land vehicles in dense signal environments. Air Force researchers want to capitalize on existing cyber and signal processing technology from academia and industry.

Companies interested should email white papers to the Air Force's Todd Howlett at Todd.Howlett@us.af.mil, who will take white papers until 13 Aug. 2027. Those submitting promising white payers may be asked to submit formal proposals.

Email questions or concerns to the Air Force's Amber Buckley at Amber.Buckley@us.af.mil. More information is online at https://sam.gov/opp/cb2c4019800049f5ab45c3ee-51ae4a72/view.

Researchers eye dialogue to help warfighters trust artificial intelligence (AI)

BY **John Keller**

ARLINGTON, Va. – U.S. military researchers are asking industry to find ways of enhancing the accountability of artificial intelligence (AI) to enable enabling accountable decision-making in complex environments for a variety of military applications.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a presolicitation (DARPA-PA-23-04-02) last week for the Friction for Accountability in Conversational Transactions (FACT) project.

FACT will explore how humans communicate in natural language with AI systems without overtrust that reveals implicit assumptions between dialogue partners, and enables accountable decision-making.

AI today is easy to use with natural language. The problem, however, is this approach can lead warfighters to use AI recommendations uncritically without considering unintended consequences.

The FACT program assumes that AI can be developed with sufficient human/machine discussion to reveal critical biases and assumptions that could lead to bad decisions in strategic planning, intelligence analysis, and reconnaissance.

Dialogue is central for human teams to solve complex problems where at each stage they understand each other's intentions, assumptions, and accountability. This also can enable warfighters can uncover flawed reasoning and change assumptions when all information necessary is not available in advance.

Currently, there are no systems that use dialogue to promote trust and accountability to ensure that solutions meet considerations not always enumerated at the start.

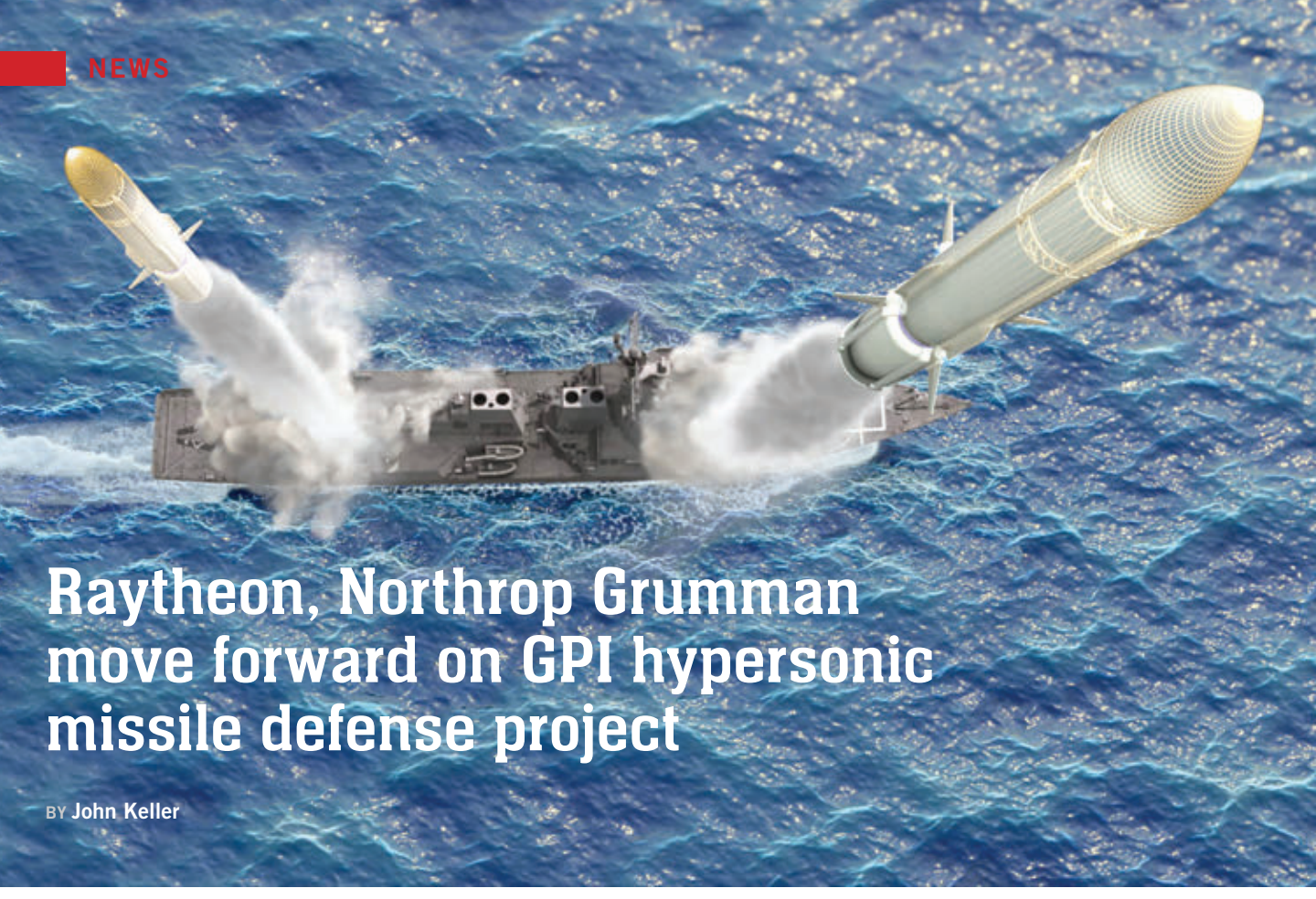
Instead, the FACT effort seeks to explore, develop, and evaluate human-AI conversation-shaping algorithms that capture mutual assumptions, views, and intentions based on dialogue history; auto-assess the consequences of potential actions and reveal costs and assumptions for critical analysis.

▲ The FACT project will explore how humans communicate in natural language with AI systems without overtrust.

FACT seeks to develop a proof-of-concept in applications like robotics, intelligence, surveillance, and reconnaissance (ISR), and mission planning.

FACT will be an 18-month effort divided into two phases: a focus on algorithm development and feasibility studies; and a detailed evaluation of proofs-of-concept in a military application.

Companies interested were asked to upload responses by December to the DARPA BAA portal online at https://baa.darpa.mil. Email questions or concerns to Matthew Marge, the DARPA FACT program manager, at FACT@darpa.mil. More information is online at https://sam.gov/opp/c0113c4db961438c9e2fbcb7860d509c/view.



Raytheon, Northrop Grumman move forward on GPI hypersonic missile defense project

BY John Keller

▲ GPI is for regional hypersonic missile defense by launching modified missiles from U.S. Navy surface warships against incoming hypersonic missiles.

DAHLGREN, Va. – Two U.S. military prime contractors are moving forward on in a major project to defend military assets from hypersonic missiles with weapons designed to attack these incoming missiles in their most vulnerable phase of flight.

Officials of the U.S. Missile Defense Agency (MDA) in Dahlgren, Va., has announced two multimillion-dollar orders or the Glide Phase Intercept (GPI) program.

Missile-defense experts from Northrop Grumman Corp. and Raytheon Technologies Corp. (RTX) will continue to develop and refine their GPI concept during the

technology development phase. The two companies have been working on defining GPI concepts since late 2021.

GPI is to provide regional hypersonic missile defense by launching specially modified missiles from U.S. Navy surface warships that engage and destroy incoming hypersonic missiles as they glide through the boundary between space and Earth's atmosphere. Hypersonic missiles can reach speeds faster than Mach 5, which is nearly 4,000 miles per hour.

These orders went to the Northrop Grumman Propulsion Systems segment in Chandler, Ariz., for $52.5 million; and to the RTX Raytheon segment in Tucson, Ariz., for $52.5 million. The companies will continue to develop and refine their GPI concept during technology development.

The GPI interceptor will fire from the vertical launch systems aboard Navy Arleigh Burke-class destroyers to intercept incoming hypersonic missiles in their glide phase of flight. GPI will bridge the gap between the Navy SM-3 and SM-6 missiles, which attack enemy missiles at various phases of their flights.

The GPI prototypes will be designed will fit into the current Aegis ballistic missile defense system" which fires from a naval vessel's vertical launching system. The GPI will involve new interceptors and modifications to the Aegis weapon system necessary to launch them.

On these orders, Northrop Grumman will do the work in Chandler, Ariz.; Colorado Springs and Boulder, Colo.; Huntsville, Ala.; San Diego; and Linthicum, Md. Raytheon will do its work in Tucson, Ariz.; El Dorado Hills, Calif.; Aurora, Colo.; Tewksbury, Woburn, and Andover, Mass.; McKinney, Texas; and Huntsville, Ala. Both companies should be finished by February 2025.

For more information contact Northrop Grumman Propulsion Systems online at www.northropgrumman.com/space/propulsion-systems, RTX Raytheon at www.rtx.com/raytheon, or the Missile Defense Agency at www.mda.mil.

Peraton Labs moves forward on self-healing networks for mosaic warfare

BY **John Keller**

ARLINGTON, Va. – U.S. military researchers are moving forward with a project to develop fast self-healing web-like networking that connect sensors and weapons on land, on and under the sea, in the air, in space, and in cyberspace, with a $9.5 million order to Peraton Labs Inc. in Basking Ridge, N.J.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., are asking Peraton to continue the company's work on the Mission-Integrated Network Control (MINC) project.

MINC seeks to build and demonstrate software that creates a secure network overlay with control mechanisms that enable distributed management of agile, self-healing networks of networks to support multi-domain kill webs in contested dynamic environments.

Peraton won its original $19.3 million MINC contract on 2 Jan. 2022. The BAE Systems Electronic Systems segment in Nashua, N.H., and CACI International Inc. in Arlington, Va., also have been involved in the DARPA MINC project.

The program is a vital part of mosaic warfare, which seeks to assemble individual warfighting platforms like the ceramic tiles in mosaics to make a larger intelligence picture and a larger force package. The idea will be to send so many weapons and sensors at the enemy that its forces are overwhelmed.

The MINC program seeks to ensure that critical data finds a path to the right user at the right time in contested environments using secure control of any available communications or networking resources, DARPA officials say.

This capability of connecting sensors to shooters replaces the manual static configuration of separate tactical networks and limited internetworking capabilities.

MINC will culminate in this paradigm shift from static manual configuration of closed rigid architectures by moving towards autonomous approaches where applications and networks adapt to changing military conditions.

The MINC program will address three key challenges tactical networks face today as they operate in extreme networking environments: the lack of network interoperability across heterogeneous communications systems at scale; insufficient network capacity to support missions; and the inability to reconfigure networks autonomously to align with military missions.

MINC contractors are developing on-demand connectivity between sensor-to-shooter networks by focusing on three key capabilities: developing an always-on network overlay to access available networking and communications resources and control parameters; using a cross-network approach for managing network configuration; and creating ways to determine the best information flows for kill web services.

▲ MINC to build secure network overlay software to manage agile, self-healing networks of networks to support kill webs in contested environments.

MINC seeks to capitalize on networking advances in software-defined networking; network function virtualization for decoupling network functions from hardware; information-centric networking to discover and retrieve data securely; and intent-driven networking for autonomous mapping of user objectives to network management policies.

On this order Peraton Labs will do the work in Arlington, Va.; Basking Ridge, N.J.; Colorado Springs, Colo.; Cambridge and Woburn, Mass.; Memphis, Tenn.; Miami; and Sherman Oaks, Calif., and should be finished by February 2025.

For more information contact Peraton Labs online at www.peratonlabs.com, or DARPA at www.darpa.mil/program/mission-integrated-network-control.

Wanted: missile-defense satellites with infrared sensors to track hypersonic missiles

U.S. missile-defense experts are reaching out to industry for a company to design and build four to eight satellites with on-board infrared sensors to detect and track enemy conventional and hypersonic missiles anywhere in the world. Officials of the U.S. Space Development Agency (SDA) in Washington have issued a solicitation (SDA-PS-24-01) for the secret Proliferated Warfighter Space Architecture's (PWSA) Fire-control On Orbit-support-to-the-war Fighter (F2) program. SDA officials want one or two companies to build and launch four F2 space vehicles, with an option for eight more. SDA plans to purchase and deploy eight F2 space vehicles with electro-optical and infrared sensors. The F2 system will provide fire-control for global detection, warning, and precision tracking of advanced enemy missiles — including hypersonic missiles. F2 missile-defense system will demonstrate missile-defense capability by incorporating fire control-quality sensors into a scalable prototype spacecraft constellation. SDA also may acquire additional satellites and sensor payloads. The prototype F2 constellation will be launched no later than fall 2026 on a government- provided launch. Additional information contained in classified attachments and documents are available for qualified companies by emailing the SDA's Amelia Brown at amelia.l.brown8.ctr@mail.mil. Put SDA F2 Solicitation Content Request in the subject line. Companies interested were asked to submit proposals by January 2024. More information is online at https://sam.gov/opp/9a53f545d8cb42ae8eda70cf29e8ef7f/view.

Munich Airport's introduction to robotic cargo handling

Autonomous vehicles can play a significant role in streamlining and enhancing various airport operations, such as ground handling, in the near- and long-term future, according to officials at the Fraunhofer Institute for Material Flow and Logistics IML. To demonstrate how autonomous mobile robots (AMRs) can contribute to efficiency, safety and flexibility in handling a wide range of tasks in the aviation industry, Fraunhofer representatives are working with leaders at Munich Airport (MUC) in Germany to serve various functions with its evoBOT. The evoBOT is capable of adaptive load pickup made possible by its arms. It can handle hazardous goods, transport parcels for longer recurring distances, relieve employees during lifting and overhead work, procure materials and provide support during the loading and unloading of aircraft. Next year's full tests of the evoBOT in April and May are planned with the support of the Digital Testbed Air Cargo (DTAC). The DTAC is focused on digital applications and solutions for the air cargo solution. The project's goal is to make the air freight industry more efficient through digitally based solutions.

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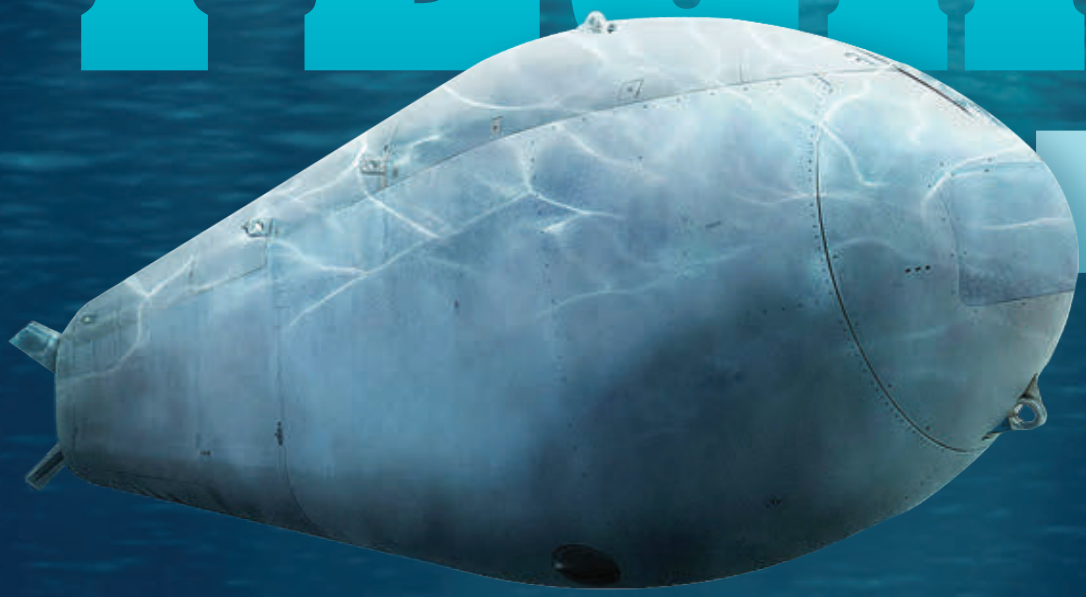

Unmanned vehicles have come a long way since post-World War I, but enabling technologies are reaching into the latest processors and data networking to put true machine autonomy within reach.

BY **Jamie Whitney**

Uncrewed vehicles for military and civilian use are garnering a lot of attention thanks to new technologies and abilities they afford to warfighters, command, commercial interests, and end-users, but their use and development have been going on for more than a century.

While armies and navies have worked to keep their warfighters out of harm's reach while inflicting damage on their enemies, the birth of systems we'd think of as uncrewed — also known as unmanned — goes back to the latter days of World War I.

The British military employed radio frequency (RF) technology to control the Hewitt-Sperry Automatic Airplane. The Brits demonstrated the Hewitt-Sperry, which was a biplane equipped with explosives, for their American allies, who

IOLOGY RENDS
in autonomous vehicles

developed their own radio-controlled (RC) aircraft. Neither country employed their RC flying bombs before Armistice Day in 1918, but the foundation for uncrewed aircraft, ground, and sea vehicles had been laid.

In the intervening century, all manner of developments were made across the air, land, and sea spectrum in the nascent uncrewed platforms — including remotely-piloted aircraft for nuclear testing and for reconnaissance purposes — but their use arguably hit public consciousness the most when the United States utilized uncrewed aerial vehicles (UAVs) in the early days of its War on Terror following the attacks of 11 Sept. 2001 to deliver missile strikes on targets.

On their own

Uncrewed vehicle capabilities have grown to where humans piloting them are being taken out of the equation and the

▲ **Boeing delivers the first Orca Extra Large Uncrewed Undersea Vehicle to the U.S. Navy in December 2023.**

machines are able to act autonomously. Whether performing underwater reconnaissance, transporting passengers through the air, or warfighters to the front, the possibilities for autonomous vehicles are near endless.

Vehicle autonomy is made possible through artificial intelligence (AI) technology. The air, land, and sea vehicles need to operate not only with human safety in mind, but also with self-preservation in mind. The technology can sufficiently go from Point A to Point B, but what happens if there's an unexpected object in the way? Why go through the trouble of taking the decisions out of the hands of humans to begin with?

Human brains are remarkably adept at solving problems. After all, humans are among of the few animals that worked out how to develop and use tools — the only to meaningful to alter nature beyond picking up and using what is nearby like rocks or sticks. Why take all that brainpower away from people to make sure a UAV doesn't run into a tree, or to enable an unmanned ground vehicle to avoid a boulder?

For the military, uncrewed vehicles, some called "drones," are a good way to reduce risk and expense. Putting pilots in the air is inherently risky, as is the crushing depth of the ocean.

Drones also avoid the biological realities of human operators and can operate for extended periods without the need for rest, food, or other human necessities. This enables longer mission durations and increased range compared to manned vehicles.

Drones equipped with surveillance capabilities can provide persistent and real-time monitoring of areas of interest. This is valuable for intelligence gathering and situational awareness. Without a crew to deploy, uncrewed vehicles can also be rapidly sent out to aid missions.

Uncrewed vehicles may result in cost savings in terms of training, personnel, and infrastructure. They eliminate the need for crew facilities, life support systems, and other components necessary for human presence. This staff reduction also can be seen in commercial aviation as the industry grapples with a pilot shortage of more than 17,000 in the previous year.

Of course, all of the promised benefits of autonomous vehicles will be for naught if they can't operate safely in all manner of conditions and to be trusted to do so with expensive materiel, and most of all, human lives.

Electronic eyes

The U.S. Federal Aviation Administration (FAA) in Washington requires that all aircraft flying within the U.S. National Airspace System (NAS) must "remain well clear" of other aircraft. With a pilot in the cockpit, they use their vision and technology to ensure safe operation. With autonomous drones, sensors and associated technology must act as the eyes and decision-making center to keep the vehicle moving safely. This is done with detect-and-avoid (DAA) systems, which the FAA mandates have an "equivalent level of safety, comparable to see-and-avoid requirements for manned aircraft."

Andrew Baker, principal systems engineer at Honeywell Aerospace Technologies in Phoenix notes that most DAA

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Savvy Verma, left, and Huy Tran, director of aeronautics at NASA's Ames Research Center in Calif.'s Silicon Valley, center, explain a recent air traffic management simulation to guests at Ames' FutureFlight Central simulator

systems use passive visual [camera], microwave [radar], light wave [lidar] and ultrasonic technologies to keep the vehicle out of harm's way.

Radar DAA sensors detect the presence and location of other aircraft, obstacles, or terrain. Radar can provide information about the distance, speed, and direction of potential threats.

Light detection and ranging (lidar) sensors use laser beams to measure distances and create detailed three-dimensional maps of the surroundings. Lidar is effective for accurate obstacle detection and mapping the environment.

Optical cameras capture visual information about the surroundings, helping the DAA system recognize objects and make decisions based on visual data. Computer vision algorithms are often employed to analyze camera feeds.

Sensor data is then analyzed by sophisticated algorithms to determine the potential threats or obstacles in the vehicle's path. These algorithms take into account factors such as distance, speed, heading, and trajectory of other objects.

Decision-making algorithms assess the level of risk of detected obstacles and generate avoidance strategies. These strategies may include altering the vehicle's course, adjusting altitude in the case of aircraft, or slowing down.

"Passive visual [sensors] have excellent range and resolution, however at the expense of lighting conditions," Honeywell's Baker says. "In nighttime or bad weather, optical is not going to work well. Radar and lidar work excellent in the dark, but you lose resolution that a camera would provide. Ultrasonic works well in the dark but has very limited range. It is best for proximity detection. There is no one sensor that does all. The environment and uses cases will determine what sensor is best. Ultimately using a passive visual with radar will provide the best of all worlds."

DAA systems often incorporate communications capabilities to exchange information with other nearby vehicles or air traffic control. This communication helps coordinate movements and avoid conflicts in shared airspace.

"ADS-B [Automatic Dependent Surveillance-Broadcast] is another piece of data which is highly used," Baker says. "While UAVs cannot yet broadcast on ADS-B, we can receive and use this information along with the sensor to achieve greater accuracy. In general, DAA sensors are used for non-cooperative traffic, which are entities that are not transmitting their locations."

Working it out

While lidar, radar, and vision technology that make up the DAA systems are mature enough for some uncrewed vehicles to operate now, the tricky question is how to integrate UAVs safely into the NAS.

"The FAA, NASA, and other partner agencies, including industry are currently defining those data exchange

Honeywell's first autonomous eVTOL aircraft was out for flight testing in January 2024.

Guangzhou, China's EHang announced it had become the first company to fly passengers on its autonomous eVTOL with a standard airworthiness certificate in early January.

requirements," says Honeywell's Baker. "UTM [unmanned traffic management] is the ecosystem for uncontrolled operations that will complement the FAA's air traffic management (ATM) system. Existing RF ground control station technology can be used, but secure LTE communications are being evaluated. A common concern is security and encryption of these networks for unmanned systems."

In preparation for air taxis and other aircraft flying passengers in and out of airports, the National Aeronautics and Space Administration (NASA) and industry partners are working with the FAA to demonstrate how creative use of existing tools and airspace procedures can support safe integration of air taxi operations into the national airspace. Robust DAA systems are crucial in scaling up the nascent UAM industry.

"Most sensors not only make detections but generate track information of objects that are moving," Baker says. "It is through the track information that determines whether an object is stationary or moving. Cameras, Lidars, and radar all have this capability built into their software. Due to the resolution of cameras, they can go one step further and classify what that object is. The Honeywell radar can track up to 30 objects at once."

An air traffic management integration simulation developed by NASA's Ames Research Center and Joby Aviation in Santa Cruz, Calif., will provide useful air traffic controller data to the FAA and industry for integrating these aircraft into operations.

Conducted at NASA's Future Flight Central, a high-fidelity virtual tower facility providing a real-time simulation of an airport with a 360-degree view, the activity involved a team of NASA and Joby engineers, pilots, and air traffic controllers. The simulation focused on traffic patterns at Dallas Love Field (DAL) and Dallas-Fort Worth (DFW) representing an intricate and bustling airspace conditions.

In the simulation, teams of controllers virtually tested the feasibility of integrating as many as 120 electric vertical take-off and landing (eVTOL) aircraft operations — either arrivals or departures — per hour from DFW's Central Terminal area, alongside existing airport traffic. At the peak of the activity, up to 45 simulated eVTOL aircraft were concurrently airborne in DFW's Class B airspace.

"Working alongside our NASA colleagues, we have now demonstrated in a real-world simulation how air taxi operations can take place in today's airspace system, alongside active airport traffic, using tools and procedures currently available to air traffic controllers," says Tom Prevot, air taxi product lead at Joby. "These successful simulations were made possible by years of careful planning and collaboration between two organizations committed to redefining what is possible, and we're proud to be paving the way towards the scaled commercialization of air taxis in the National Airspace System."

NASA's initial assessment of the simulation suggests that the procedures developed for operating eVTOL vehicles could be scaled for implementation in airports across the country. This scaling has the potential to alleviate the workload on air traffic controllers. NASA intends to release a comprehensive analysis of the simulation results in 2024. The newly generated data will be shared with the FAA, the commercial industry, and airports to assist in identifying tools and procedures for air traffic controllers. These tools and procedures aim to facilitate the integration of eVTOLs into current and future airport operations at a high tempo. The envisioned future use of eVTOLs as a taxi service for passenger transportation to and from airports holds the promise of reducing carbon emissions and significantly enhancing the overall commuting experience for passengers.

"This simulation validates the idea that we can find a way

to safely integrate these vehicles into the airspace at scale," says NASA researcher Ken Freeman.

While American government agencies and eVTOL industry experts work to integrate next-generation technology into an existing structure, UAM is taking off elsewhere. Early this year, Chinese eVTOL aircraft company EHang announced that it was the in the first urban air mobility (UAM) to carry paying passengers. Its aircraft, the EH216-S, carried passengers on a pre-planned route that was surveyed by the company. In the event of an experienced anomaly, the aircraft's DAA system will reroute to another pre-approved landing site.

While advancements in this field have primarily concentrated on future civil and commercial airspace navigation, military applications are crucial for ensuring the secure passage of military UAS through the NAS and over international waters, minimizing the risk of collision with other aircraft.

On the ground

Like autonomous aircraft, self-driving ground vehicles use a suite of sensors to analyze information at a breakneck speed to sense, think, and react. The Society of Automotive Engineers (SAE) defines six levels of sophistication for autonomous vehicles, from zero to five.

For consumers, level two autonomy could be active cruise control where the vehicle slows itself and speeds back up automatically. SAE categorizes a level five vehicle as having no human input. To achieve this, many more sensors will be required. Simply put, the more autonomous a vehicle, the more data it needs to collect, sort, and prioritize.

Siemens in Munich notes that level two vehicles require approximately 17 sensors, while a level five vehicle will have around 50, including ultrasonic, surround camera, long- and short-range radar sensors, long range and stereo cameras, LiDAR, and dead reckoning sensors.

Stephan Heinrich from commercial car manufacturer Lucid Motors in Newark, Calif., estimates a low-level vehicle's system's sensors will produce 3 gigabits of data per second or 1.4 terabytes per hour. Siemens extrapolates that at high levels of autonomy, sensors will deliver approximately 40 gigabits per second, or 19 terabytes per hour.

Whether in commercial or military vehicles, DAA systems for autonomous vehicles (AVs) will need to employ edge computing with a massive amount of processing power as offloading computing to operate safely.

"While AVs are the main subject of discussion regarding the evolution of how we get from point A to point B, other technologies may prove even more vital. Vehicular communications technologies, known broadly as vehicle-to-everything (V2X) communication, will form the foundation of future mobility systems," writes Piyush Karkare, director of global automotive industry solutions at Siemens Digital Industries Software for his company in a piece titled The Data Deluge: What do we do with the data generated by AVs? "V2X technologies, such as vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I), enable real-time communication between vehicles, and between vehicles and their surroundings to provide a safe, convenient, connected, and affordable mobility experience. Critically, these real-time communications allow vehicles to interact with each other and with the environment directly, in a way that humans cannot replicate. Such interaction can improve road safety, avoid traffic congestion, and reduce fuel consumption to enhance the overall mobility experience."

Karkare continues, "Here is a use case: an autonomous vehicle recognizes a fallen tree in the road and applies the

▼ Kodiak Robotics, Inc. unveiled its first autonomous test vehicle designed specifically for the U.S. Department of Defense in December 2023.

brakes to avoid a collision. The vehicle can simultaneously warn vehicles behind it to decelerate, ensuring all vehicles safely come to a stop. The leading vehicle can even inform the local network of vehicles about the tree, allowing them to avoid that specific road until it can be cleared. To make this vision a reality, automotive manufacturers and suppliers are working together to develop vehicular communications based on cellular networks. The technology can use today's mobile network and future 5G networks, enabling transmission times in the millisecond range."

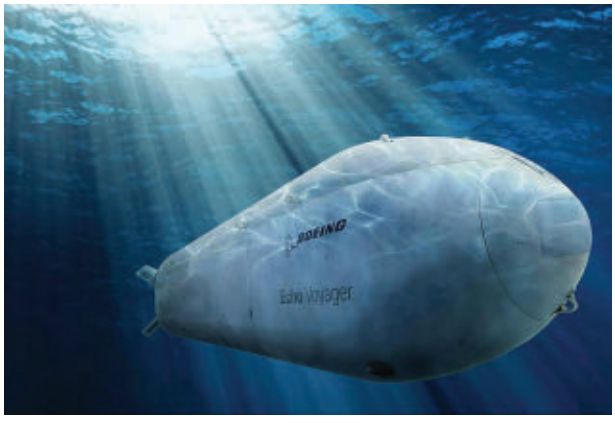
The U.S. Department of Defense (DOD) tapped Kodiak Robotics Inc. in Mountain View, Calif., to build an test vehicle equipped with the company's autonomous system dubbed the Kodiak Driver. Built into a Ford F-150 half-ton pickup truck, the Kodiak Driver-equipped vehicle is designed to handle complex military environments, diverse operational conditions, and areas with degraded GPS, as well as off-road variables like rocks, dust, mud, and water. The Kodiak Driver also provides the Army the ability to remotely operate vehicles when necessary.

The Kodiak Driver is a vehicle-agnostic autonomous system and runs the same software as Kodiak's autonomous long-haul trucks, and features Kodiak DefensePods, an adapted version of Kodiak's modular, swappable SensorPods, designed for defense applications. A technician can swap out a DefensePod in the field, which the company says can be done in 10 minutes or less, with no specialized training required.

"Kodiak's new autonomous vehicle shows the maturity and portability of our autonomous system, which we call the Kodiak Driver," says Don Burnette, Founder and CEO, Kodiak. "We have built a comprehensive autonomous system that can be integrated into any vehicle, from a Class 8 truck, to a pickup, to a next-generation defense vehicle. Integrating Kodiak's technology into an off-road capable vehicle shows the potential for commercial and dual-use technology to revolutionize national security, just as the Department of Defense is looking to ramp up its focus on autonomous technology. We are proud to support the military and look forward to the day that Kodiak Driver-powered vehicles can provide the U.S. military with more mission options and technical superiority, all while keeping our servicemen and women out of harm's way."

Down deep

Autonomous underwater vehicles (AUVs) are similar to their airborne and land technology cousins in needing lots of data to operate, but due to their operating environment, differences abound.



▲ The Navy's XLUUV payload-delivery system aboard the Boeing Orca will include persistent-surveillance sensors, and the ability to deploy weapons, other UUVs, and unmanned aerial vehicles (UAVs).

Like surface and air drones, AUVs are designed for various military applications, including reconnaissance, surveillance, mine countermeasures, and environmental monitoring, while the vehicles see heavy use in natural resource extraction to map the sea floor.

Unique to AUVs compared to their above-surface cousins are sensors seen on other maritime equipment, including surface and submarines like inertial measurement units, Doppler velocity logs, depth sensors, and magnetometers.

In December, the U.S. Navy accepted delivery of its first Extra Large Unmanned Undersea Vehicle (XLUUV) test asset system from the Boeing Company in Arlington, Virginia. The autonomy-capable craft, dubbed "Orca," is a new class of autonomous submarine that can perform long duration critical missions in changing environments and contested waters. The Orca XLUUV is a cutting-edge, autonomous, unmanned diesel-electric submarine with a modular payload section to execute a variety of missions critical to enhancing the Navy's undersea prowess. Configured to accommodate various payloads, the Orca XLUUV allows for the seamless integration of sensors, communication systems, and other mission-specific components.

"This has been a very busy year for the XLUUV team and their hard work is culminating in delivery of the Navy's first-ever unmanned diesel-electric submarine," says Capt. Scot Searles, program manager of the Unmanned Maritime Systems (PMS 406) program office. "We look forward to continued success with our Boeing teammates in fielding this important capability for the warfighter."

Rugged computing for the military stands up to heat, shock, and vibration

Today's designers are under pressure to move advanced capabilities like artificial intelligence to the edge, and look forward to big advantages in additive manufacturing in the future.

BY **John Keller**

Rugged computers for the warfighter are hitting the market today with broad new capabilities in artificial intelligence (AI), innovative ruggedization and thermal management, distributed architectures for tight packaging for deployment at the edge, and a pursuit of new and emerging open-systems industry standards in efforts to "future-proof" the latest designs.

The innovations don't stop there. Not only are enabling technologies for AI like fast general-purpose graphics processing units (GPGPUs), field-programmable gate arrays (FPGAs), and multi-core central processing units (CPUs) taking the market by storm, but systems designers also are investigating future uses of additive manufacturing and 3D printing to tackle tomorrow's thermal-management and packaging issues.

▲ **The Crystal Group rugged RS2608 has the latest server-class CPUs from Intel (Emerald Rapids) and AMD (Epyc) with enhanced CPU cores and gen 5 PCIe lanes.**

Artificial intelligence

"As the increased number of sensors and increase data, we are seeing requirement for a lot more centralized processing and capability to process that data," says Jason Wade, president of ZMicro Inc., in San Diego. "Customers are looking to leverage AI. From a hardware side, SWaP [size, weight, and power consumption] always will be important, but is no longer the sole focus and driver."

While AI may be overtaking SWaP as the central issue in aerospace and defense rugged computing, the reasons revolve around an ever-increasing number of sensors and sensor processing, and a driving need to support military decision-making in real time.

"AI is a common trend, and we see that constantly," Wade continues. "Collection of data is critical, and the ability for high-end GPGPUs to process data is important. ZMicro has seen evolution of GPGPU as an integral component — sometimes even more important even than the CPU."

Among the most influential purveyors of enabling technologies for AI are Nvidia Corp. in Santa Clara, Calif., for GPGPUs; Intel Corp. of Santa Clara, Calif., for multicore CPUs; and Advanced Micro Devices (AMD) Inc. in Santa Clara, Calif., and Xilinx Inc. of San Jose, Calif., for FPGAs.

The military's demand for sensors and sensor-processing technologies is driving interest in companies that offer AI-related products. "All these sensors connected, and more sensor data transported from sensors to computers, are seeing speeds go from 1 gigabit per second to 10 gigabits per second," says Jim Shaw, chief technical fellow at Crystal Group Inc. in Hiawatha, Iowa "This is a trend that is exploding with sensor connectivity, and situational awareness, and the need to process a tremendous amount of data. The military loves real-time situational awareness."

▲ **Crystal Group developed the Tamper and Zeroization Response (TAZR) device that monitors bus signals, tamper sensors, and remote commands to eliminate the threat of compromised data.**

That's good news for companies like Nvidia and Intel. "It's interesting to watch the Nvidia and Intel market space in GPGPUs and accelerators," Shaw says. "Intel is doing a pretty good job of coming up with an alternative to Nvidia, and we will see more of those products coming up. Nvidia has done a good job of carving out that market space, particularly with the Cuda coding. That drives a tremendous amount of volume in GPUs."

There's no end in sight for the military's appetite for AI. "We are seeing more and more the tremendous focus on AI and autonomy across the board, which is driven by the new capabilities we are seeing, such as the Nvidia GPGPUs, says Aneesh Kothari, president of rugged computer specialist Systel in Sugar Land, Texas. "This density and compute technology available on the market can be deployed in a harsh environment outside the data center."

AI is considered one of the chief enablers of the military's vision for real-time situational awareness. "We are swimming in sensors and drowning in data, so using AI to do the analysis piece is really helpful, and if it can be done in real time you can take action faster," points out Jason Dechiaro, systems architect at the Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va.

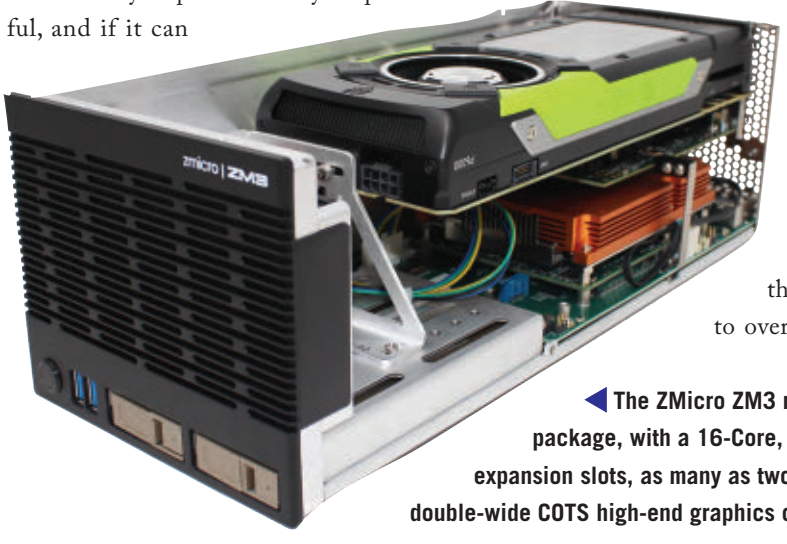
"The military wants to transmit the results of the analysis rather than the raw data itself," Dechiaro says. "For this AI piece, Nvidia is in that game. At Curtiss-Wright we take advantage of Nvidia GPGPUs for AI processing."

Cooling and thermal management

AI and the powerful processing that enable it does have consequences, however. Powerful processors generate substantial waste heat, which systems designers must find ways to remove without compromising performance.

"We are seeing a lot of the Intel and AMD products power budgets are just exploding," says Crystal Group's Shaw. "It is becoming more and difficult to put two large-core-count processors in a rugged server rack because of power dissipation. The challenge continues to be the output from these GPUs in waste heat. It is the age-old argument — always trying to dissipate more power. Things are getting smaller, and we plan for more capability into a smaller package."

Those designing rugged computers with simple convection cooling must make tough decisions on what they can and cannot install in a small space. "It's not really feasible to put two large CPUs into a single-server application; is just too much power draw, and thermal limitations are extraordinarily difficult to overcome in an air-cooled environment," Shaw



◀ **The ZMicro ZM3 mission computer comes in a small, rugged package, with a 16-Core, Intel Xeon D processor, three PCI Express expansion slots, as many as two removable NVMe storage drives, and double-wide COTS high-end graphics cards.**

This remote storage box from ZMicro supports distributed computing by connecting a host computer with the remote storage system through fiber-optics.

says. "In a 1U server application, you struggle to see one CPU in that space because of the thermal load.

Other cooling approaches, such as liquid cooling, can offer efficient solutions, but the drawback often is higher costs, system complexity, potential compromised reliability, and increased size and weight to accommodate the pumps and plumbing necessary for liquid cooling.

Still, there are instances where liquid cooling or something equally exotic might be among the only solutions. "We are seeing liquid cooling as one technology that is gaining traction," Crystal Group's Shaw says. "We find that it is much more likely that liquid-cooled application will be successful if the integrator plans for that; it is not something you add later. Dealing with liquid cooling and where that heat is going has to be at the system level or you will not be very successful."

Planning for cooling has to be at the top of the list for designers of rugged aerospace and defense rugged computing. Our business, ruggedized computing, is really about cooling," says James Tierney, vice president of aerospace and defense at Atrenne Computing Solutions, A Celestica company in Brockton, Mass. "We do classic conduction-cooled computing; that's where the technology is today."

Choosing the right enabling technologies for each separate operating environment is key, Tierney says. Our role in this industry is to bring reality to the requirements," Tierney continues. "We bring reality into what you can do; you can't ask the enclosure manufacturer to put the card where it can't operate."

Atrenne engineers also are trying to design off-the-shelf high-performance rugged computers suitable for a range of military applications. "Our customers are trying to leverage their hardware in a number of platforms," Tierney points out. "They are looking for an environment they would like to meet to fit in multiple platforms. It used to be very specific requirements, but they are trying to future-proof technology. Customers are pushing beyond, to accommodate multiple platforms. It comes down to cooling, and meeting those standards for a much broader set of applications."

Designing rugged computing today "has become this thermal dynamics physics problem," says Systel's Kothari. "Each application has its own technology, and we make sure we take the time for rigorous testing to make sure it will work in those extreme environments. I have this much space, this much heat, and must dissipate that heat with the air flow I have. We go through the rigor and going through the testing and the analysis. We need to get the heat out of the box at the end of the day. More and more performance is more and more Wattage, but in the field it needs to be smaller and smaller."

In rugged computing, "the hardest problem to solve is thermal management," says Curtiss-Wright's Dechiaro.

"As processors get faster they tend to generate more heat. What's available on the platform drives what we can do. Liquid flow-through on the chassis can cool everything on the platform — if it's available."

Liquid cooling "takes a tremendous amount of work to get that on a platform," points out Dominic Perez, chief technology officer at Curtiss Wright. Using liquid, thermally efficient though it may be, is available only in selected environments.

▲ **The Systel Kite-Strike II is a small rugged embedded computer for edge-deployed processing, and uses the Nvidia Jetson AGX Orin system on module processor.**

"Generally the platform has an approach," says David Jedynak, vice president of strategic planning at Curtiss-Wright. "A pod has an inlet and outlet, which is essentially forced air, and maybe some fans to help channel the air. Other platforms may run liquid, like a fuel, through everything, when that is available. It is very much on the platform design."

Ruggedized designs

One of the central challenges of ruggedized military computer systems is capitalizing on commercially available technology and using specialized manufacturing to create systems able to withstand the environmental rigors of military applications — shock, vibration, temperature extremes, and exposure to dust and other contaminants.

"Ruggedization is what we do; it's our business," says ZMicro's Wade. "there are a couple different approaches we are taking. One is we transitioned away from the process of conformal coating to nanocoating technologies. Instead of using traditional conformal coating of sensitive components, we use nanocoating."

For this technique, ZMicro relies on nanocoating technology from Nanoflow X LLC in Carrollton, Texas. Nanocoating uses coating for electronic components with a thickness of a few tens to a few hundreds of nanometers to improve boost protection from corrosion, water, ice, friction, and bacteria. Nanocoating is self-cleaning, and resists the effects of heat and radiation.

"You dip your electronics in, and it prevents intrusion of liquids and dust into the system, but does not inhibit the flow of electrons," Wade says. "It has taken the labor-intensive and relatively expensive process of conformal coating, and replaced it with a more seamless process of dipping electronics and providing the same level of ruggedization for mil-spec environments. Nanocoating streamlines the whole process."

Rugged computer design at ZMicro also involves distributed computing — or placing different parts of a computer system in different parts of a military platform and connecting them by optical fiber. "We are seeing a push to more distributed computing, with servers in the back end, and distributed thin client to interface back to the enterprise-class server," Wade says.

▲ **ZMicro offers a distributed computing approach to enable use of thin-clients for edge computing applications, with a 3.2-pound computer that sends data back to a central server.**

Adapting commercial off-the-shelf (COTS) computer technology to the rugged military environment can be a difficult challenge, says Systel's Kothari. "Customers want that COTS technology, but when you actually have to deploy that with limited power draw and cooling, we find these interesting problem sets."

Systel and other rugged computer designers face harsher and harsher shock and vibration requirements to survive and operate through military operations at the edge of the battlefield. "We use MIL-STD-901, and we are tested to that," Kothari says. "We have been around for a long time, and we have experience, with products deployed across all domains. We understand very deeply shock and vibration."

Many, if not most, of computer ruggedization challenges are customer-driven, says Atrenne's Tierney. We follow what the board and processors guys are doing, and we put them into a rugged environment in the chassis; the customer will put on us their own challenges."

Customer requirements often can confront rugged computer designers with their toughest challenges, echoes Chris Ciufo, chief technology officer at General Micro Systems in Rancho Cucamonga, Calif.

"We are seeing an increase in the willingness to use 'barely rugged' new technical products as a way of getting much-needed technology onto the battlefield," Ciufo says, "but this equipment still needs to be rugged, and still needs to pass mil-spec qualifications. It's a 'damn-the-torpedoes' moment, where they'll deploy whatever since it's cheap, and not worry about things breaking or having shorter lives."

Systems designers may overlook some crucial issues if they pursue using barely rugged technologies. "If one chooses to use a perfectly good product like Nvidia's Jetson Orin, what do you do about the connectors? Helicopters, jets, pods, and armored vehicles are harsh environments, and plastic, flimsy connectors won't cut it."

There is trend emerging called "cocooning," in which systems designs use commercial-grade components and connectors, and design ruggedized enclosures to protect vulnerable components from shock, vibration, and temperature extremes, Ciufo says.

Open-systems industry standards are going a long way to help systems designers tame the challenges of ruggedization, says Curtiss-Wright's Jedynak. "Ruggedization really

▶ **The Sparrow-Strike from Systel is an ultra-small-form-factor (USFF) mil-spec rugged edge computer that uses a Modular Open Systems Approach (MOSA) with a modular chassis and architecture design.**

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comes down to physics and different techniques. What's more important that we've seen over the years is the VITA community creating good definitions of what the ruggedization levels are. These levels are well defined on up the harshest levels."

Additive manufacturing

One of the most notable trends in rugged computers involves additive manufacturing, also known as 3D printing. "Additive manufacturing will enable our customers to speed time to market, since I'll be able to do design jobs in weeks, and not months," says Atrenne's Tierney.

Atrenne is experimenting with additive manufacturing to produce a 3D-printed rugged computing chassis to create lightweight rugged computing at the edge in the future.

"For all these cooling and weight requirements, additive manufacturing enables you to put metal only where you need it and want it. You can put in pockets and cooling channels. You can stay within the realm of machining, but additive manufacturing helps you with tooling, and with weight.

Examples of potential advantages of additive manufacturing include custom very intricate cooling approaches for directed liquid and air flow. "We have done some very creative enclosure systems using additive manufacturing that are much lighter, and time to market is very quick, while maintaining all the ruggedized characteristics, Tierney says.

Is additive manufacturing a viable option today for production-level rugged computing? Probably not, Tierney admits. "Today additive manufacturing in our business is almost negligible — about one percent of our business. I would expect in next three to five years it could be 15 or 20 percent, and from there it just will overtake traditional machining."

3D printing in the future could enable rugged computer manufacturers to use even more intricate designs than they can today with traditional manufacturing, points out Curtiss-Wright's Jedynak. "Looking way out in the future, I could conceive that things like additive manufacturing might allow you to create some geometries in the materials that could allow you to solve a thermal or mechanical problem in a new way."

For some tasks, additive manufacturing is a valuable design approach in rugged computing even today, says Curtiss-Wright's Perez. "We are using additive manufacturing for the duct work inside our 400 chassis, and we have for a number of years."

The future, Perez predicts, will see even more. "Additive manufacturing will be a fairly big deal. We use CAD and digital engineering, and using additive manufacturing to prototype is what we use frequently today. Metal additive manufacturing is still somewhat exotic. No there yet for additive metal, but will be something that will be widely used 5 and 10 years from now."

It's an open question when additive manufacturing will have a big influence on rugged computing design. We are aware of additive manufacturing to improve efficiency in components and products," says ZMicro's Wade. "ZMicro does not use additive manufacturing yet because we haven't hit that sweet spot in cost. It's a trend that always seems like it's tomorrow, and tomorrow eventually will come when we can meet the price points."

RUGGED COMPUTERS

For more information on 3D printing search for "radiation hardened" at www.militaryaerospace.com

Air Force approaches industry for EMP electromagnetic weapons to counter unmanned aircraft

BY **John Keller**

ROME, N.Y. – U.S. Air Force researchers have approached industry for enabling technologies in using ground- or aircraft-based electro-magnetic pulse (EMP) generation to counter formations of enemy unmanned aerial vehicles (UAVs).

Officials of the Air Force Research Laboratory Information Directorate in Rome, N.Y., issued a request for information (RFI) in December for the Electromagnetic Pulse (EMP) Defense Against Unmanned Aircraft Systems (UAS) project.

EMP is an electromagnetic warfare weapon that generates high-power microwaves intended to destroy or disable sensitive electronic components — such as the navigation, guidance, and sensor systems of UAVs.

EMP also is a byproduct of a nuclear explosion, which produces a devastatingly powerful electromagnetic field that causes massive power surges that can destroy electronics, power generation, and electric distribution systems.

▲ U.S. Air Force researchers have surveyed the U.S. defense industry for electromagnetic warfare enabling technologies to counter unmanned aircraft.

Proposed electromagnetic weapons EMP solutions for this counter-UAV project could be ground or aerial based that provide effective mitigation against large-, medium-, and small-sized military UAVs.

Proposed aerial solutions must be reusable, and made from U.S. components and electronics. Aerial and ground-based solutions must have some level of system autonomy; resist the effects of shock, dirt, water, and temperature extremes; and be able to operate at night.

Companies interested were asked to email 10-page capability statements by January to the Air Force's Matthew Zawisza at matthew.zawisza@us.af.mil. More information is online at https://sam.gov/opp/0df436d156e046a1a7101409f1712c48/view.

Raytheon to develop and demonstrate two prototype advanced photonic radar systems

BY **John Keller**

ARLINGTON, Va. – U.S. Navy researchers needed a company to develop and demonstrate two wideband passive photonic radar systems for precise tracking of targets of interest. They found their solution from Raytheon Technologies Corp. (RTX).

Officials of the Office of Naval Research in Arlington, Va., have announced a $20.7 million three-year contract to the RTX Raytheon segment in Tewksbury, Mass. for the Birdseye Yonder (BEYOND) project.

BEYOND is a 2023 Joint Capability Technology Demonstration (JCTD) that seeks to mature and integrate advanced, photonic-based radio frequency (RF) sensors (referred to as "Wall Fly") that generate high-quality geolocation and signals intelligence of threats far beyond current capabilities.

This contract provides for building and demonstrating two prototype wideband passive sensor systems. BEYOND seeks to mature and integrate sensors into existing U.S. European Command sensor networks. It will demonstrate signals intelligence (SIGINT) and high-quality passive geolocation far beyond current capabilities, Navy researchers say.

The sensor technology is a 360-degree wideband passive geolocation, track, and target classification capability designed around physically assisted wideband correlator technology.

Photonic radar produces and analyzes radar signals with help from photonics rather than traditional RF engineering techniques. The frequency of the radar is in the RF, but lasers create and analyze the RF signals with high precision.

▲ **Photonic radar produces radar signals with photonics rather than traditional RF engineering; the frequency of the radar is in the RF, but lasers create the RF signals with high precision.**

China, Russia and India reportedly have research projects in photonic radar to equip jet fighter aircraft with long-range detectors, position sensing, and 3D model target reconstruction.

Photonic radar reportedly could exceed the range and resolution of today's state-of-the-art RF-only radar to create high-resolution 3D images of airborne targets, and potentially could help defeat conventional stealth aircraft technology.

On this contract Raytheon will do the work in Tewksbury, Mass.; El Segundo, Calif.; and Arlington, Va., and should be finished by November 2026. For more information contact RTX Raytheon online at www.rtx.com/raytheon, or the Office of Naval Research at www.nre.navy.mil.

Military researchers ask industry for digital signal processing in radar phased arrays

BY **John Keller**

ARLINGTON, Va. – U.S. military researchers are asking industry to develop advanced sensor processing for radar digital phased arrays of different sizes and bandwidths.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a solicitation (DARPA-PS-24-05) for the Scalable On Array Processing (SOAP) project.

SOAP seeks to develop scalable software algorithms that replace large matrix operations in digital signal processing with the codesign of distributed processing hardware to support the rapid and efficient execution of the algorithms.

▲ **Digital array architectures have advantages over analog arrays, notably the ability to support several simultaneous beams and functions.**

The target application of the effort will be elemental digital phased arrays scaled to arbitrary sizes and bandwidths. Novel processing approaches adapted from disciplines outside of radar and phased arrays are of particular interest.

Digital array architectures have advantages over analog arrays, notably the ability to support several simultaneous beams and functions. Yet digital arrays have evolved using algorithms for signal processing and tracking that typically are for analog arrays.

Digital bottlenecks from traditional array computations have limited development of digital arrays. Phased arrays larger than 1000 elements and instantaneous bandwidths of 1 GHz can require the real time numerical inversion of 1000 x 1000 matrices, with greater than 1 terabit per second of data between the array front end and intermediate processor stages.

This has resulted in digital bottlenecks, which limit the number of independent elements and instantaneous bandwidths achievable in today's digital array architectures.

Current digital arrays do most of their processing on a centralized back-end processor, which often requires many racks of equipment and consumes thousands of Watts of power. At the same time, this centralized approach requires all of the array data to be moved off the array, creating data movement bottlenecks.

Instead, SOAP seeks to do scalable algorithms and processing to overcome digital bottlenecks, and develop new approaches to array operations for large amounts of data in applications like machine vision, and large language model training.

SOAP aims to reduce computational complexity, and move the processing from physically separated back-end processors to processors integrated into the array by designing processors that can be distributed within the array, as close to the elements as possible. These processors should be networked such that the data from any element can be processed by any processor.

SOAP has two technical challenges: Realizing scalable algorithms for digital array computations; and realizing processing architectures that can scale to extremely large aggregate data rates.

The SOAP project should start around next September, and several contract awards are expected. Companies interested were asked to submit full proposals by early March. More information is online at https://sam.gov/opp/25a65f92d52b41e4bfadb968ea848d49/view.

Peraton Labs to develop artificial intelligence (AI) for unmanned ground vehicles

BY **John Keller**

ARLINGTON, Va. – U.S. military researchers needed artificial intelligence (AI) systems that respond well to conditions and events that these systems have never seen before. They found their solution from Peraton Labs Inc. in Basking Ridge N.J.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced a $9.3 million contract to Peraton Labs for the Learning Introspective Control (LINC) project.

LINC aims to develop AI- and machine learning-based technologies that enable computers to examine their own decision-making processes in enabling military systems like manned and unmanned ground vehicles, ships, drone swarms, and robots to respond to events not predicted at the time these systems were designed.

▲ **LINC aims to develop AI- and machine learning to computers to examine their own decision-making in manned and unmanned ground vehicles, ships, drone swarms, and robots.**

Peraton Labs actually won the DARPA LINC contract on 3 Nov. 2022. The contract announcement came on Tuesday in a post-award synopsis issued by the U.S. Naval Information Warfare Center-Atlantic in Charleston, S.C.

LINC technologies will update control laws in real time while providing guidance and situational awareness to the operator, whether that operator is human or an autonomous controller.

Today's control systems seek to model operating environments expected at design time. Yet these systems can fail when they encounter unexpected conditions and events.

Instead, LINC will develop machine learning and introspection technologies that can characterize unforeseen circumstances like a damaged or modified military platform from its behavior, and then update the control law to maintain stability and control.

A LINC-equipped platform will compare the behavior of the platform, as measured by on-board *Continued on page 36*

General Atomics to build long-range unmanned aircraft with open-systems architecture

BY **John Keller**

▲ The MQ-1C-25M is the latest version of the MQ-1C Gray Eagle, and is a multi-mission, medium-altitude, long-endurance unmanned aircraft for artillery spotting, surveillance, and reconnaissance.

POWAY, Calif.–U.S. Army unmanned aircraft experts are asking General Atomics Aeronautics Systems Inc. in Poway, Calif., to build MQ-1C-25M Gray Eagle modernized extended-range unmanned aerial vehicles (UAVs) under terms of a $389 million one-year contract.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking General Atomics for MQ-1C-25M UAVs for multi-domain operations.

The MQ-1C-25M is the latest version of the MQ-1C Gray Eagle, and is multi-mission, medium-altitude, long-endurance unmanned aircraft for real-time artillery spotting and targeting; and intelligence, surveillance, target acquisition, and reconnaissance.

The Army operates the Gray Eagle in each of its 11 Combat Aviation Brigades. The Gray Eagle 25M variant adds an open systems architecture, upgraded sensors, and new communications links.

The Gray Eagle 25M new communications links will include over-the-horizon Ku and Ka-band satellite communications, Link 16, and software-defined ultra-high frequency and very high frequency communication links.

The unmanned aircraft will carry the Eagle Eye radar to detect and track moving targets on land or at sea. It also can have other sensors because of its open-systems architecture.

The new variant also includes a 200 horsepower heavy-fuel engine to improve electrical power by about 50 percent. The Gray Eagle 25M is the latest version of the General Atomics MQ-1C Gray Eagle attack drone medium altitude long endurance unmanned aircraft, which is an upgraded MQ-1 Predator. *Continued on page 36*

Continued from page 35

The aircraft can be fitted with the AGM-114 Hellfire missile or GBU-44/B Viper Strike guided bomb for attack missions.

The Gray Eagle UAV has a synthetic aperture radar and ground moving target indicator (SAR-GMTI) system, and targeting capability from an AN/AAS-52 multi-spectral targeting system (MTS) under the nose. The aircraft can carry a payload as heavy as 800 pounds.

The MQ-1C Gray Eagle provides reconnaissance, surveillance, and target acquisition; command and control; communications relay; signals intelligence; electronic warfare; attack; detection of weapons of mass destruction; battle damage assessment; and manned and unmanned teaming capabilities.

Compared with its MQ-1 Predator predecessor, the Gray Eagle has an increased wingspan, and a Thielert Centurion 1.7 heavy-fuel engine (HFE) able to burn jet and diesel fuel. The UAV can fly for as long as 36 hours at altitudes to 25,000 feet. It has an operating range of 200 nautical miles.

Army commanders deploy the Gray Eagle UAV in platoons, each with four aircraft, support equipment, and payloads like electro-optical/infrared/laser range finder/laser designator; communications relay; and as many as four hellfire missiles. The common sensor payload and synthetic aperture radar ground moving target indicator are one per aircraft. Ground equipment per platoon includes two universal ground control stations; three universal ground data terminals; one satellite communication ground data terminal; and one mobile ground control station per company.

On this contract General Atomics do the work at locations to be determined with each order, and should be finished by November 2024. For more information contact General Atomics Aeronautical Systems online at www.ga-asi.com, or the Army Contracting Command-Redstone at https://acc.army.mil/contractingcenters/acc-rsa/.

Continued from page 34

sensors, continually with a learned model of the system, determine how the system's behavior could cause danger or instability, and implement an updated control law when required.

This could be an improvement of today's approaches to handling platform damage, which places the burden of recovery and control on the operator, whether that operator is human or an autonomous controller.

LINC will help operators maintain control of military platforms that suffer damage in battle or have been modified in the field in response to new requirements. LINC-enabled control systems will build models of their platforms by observing behavior, learning behavioral changes, and modifying how the system should respond to maintain uninterrupted operation.

LINC should be able to detect disruptive changes in control response and quickly develop a control regime based not only on the learned model, but also on changes that take place after the model has been learned.

LINC focuses on two technical areas: learning control by using onboard sensors and actuators; and communicating situational awareness and guidance to the operator.

Learning control by using onboard sensors and actuators will perform cross-sensor data inference to characterize changes in system operation, rapidly prune possible solutions to reconstitute control under changed dynamics, and identify an area of nondestructive controllability by continually recalculating operating limits.

Communicating situational awareness and guidance to the operator involves informing the operator of changes in system behavior in a concise, usable form by developing technologies to provide guidance and operating cues that convey details about the new control environment and its safety limitations. LINC is a four-year, three-phase program.

Initial work involves an iRobot PackBot and a remote 24-core processor. This ground robot weighs 20 pounds; measures 26.8 by 15.9 by 7.1 inches; has tracked and untracked flippers; moves at 4.5 miles per hour, and operates in temperatures from -20 to 50 degrees Celsius.

The remote processor has an Nvidia Jetson TX2 general-purpose graphics processing unit (GPGPU), dual-core NVIDIA Denver central processor, Quad-Core ARM Cortex-A57 MPCore processor; 256 CUDA software cores, eight gigabytes of 128-bit LPDDR4 memory, and 32 gigabytes of eMMC 5.1 data storage.

A key goal of the program is to establish an open-standards-based, multi-source, plug-and-play architecture that allows for interoperability and integration — including the ability to easily add, remove, substitute, and modify software and hardware components quickly.

For more information contact Peraton Labs online at www.peratonlabs.com; DARPA at www.darpa.mil; or the Naval Information Warfare Center-Atlantic at www.niwcatlantic.navy.mil.

Army asks industry for prototype visors that adjust from darkness to full sunlight

BY **John Keller**

ORLANDO, Fla. – U.S. Army researchers are asking industry to develop prototype electrochromic auto-tinting goggles, glasses, and helmet visors that adjust automatically from near total darkness to full sunlight that improve existing military visual display systems.

▲ Army researchers want industry to develop military helmet visors that adjust automatically from total darkness to full sunlight.

Officials of the Army Contracting Command in Orlando, Fla., have issued a request for solutions (W900KK-24-R-900) for the Advanced Electrochromic Manufacturing Prototype Project. This efforts seeks to identify potential prototype solutions for single piece electronically dimmable eyewear protection, such as goggles, glasses, or helmet visors.

Electrochromic materials change color or darkening in response to an electrical stimulus to create a smart window able to block specific wavelengths of ultraviolet, visible, or infrared light.

The Army Contracting Command is issuing this solicitation on behalf of the Office of the Under Secretary of Defense, Analysis & Sustainment, Innovation Capability and

Modernization (ICAM) Office, Industrial Base Analysis & Sustainment (IBAS) Program.

Proposals are to involve U.S-based solutions that use mature electrochromic technology that can be manufactured expediently and completed within two years.

Goggles, glasses, and helmets for aircraft pilots, battlefield airmen, soldiers, and Marines traditionally have relied on using separate units protect the user's eyes in conditions that include very dark, moonless overcast night, inside of buildings and caves, to extremely bright full sun.

The current solution for infantry is carrying two sets of goggles, while aircraft pilots wear helmets with two passive polycarbonate visors — one clear, and one dark. This requires pilots to switch visors manually as lighting changes which can hinder safe operation of the aircraft.

The project's goal is to enable expedient manufacturing of an electrochromic lens to improve existing military visual display systems, and benefit several military programs that use electrochromic auto-tinting technology.

Of particular interest are helmet visors for the F-35 joint strike fighter; Special Operations Forces helmet visors; naval and Marine Corps helmet visors; and goggles for Army infantry.

Companies interested will be asked to deliver prototype one-piece electronically dimmable eyewear protection for helmet visors and may include goggles and glasses, and demonstrate manufacturing using U.S.-based sourcing.

Solutions will identify several sets of test articles, and a final set of test articles that include 20 toroidal visors, 35 spherical goggles, and 200 glasses lenses.

Companies interested were asked to email responses by January to the Army's Jamie Morrison at jaime.morrison.civ@army.mil and Kurt Kleinlein at kurt.l.kleinlein.civ@army.mil. Email questions to Morrison and Kleinlein with Advanced Electrochromic Prototype Project Question in the subject line. More information is online at https://sam.gov/opp/d7d0597c69e448f19bf07dfb655bf6c6/view.

Fiber-coupled LED source for spectroscopy introduced by LumeDEL LLC

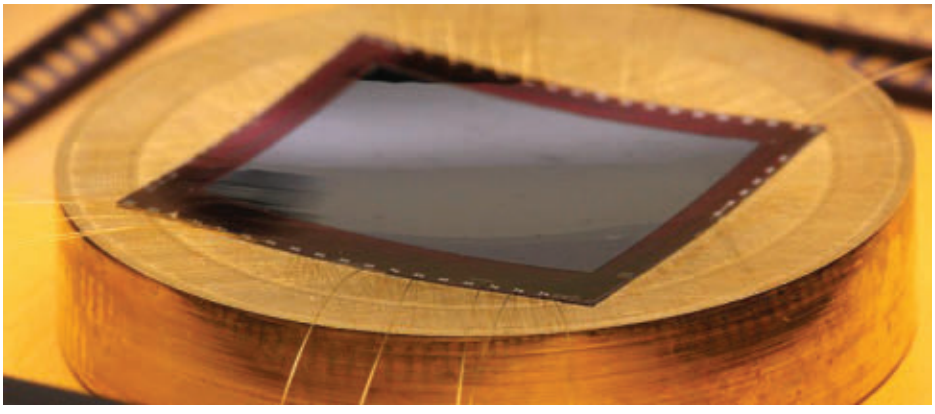
LumeDEL LLC in Manchester, N.H., is introducing the NewDEL model X3312 fiber-coupled LED source as a replacement for halogen lamps for applications in spectroscopy. The NewDEL model X3312 fiber-coupled LED source employs a phosphor-coated ultraviolet-LED to emit a spectrum from 330 to 1,100 nanometers. If the ultraviolet peak is unnecessary or intrusive, it can be blocked by a long pass filter that only passes VIS-NIR light, thus providing a continuous and balanced spectrum without peaks. The compact integrated model X3312 incorporates its own driver and microcontroller circuitry; a separate driver and controller module is not required. Device operation is through Windows-based graphic user interface software or personally programmed using serial commands. The NewDEL electro-optical product line of fiber-coupled LEDs includes three different broadband sources as well as 17 narrowband models with peak wavelengths from the ultraviolet to the near-infrared spectral regions. The reconfigurable models operate from a continuous operating mode to pulsed or triggered modes, so that users at any level can set up a light source suited to their systems. LumeDEL also offers fiber optic patch cords, collimating lenses, filter holders, and mounting hardware. For more information contact LumeDEL online at https://lumedel.com/newdel-fiber-coupled-leds.

Wide-aperture color cameras for high-resolution night imaging introduced by Hikvision USA

Hikvision USA in City of Industry, Calif., is introducing the DS-2CE70DF0T-MF ColorVu Fixed Turret and DS-2CE10DF0T-F and Bullet cameras featuring an F1.0 aperture for surveillance and situational awareness applications. These cameras provide high-quality round-the-clock color imaging with HD over analog cabling 3D digital noise reduction technology, and extreme white light distance. The ColorVu cameras' F1.0 aperture enables full-color imaging even in low-light conditions. Built-in 3D DNRtechnology further ensures that images are clean and sharp, reducing interference and noise for a more accurate representation of available surroundings. These sensors offer white light distance to as far as 65 feet to provide bright and vivid night imaging. The ColorVu 2 MP Fixed Turret and Bullet Camera feature a single port for four switchable signals, including TVI, AHD, CVI, and CVBS, and are water and dust-resistant. Users of these electro-optical sensors can choose between a fixed focal lens option of 2.8 or 3.6 millimeters. For more information contact Hikvision USA online at www.hikvision.com.

HRL Laboratories to develop curved micro-bolometers to shrink infrared thermal sensors

BY **John Keller**



HRL engineers will curve a commercial microbolometer spherically to improve its sensitivity and uniformity to reduce the size and weight of wide-field-of-view cameras.

ARLINGTON, Va. – U.S. Navy researchers needed a company to reduce the size and improve the sensitivity and uniformity of wide-field-of-view infrared thermal cameras. They found their solution from HRL Laboratories LLC in Malibu, Calif.

Officials of the Office of Naval Research (ONR) in Arlington, Va., announced a $3.2 million contract to HRL Laboratories for the Spherical Longwave Infrared Micro-bolometers (SLIM) project.

HRL engineers will curve a commercial microbolometer spherically to improve the sensitivity and uniformity, and to reduce the size and weight of wide-field-of-view cameras. HRL is an industry leader in the curving of sensors, Navy researchers say. The company also has expertise in non-standard semiconductor fabrication and infrared fabrication, packaging, and testing, Navy officials say.

The goal of the SLIM project is to develop and deliver a curved uncooled long-wave infrared (LWIR) cameras. LWIR sensors key on the heat that targets of interest generate. These kinds of infrared sensors are particularly useful to detecting humans and animals at night, in bad weather, and in smoke and haze by detecting the warmth of the targets against a relatively cool background. They also can detect and track the heat of vehicle engines.

LWIR sensors also are useful for detecting and targeting rocket and jet engine exhaust, and can help detect and the presence of jet aircraft without using active sensors like radar. LWIR sensors also can be paired with light-amplification sensors to improve the night vision of warfighters who are operating after sundown, in bad weather, or in smoke and haze.

Curved imaging sensors have significant advantages over flat sensors in that they increase performance and reduce the cost, weight, and volume of optics for many types of cameras, HRL officials say. Curved sensor technology has the potential to improve optic-related scientific fields such as computer vision and automation, reconnaissance and surveillance imaging, photography, videography, microscopy, and telescopy.

Six years ago HRL Laboratories won a contract from the U.S. Intelligence Advanced Research Projects Activity (IARPA) in Washington to develop spherically curved short-wave (SWIR) and medium wave (MWIR) infrared image sensors.

That project sought to develop improve technology understanding of the effects of bending on the performance of III-V semiconductor SWIR and MWIR image sensors. One part of the program examined the benefits of curved sensors for infrared lens design.

Infrared sensor performance is sensitive to the mechanical strain of bending, and the cooling process can affect the sensor's performance. HRL engineers investigated the limits of bending and cooling infrared sensor material to characterize how bending can change sensor performance, and sought to determine how best to use the technology. For more information contact HRL Laboratories online at www.hrl.com, or the Office of Naval Research at www.nre.navy.mil.

Elbit to provide night vision goggles that combine infrared and light-amplification

BY **John Keller**

QUANTICO MARINE BASE, Va. – U.S. Marine Corps night vision experts needed an updated helmet-mounted night vision system that combines thermal imaging and light amplification. They found their solution from Elbit Systems of America-Night Vision LLC in Roanoke, Va.

Officials of the Marine Corps Systems Command at Quantico Marine Base, Va., announced a $500 million five-year contract for the Squad Binocular Night Vision Goggle (SBNVG), which enhances the infantry's lethality and situational awareness at night and in poor visibility.

The military electro-optics contract includes spare and repair parts; contractor logistics support; and test article refurbishment. Elbit prevailed in this SBNVG contract over two other unnamed bidders.

The SBNVG is lightweight and enhances Marines depth perception during maneuvers, Marine Corps officials say. The SBNVG combines longwave infrared thermal imaging with light-amplification technologies. Elbit won a $249 million SBNVG contract in 2019.

The SBNVG is a commercial item purchase that includes a binocular image intensifier night vision goggle with a modular uncooled thermal imaging sensor, a carrying case, a dual-power cable, an associated external power supply, a helmet mounting system, and operator manual.

The optical sensors combines several technologies to enhance the infantry warfighter's capabilities in low-light and degraded-visibility conditions. Light amplification helps illuminate targets at night, thermal imaging enhances vision in

smoke and other obscurants, and the binocular design enhance the warfighter's depth perception.

On this contract Elbit will do the work in Roanoke, Va., and should be finished by November 2028. For more information contact Elbit Systems of America online at www.elbitamerica.com/night-vision, or Marine Corps Systems Command at www.marcorsyscom.marines.mil.

▲ **The lightweight SBNVG enhances Marines depth perception, and combines longwave infrared with light-amplification sensors.**

POWER CONTROL

▲ Honeywell selects Triumph's electronic control for next-gen auxiliary power unit

Honeywell Aerospace in Phoenix needed engine-mounted electronic control for auxiliary power on the company's future commercial and military aircraft. They found their solution from Triumph Group Inc. in Radnor, Pa.

Honeywell is choosing the next-generation, engine-mounted electronic control unit (ECU) from the Triumph Group Systems, Electronics and Controls business to provide the engine-mounted electronic control unit (ECU) for future auxiliary power unit (APU) models for commercial and non-commercial aircraft.

Using proprietary technology, Triumph's engineers are designing and manufacturing an ECU for Honeywell's next generation APU with processors that meet the latest cyber security requirements. Triumph and Honeywell also signed a long-term agreement for multi-fleet engine controls and components.

"Partnering with Honeywell on this APU Controller allows us to provide an innovative solution that addresses future performance requirements and threat environments for both legacy and next generation platforms," says Justin Wolfanger, president of Triumph Systems, Electronics and Controls.

The contract includes Triumph's manufacturing and maintenance of boost pumps, electronic control units, and hydro-mechanical fuel controls for T55 helicopter engines along with the main fuel pumps for F124 fighter/trainer engine and HTF7000 business jet engines. This work will be at Triumph's Systems, Electronics and Controls facility in West Hartford, Conn.

Triumph designs, develops, manufactures, repairs, and overhauls a broad portfolio of aerospace and defense systems and components. The company serves the global aviation industry, including original equipment manufacturers and the full spectrum of military and commercial aircraft operators.

For more information contact Triumph Systems, Electronics and Controls online at https://www.triumphgroup.com/companies/triumph-systems-electronics-and-controls.

ELECTRONICS COOLING

▼ Three companies seek to cool 3D heterogeneous integration (3DHI) chip stacks

HRL Laboratories LLC in Malibu, Calif., is joining Teledyne Scientific & Imaging LLC and Northrop Grumman Corp. in a project to develop scalable thermal management technologies to help with electronics cooling architectures in the future that involve 3D heterogeneous integration (3DHI) chip stacks.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) have announced a $14.5 million contract to HRL Laboratories for the Miniature Integrated Thermal Management Systems for 3D Heterogeneous Integration (Minitherms3D) project.

The Northrop Grumman Mission Systems segment in Linthicum Heights, Md., and Teledyne Scientific & Imaging LLC in Thousand Oaks, Calif., also have won Minitherms3D

contracts. The program seeks to revolutionize electronics cooling for 3DHI packages and significantly reduce thermal resistances within the 3D stack and external to the stack of 3DHI systems, while increasing volumetric heat removal.

Minitherms3D, sponsored by the DARPA Microsystems Technology Office, seeks electronics cooling technology scalable to an arbitrarily large number of high-power tiers in 3DHI chip stacks. HRL Laboratories, Teledyne Scientific & Imaging, and Northrop Grumman will handle the program's 18-month first phase.

Program goals include 3D stacking of five tiers with total heat dissipation more than 6.8 kilowatts with the heat rejection system limited to less than 0.006 cubic meters.

Continued rapid growth of compact high-performance microsystems is limited by inadequate integrated thermal management, including acquisition of heat from 3D integrated circuits, to the heat's transport and ultimate rejection to the ambient environment.

For example, the state of the art in 3DHI in high-performance computing typically uses one tier of logic and several tiers of high-bandwidth memory. Stacking of logic is currently limited to low-power tiers.

Three-dimensional (3D) stacking of several tiers of high-power logic and other functional blocks, including radio frequency devices, offers significant advancement in future microsystems, but today is infeasible because of insufficient in-plane and out-of-plane heat acquisition from each tier, and poor thermal isolation between functional blocks.

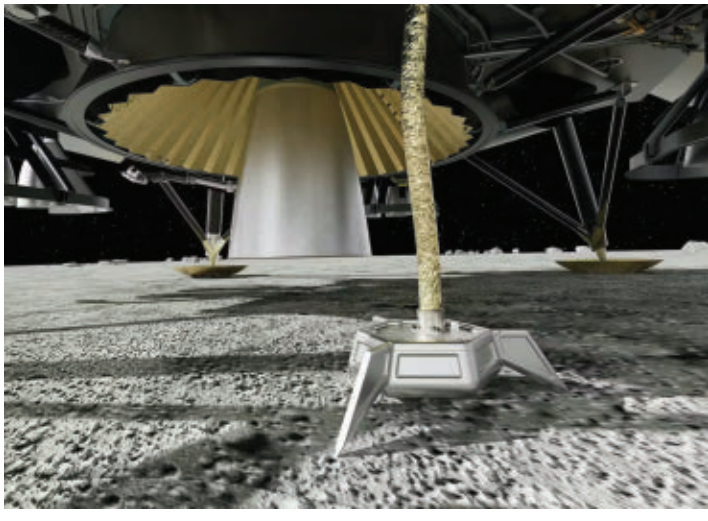
Unoptimized heat transmission and rejection also result in large overall size of electronics cooling hardware, which limits growth in system capabilities, particularly in radio frequency systems, image analysis, and high-performance computing applications such as artificial intelligence (AI) and machine learning.

The Minitherms3D project has two technical challenges: reducing thermal resistances within the 3D stack; and reducing thermal resistance external to the 3D stack.

Reducing thermal resistances within the 3D stack involves increasing in-tier heat transfer without increasing tier thickness. Regions of average heat flux more than 150 Watts per square centimeter along with localized hot spots more than 1 kilowatt per square centimeter in 3DHI tiers simultaneously must be managed thermally to maintain acceptable chip temperatures.

In a 3D stack, hot spot electronics cooling must rely on in-tier heat spreading, since interior tiers do not have direct access to top or bottom cooling. In a Si tier of 100-micron thickness, thermal conduction limits heat spreading to hot spot of 1-by-1 millimeter to 200 Watts per square centimeter with a temperature rise below 10 degrees Celsius over the rest of the tier.

For more information contact HRL Laboratories online at www.hrl.com; Teledyne Scientific & Imaging online at www.teledyne-si.com/en-us; Northrop Grumman Mission Systems online at www.northropgrumman.com/who-we-are/business-sectors/mission-systems; or DARPA at www.darpa.mil.



SPACE SENSORS

▲ Fleet Space selects Firefly to deliver sensor payload to the far side of the moon

Fleet Space Technologies, a Beverly, Australia-based space exploration firm, needed a launch partner to deliver and operate Fleet's Seismic Payload for Interplanetary Discovery, Exploration, and Research (SPIDER) to the far side of the moon. They found their solution from Firefly Aerospace Inc. in Cedar Park, Texas.

In addition to payloads from the National Aeronautics and Space Administration (NASA) and the European Space Agency, the Australian SPIDER payload will fly on Firefly's Blue Ghost lander as part of Firefly's second lunar mission in 2026.

Fleet Space's SPIDER payload is part of the Australian Space Agency's moon to Mars initiative that's aligned with NASA's Artemis program to support future habitation on the moon. Upon deployment of the payload,

Firefly's Blue Ghost lunar lander will provide ongoing power and communications, enabling SPIDER to capture seismic data from the lunar surface for up to 14 days. This data will offer insights into the geological properties of the lunar subsurface and its mineral profile, such as water ice, that can support lunar infrastructure and further regolith exploration.

In addition to SPIDER, Firefly's second lunar mission will deliver the European Space Agency's Lunar Pathfinder satellite to lunar orbit and NASA's LuSEE-Night radio telescope to the lunar surface as part of the NASA Commercial Lunar Payload Services (CLPS) initiative. The mission's two-stage spacecraft design, using Firefly's Blue Ghost lunar lander stacked on Firefly's Elytra orbital vehicle, provides robust versatility for both surface and orbital deliveries in support of growing international lunar infrastructure.

For more information contact Fleet Space Technologies online at https://fleetspace.com, or Firefly Aerospace at https://fireflyspace.com.

THERMAL MANAGEMENT

▶ BAE Systems and Qorvo to help cool GaN power amplifiers for electronic warfare (EW) and radar

BAE Systems and Qorvo Inc. are joining a U.S. military research project to limit waste heat in gallium nitride (GaN)-based power amplifiers that could limit the performance and lifetimes of military radar, electronic warfare (EW), communications, and other RF and microwave systems.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have awarded contracts to the BAE Systems Electronic Systems segment in Merrimack, N.H., and to Qorvo Inc. in Richardson, Texas, for the Technologies for Heat Removal in Electronics at the Device Scale (THREADS) program.

BAE Systems and Qorvo join Raytheon Technologies Corp. (RTX) and Northrop Grumman Corp. on the THREADS program to cool RF and microwave GaN components. BAE Systems on a $12.4 million THREADS contract on 17 Nov., and Qorvo won a $12.7 million THREADS contract on 28 Nov. Raytheon and Northrop Grumman won their THREADS contracts in September.

THREADS seeks to develop RF and microwave microelectronics technologies that will overcome the thermal limitations that can prevent transistors from operating reliably at RF output power density close to their fundamental electronic limits.

The performance of radar and communication systems depends on the signal-to-noise ratio achievable at the receiver, which is proportional to the RF output power of the transmitter. The size of RF apertures in military systems often are limited, so the only way to increase range is by increasing the RF output power of the transmitter power amplifier.

The RF output power densities of today's military RF transmitters substantially are thermally limited to below their theoretical electronic limits. Wide-bandgap transistors like gallium nitride (GaN) were developed to improve output power in power amplifiers by as much as five times compared to older gallium arsenide (GaAs) transistor technology.

Yet limiting increases in sustained GaN power output continues to be excessive waste heat in the transistor channel layer, which causes elevated channel temperatures and device damage.

Achieving the transistor output power near the GaN fundamental electronic limit while maintaining a channel temperature below the nominal maximum temperature of 225 degrees Celsius requires a significant reduction in the thermal resistance of the transistor, while preserving electronic properties of wide-bandgap semiconductors.

In the THREADS program, the four companies will focus on achieving high power density by reducing transistor thermal resistance in two ways: reducing thermal resistance within the device while maintaining good channel current transport properties; and moving heat away from

high-power transistors more efficiently without degrading RF performance.

The companies will demonstrate efficient X-band transistors and power amplifiers. an eight-times reduction in transistor thermal resistance; and reliable operation with a mean-time-to-failure of 106 hours at 225 C channel temperature.

Engineers will try to reduce thermal resistance within the device while maintaining good channel current transport properties by reducing interfacial and thin film thermal resistance within the device's epitaxial layer stack. THREADS also will develop new ways to spread waste heat and reduce transistor thermal resistance to maintain channel temperature of 225 C.

The companies will incorporate electro-thermal co-design, modeling, and simulation to guide device optimization. THREADS is a four-year program.

For more information contact BAE Systems Electronic Systems online at www.baesystems.com; Qorvo at www.qorvo.com; Raytheon at www.rtx.com/raytheon/what-we-do/advanced-technology/microelectronics; Northrop Grumman at www.northropgrumman.com/what-we-do/microelectronics-space-park; or DARPA at www.darpa.mil.

COMMUNICATIONS

▶ Navy asks L3Harris to upgrade information security for military communications

Secure communications experts at L3Harris Technologies, Inc. will upgrade information security for a U.S. military secure digital data and voice communications system under terms of a $15 million order.

Officials of the Naval Information Warfare Systems Command (NAVWARSYSCOM) in San Diego are asking L3Harris Communication Systems-West in Salt Lake City for Secure Data Units (SDUs) for the Multifunctional Information Distribution System (MIDS) Low Volume Terminals (LVT) that support MIDS-LVT terminals and Link-16 capabilities.

These terminals provide secure, high-capacity, jam-resistant, digital data and voice communications capability for Navy, Air Force and Army systems, as well as U.S. allies.

The MIDS-LVT system provides high-capacity, jam-resistant digital data and voice secure communications capability for aircraft, ships, and ground applications. The MIDS-LVT block upgrade II involves crypto-modernization, enhanced throughput, and frequency remapping requirements.

MIDS-LVT was developed to provide secure Link 16 capability at a relatively low weight, volume, and cost. Link 16 provides real-time data communications, situational awareness and navigation, and in some cases digital voice, all in a jam-resistant, crypto-secured, information security package.

With Link 16, military aircraft as well as ships and ground forces may exchange their tactical picture in near-real time. Link 16 also supports the exchange of text messages, imagery data and provides two channels of digital voice at 2.4 kilobits per second and/or 16 kilobits per second in any combination.

Link 16 is defined as one of the digital services of the JTIDS / MIDS in NATO's Standardization Agreement STANAG 5516.

This order is part of a long-term program designed to meet the requirements of U.S. and allied forces for communications among airborne, shipboard, and ground forces.

The terminals are being installed on the U.S. Navy F/A-18E/F, U.S. Air Force F-16, B-1, B-2 and B-52, and on U.S. and allied naval ships. This order brings the contract's cumulative total to $694 million, which will be added to a new contract line item number to the base contract for the procurement of SDUs, which expires in June 2025.

On this order L3Harris will do the work in Salt Lake City, and should be finished by June 2025. For more information contact L3Harris Communications Systems-West online at www.l3harris.com/all-capabilities/integrated-communications-solutions, or NAVWARSYSCOM at www.navwar.navy.mil.

COMMUNICATIONS

▲ 8-port Gigabit Ethernet switch for SWaP-constrained flight test introduced by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va., is introducing the NSW-8GT-TGE-1 rugged 8-port non-blocking Gigabit Ethernet switch for flight test applications. The NSW-8GT-TGE-1 provides IRIG-106 Chapter 21-28 Telemetry Network Standard (TmNS) compliance, including MDL programming. TmNS replaces unidirectional PCM-based architectures and enables bi-directional communications. TmNS specifies the configuration, management, network transport protocols, telemetry link, and other system and component capabilities of data acquisition units, network switches, recorders, radios, and ground components like antennas and ground system software. To optimize size, weight and power (SWaP) on space-constrained airborne test platforms, the NSW-8GT-TGE-1 supports the packet switching and IEEE 1588 precision time protocol (PTP) time distribution required by networked flight test instrumentation (FTI) system components. The switch supports IEEE 1588 with an IRIG-B time code reader and generator, a built-in battery-backed real-time clock, and a GPS receiver. The switch supports managed operation, enabling dynamic configuration, statistics gathering, and health monitoring using Simple Network Management Protocol (SNMP). For more information contact Curtiss-Wright Defense Solutions online at www.curtisswrightds.com.

CABLE AND CONNECTORS

▼ Cable assemblies for UHD audio and video data transfer introduced by Fischer

Fischer Connectors SA in Saint-Prex, Switzerland, is introducing high-speed connectors and cable assemblies for ultra-high-definition (UHD) audio and video data transfer. Applications for these cable assemblies and connectors include aerial imaging, especially in military operations for drones equipped with high-resolution cameras. UHD audio and video connectivity is also needed in scientific, industrial, instrumentation, test and measurement and medical applications with 4K camera devices. These cable and connector products operate at 18 gigabits per second, and are for use in demanding environments to match the performance speed of HDMI 2.0. The Fischer Connectors UHD connectors are available in the Fischer MiniMax and Fischer Core product lines with 10,000 mating cycles, 360-degree EMI protection, different sealing performances from IP68 to hermeticity and sterilization capacities, as well as three locking mechanisms — push-pull, screw, and quick-release. Fischer MiniMax UHD connectors available in a 12.9-millimeter-diameter plug, and have a miniature, lightweight, compact, high-density layout with 19 contacts. For more information contact Fischer Connectors online at https://fischerconnectors.com.

CHASSIS AND ENCLOSURES

▲ Rackmount 1U electronics enclosure for aircraft, ships, and vehicles introduced by Pixus

Pixus Technologies in Waterloo, Ontario, is introducing the RX310 series rackmount 1U-tall electronics enclosure for military airborne, shipboard, ground vehicle, or outdoor applications. The enclosure holds two National Instruments Ettus Research-brand X310 software defined radios (SDRs). The air-cooled RX310 meets Transport Grade ruggedization for military rackmount applications. The semi-rugged enclosure features a thick and reinforced metal structure, and offers a front-to-rear airflow orientation. The inside of the unit is designed to cool any potential hot spots in the system. With IP67 weather-resistant and military-rugged design styles available, the RX310 series has pole-mount and other special mounting options are available. Other applications include signals intelligence (SIGINT), radar, smart agriculture, smart energy, and prototyping systems for advanced wireless uses. Pixus also offers other ruggedized SDRs from NI, including the X410, B210, and N310. For more information contact Pixus online at https://pixustechnologies.com.

PRODUCT & LITERATURE SHOWCASE

ADVERTISERS INDEX

ADVERTISER	PAGE
AFCEA International	C3
Airborn Inc.	10
Annapolis Micro Systems Inc.	11
Axiom Electronics	5
Dawn VME Products	7
Elma Electronic Inc.	13
Fairview Microwave	3
General Micro Systems Inc.	C4
IMS International Microwave Symposium	29
LCR Embedded Systems Inc.	1
Master Bond Inc.	26
Pasternack	19
Phoenix International	47
Pico Electronics Inc.	15
Pixus Technologies	12
RGB Spectrum	46
State of the Art, Inc.	9
Viking Technology	C2
Z Micro	27

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SWITCH FABRICS

▼ Harsh-environment 3U VPX Ethernet router introduced by Elma Electronic

Elma Electronic Inc. in Fremont, Calif., is introducing the NetKit-3110, based on the Cisco ESR6300 Ethernet router, for harsh-environment deployed industrial and military applications. With six high-performance Gigabit Ethernet interfaces — two routed and four switched — the conduction-cooled VITA 48.2 3U VPX router serves as an aggregation point for on-demand network connectivity in mobile or fixed deployments. From mobile ground operations, shipboard and air defense equipment, homeland security and emergency services to harsh industrial environments such as drilling and mining operations, the 3U VPX-based NetKit-3110 enables enterprise-grade routing and switching security using the Cisco IOS XE software, ensuring secure voice, video, and data communications. The NetKit-3110 harsh-environment Ethernet router manages network resources for increased performance. The included SD-WAN features enable unified distributed network management at the edge and an onboard hardware encryption module offloads packet encryption and decryption from the routing engine. To ensure that the code running on the ESR6300 is authentic, unmodified, and operating as intended, the NetKit-3110 includes an Onboard Trust Anchor module (TAm), along with image signing, Secure Boot, and runtime defenses. The NetKit-3110 offers three throughput license tiers: 50 megabits per second encrypted; 250 megabits per second encrypted; and 350 megabits per second encrypted. The router weighs one pound and meets MIL-STD-810H and RTCA DO-160G environmental specifications. Elma Electronic at www.elma.com.

RUGGED COMPUTERS

▲ Short-depth server for artificial intelligence (AI) introduced by One Stop Systems

One Stop Systems Inc. in Escondido, Calif., is introducing the OSS Gen 5 short-depth server for artificial intelligence (AI), machine learning ,and sensor processing at the edge. Powered by four PCI Express NVIDIA H100 Tensor Core graphics processing units (GPUs), the OSS Gen 5 addresses the growing demand for more powerful AI transportables at the edge. It uses high-performance GPUs, networking, and NVMe solid-state storage to deliver double the bandwidth as compared to its Gen 4 predecessors. The Gen 5 short-depth server is a hyperconverged data center-class embedded computing server that supports configurations of as many as five GPUs, 16 fast NVMe solid-state storage devices, and low-latency, high-bandwidth PCI Express scale-out expansion systems. It also supports SAN and NAS storage software and 400-gigabit-per-second networking. The short-depth embedded computing server handles as many as 35 simultaneous AI workloads, high-speed transportable data recorder and logger with hot-swap drive packs with 1 petabyte capacity, or a rugged SAN or NAS data storage unit. For more information contact One Stop Systems online at https://onestopsystems.com.

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NASA seeks industry input on rotating detonation rocket engine development

BY **Jamie Whitney**

HUNTSVILLE, Ala. - The U.S. National Aeronautics and Space Administration (NASA) is reaching out to industry and academic experts to gauge technology investment in rotating detonation rocket engines (RDRE).

NASA is focusing on reducing system length while maintaining a comparable impulse to traditional deflagrative engine systems. 7298733 © Alexandr Blinov | Dreamstime.com.

NASA explains that potential applications encompass hypersonic vehicles, small launch systems, launch system upper stages, lander system propulsion, and in-space propulsion.

NASA's primary focus for an operational system revolves around reducing system length while maintaining a comparable specific impulse to traditional deflagrative engine systems.

In a conventional rocket engine, combustion occurs in a constant volume or at a relatively low frequency. In contrast, an RDRE exploits detonation — a supersonic combustion wave — and rotates this detonation wave around the engine's ring-shaped combustion chamber.

NASA experts say that preliminary input indicates early market demand for systems with thrust levels ranging from

750 foot pounds to 2,000 foot pounds using propellants such as peroxide/kerosene, LOx/RP1, LOx/LH2, LOx/LCH4, and MON25/MMH.

The NASA Space Technology Mission Directorate (STMD) is contemplating an integrated system ground demonstration aimed at mitigating risks, validating performance, and seamlessly transitioning into an operational flight demonstration.

The target for operational flight infusion is 2030. In conceptual terms, the ground system validation could be carried out with a NASA-led system design and demonstration, followed by a transition to an industry-led operational system flight.

The objective is a smooth transition to commercial use with an emphasis on enhancing the cost, risk, and performance aspects of future applications. The goal is to make the underlying RDRE technology widely accessible to for space applications.

Respondents are requested to outline the optimal thrust class and propellant combination suitable for the initial user adoption of an operational system. This should encompass explicit applications, relevant market analyses, and the identification of specific operational infusion paths.

Additionally, the submission should include details on critical interfaces crucial for maintaining a high probability of successful infusion, taking into account limiting or driving key performance parameters for market viability, such as mass, cost, specific impulse, length, and thrust-to-weight, among others.

Respondents are encouraged to furnish information on critical tests, activities, and/or data products essential for mitigating cost, risk, and/or schedule challenges associated with operational infusion. Specific considerations should be provided regarding any engine cycle requirements, trades, or considerations that are particularly favorable for early adoption in an operational system.

Lastly, the viability of a Cooperative Research and Development Agreement (CRADA) as an approach for investment through transition is to be addressed, taking into account NASA's intention to publicly disclose all ground system development testing data, subject to ITAR and Export Control limitations.

NASA asked for submissions by 5 Jan. 2024 to Belinda Triplett (belinda.f.triplett@nasa.gov) and John W. Dankanich (john.dankanich@nasa.gov). More information is online at https://sam.gov/opp/d059e1d103fe453a839fd2c4402b6703/view.

EcoPulse aircraft demonstrator makes first hybrid-electric flight

EcoPulse, the hybrid-electric distributed propulsion aircraft demonstrator developed together by Daher, Safran, and Airbus has made its first flight test in hybrid-electric mode. The demonstrator flew with its ePropellers activated, powered by a battery and a turbogenerator. EcoPulse took off from Tarbes Airport in late November for a test flight that lasted approximately 100 minutes. During the flight, the crew engaged the electric propellers and verified the proper functioning of the demonstrator's flight control computer, high-voltage battery pack, distributed electric propulsion, and hybrid electric turbogenerator. EcoPulse's first hybrid flight is the culmination of several technical milestones, including extensive ground tests and 10 hours of flight tests of the aircraft with the electrical system inactive. EcoPulse is one of the major collaborative projects in Europe in the field of aviation decarbonization. It is supported by CORAC (the French Civil Aviation Research Council), and co-funded by DGAC (the French Civil Aviation Authority) through France Relance (the French government's economy recovery plan) and NextGeneration EU.

Astrobotic commercial lunar lander has propellant leak; unable to complete Moon landing

The Astrobotic commercial lunar mission - the world's first private Moon launch - took off, but soon suffered a critical leak of the propellant that threatens its ability to complete its mission. Astrobotic's Peregrine launched in the early morning hours on 8 Jan. 2024 from United Launch Alliance's Vulcan. The rocket took off from Launch Complex 41 at Cape Canaveral Space Force Station, Fla. The Peregrine had been operational for approximately 32 hours, but the team had faced another spacecraft-pointing issue when the spacecraft started to tilt away from the Sun, which reduced solar power generation. The team was able to update control software, which fixed the problem. Given the propellant leak, however, there is no chance of a soft landing on the Moon. The Peregrine lander's payload was to explore the lunar exosphere, thermal characteristics of the lunar regolith, hydrogen concentrations in the soil at the landing site, and radiation environment monitoring.

Unifly completes FAA-backed unmanned traffic management (UTM) project to safeguard flight automation

BY **Jamie Whitney**

ANTWERP, Belgium - Unmanned traffic management (UTM) technology company Unifly in Antwerp, Belgium, has completed a cyber security project aimed at safeguarding the autonomy of uncrewed aircraft in controlled airspace.

Unifly has completed the Unified UTM Cybersecurity Model project to refine and validate a UTM cyber security model, including requirements and a certification scheme, within an operational setting.

This initiative is sanctioned by the Federal Aviation Administration (FAA) under Broad Agency Announcement call 003 in collaboration with the Rhea Group in Brabant Wallon, Belgium, and the NY UAS Test Site (NYUASTS) in Rome, N.Y.

Ranking the safety and security of our airspace highly is important to the burgeoning drone industry. Software-based UTM systems are automated and are targets for cyber threats that pose risks to aviation safety, and to the privacy of airspace users.

Despite acknowledgment of cyber security as a critical safety concern, UTM cyber security has been explored only partially, leaving gaps in system requirements and a lack of a unified certification scheme.

▲ The Unified UTM Cybersecurity Model seeks to refine and validate a UTM cyber security model within an operational setting.

Unifly and others worked with the FAA, NSA, Nav Canada, and DroneUp in Virginia Beach, Va., to get suggestions for security requirements for UTM needs. The feedback and security requirements collected during these interviews highlighted the urgent need for an updated security framework, with emphasis on a UTM cyber security model.

The project team refined system requirements and security controls for an updated prototype model that has been tested in actual flights at the NY Test site.

Validation involved more than 60 flights, covering scenarios of optimal conditions, simulated attacks, and operations with countermeasures.

Industry best practices from this project will be a baseline for future cyber security framework development to help boost confidence in the security of U.S. commercial airspace.

Boom Supersonic selects Honeywell's Anthem for its Overture flight deck

DENVER - Avionics designers at Boom Supersonic, a Denver-based aerospace company building a faster-than-sound airliner, needed an integrated flight deck for its Overture aircraft. They found their solution from Honeywell Aerospace in Phoenix.

Boom selected Honeywell's Anthem integrated flight deck, which will be tailored for Overture's specific mission requirements, helping to enable situational awareness and enhanced safety. The advanced avionics interface provides continuity to Overture pilots from initial simulator-based flight training through to actual flights.

Avionics interface provides continuity to Overture pilots from initial simulator-based flight training through to actual flights.

Honeywell completed the first flight of its Anthem integrated flight deck using its Pilatus PC-12 test aircraft in May 2023, paving the way for Federal Aviation Administration certification.

"Honeywell has an extensive history of aerospace innovation and shares our vision of a faster future through sustainable supersonic flight," said Blake Scholl, founder and CEO of Boom Supersonic. "We're proud to work with Honeywell to realize one of the most advanced flight decks in the sky, with state-of-the-art technologies that reduce pilot workload and increase safety."

In addition to commercial supersonic travel, Boom announced the launch of its Defense Advisory Group to assess Boom's Overture aircraft for national security missions this fall. The independent council brings together top military and defense experts to progress the development of defense variants of Overture. Overture will fly twice the speed of today's airliners with a max range of 4,250 nautical miles.

Boom named seven founding members ranging from retired General Officers to Department of Defense civilian senior executives with expertise in mobility operations, executive airlift, Air Force acquisitions, and research and development within the defense community.

The Defense Advisory Group founding members include retired Air Force Gen. William M. Fraser III, former Commander of U.S. Transportation Command, Air Combat Command, and Air Force vice chief of staff; retired Air Force Gen Raymond E. Johns, former Commander of Air Force Air Mobility Command; retired Air Force Gen. Carlton Everhart II, former Commander of Air Force Air Mobility Command; retired Lt. Gen. Ted Bowlds, former Commander Electronic Systems Command; David E. Hamilton, retired senior executive service, former director and program executive officer for the Air Force Rapid Capabilities Office; retired Air Force Maj. Gen. Lawrence M. Martin, Jr., former assistant deputy undersecretary of the Air Force, International Affairs; and retired Air Force Maj. Gen. Kyle Kremer, former director of strategy, plans, requirements and programs for Air Mobility Command.

Boom officials announced in July that they will support Northrop Grumman on a NASA contract to deliver solutions for the High-Speed Endo-atmospheric Commercial Vehicle Conceptual Design Study and Technology Roadmaps Development program. The study for future research and development will identify technologies to continue the advancement of commercial supersonic flight efficiency.