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THE EVOLUTION OF 3D PRINTING

Additive manufacturing matures and continues
to be adopted in the defense industry. PG. 12

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NASA making big push for sophisticated electro-optical sensors for Earth-observation satellites



BY **John Keller**
EDITOR IN CHIEF

U.S. Earth-observation specialists are placing renewed emphasis on space-based sensors development for ever-more-sophisticated electro-optical satellite payloads to keep tabs on how the planet's environment is evolving.

These satellite sensor payloads will involve electro-optical sensors, RF and microwave sensors, or a combination of both — including hyperspectral sensors, which involves slicing an image into many different spectral bands to uncover details that otherwise might be hidden.

In late May, the National Aeronautics and Space Administration (NASA) announced plans to ask industry to develop a new hyperspectral infrared sensor to fly on the Geostationary Extended Observations (GeoXO) series of geostationary Earth-observation satellites.

The sensor will be a hyperspectral ultraviolet-through-visible-imaging spectrometer to measure environmental data as part of a 3-axis stabilized geostationary weather satellite system. It will imagery for national air quality forecasting, hazard forecasting, and fire pollutant forecasting and warnings.

NASA officials say they expect to ask industry to build two ACX sensors flight models, with an option for an additional spare flight model. The base contract will ask industry to build, deliver, integrate, and support one flight model and parts for a second flight model. A draft RFP is expected in July, and a final RFP is expected in September. The anticipated contract award date is April 2024.

A separate sensor payload for the GeoXO satellites is called the GeoXO Lightning Mapper (LMX) instrument, which will be a single-channel near-infrared optical persistent surveillance sensor

to monitor for potentially damaging lightning storms near the Earth's surface, which could indicate threats to property, commercial aviation, and the formation of tornadoes.

NASA announced plans in late April to release a formal solicitation for the LMX instrument sometime this month. Lightning mapping from geostationary orbit improves severe storm analysis and increases lead time to detect tornado formation. The LMX instrument should improve lightning hazard detection, hurricane intensity prediction, wildfire detection and response, heavy rain estimation, and aviation hazard mitigation.

Geostationary lightning data is available where other sources are more limited — especially over oceans and in mountainous and rural areas. The data updates faster than local radar, and also fills-in radar coverage gaps. Lightning is an essential climate variable necessary to understand and predict changes in climate, NOAA experts say.

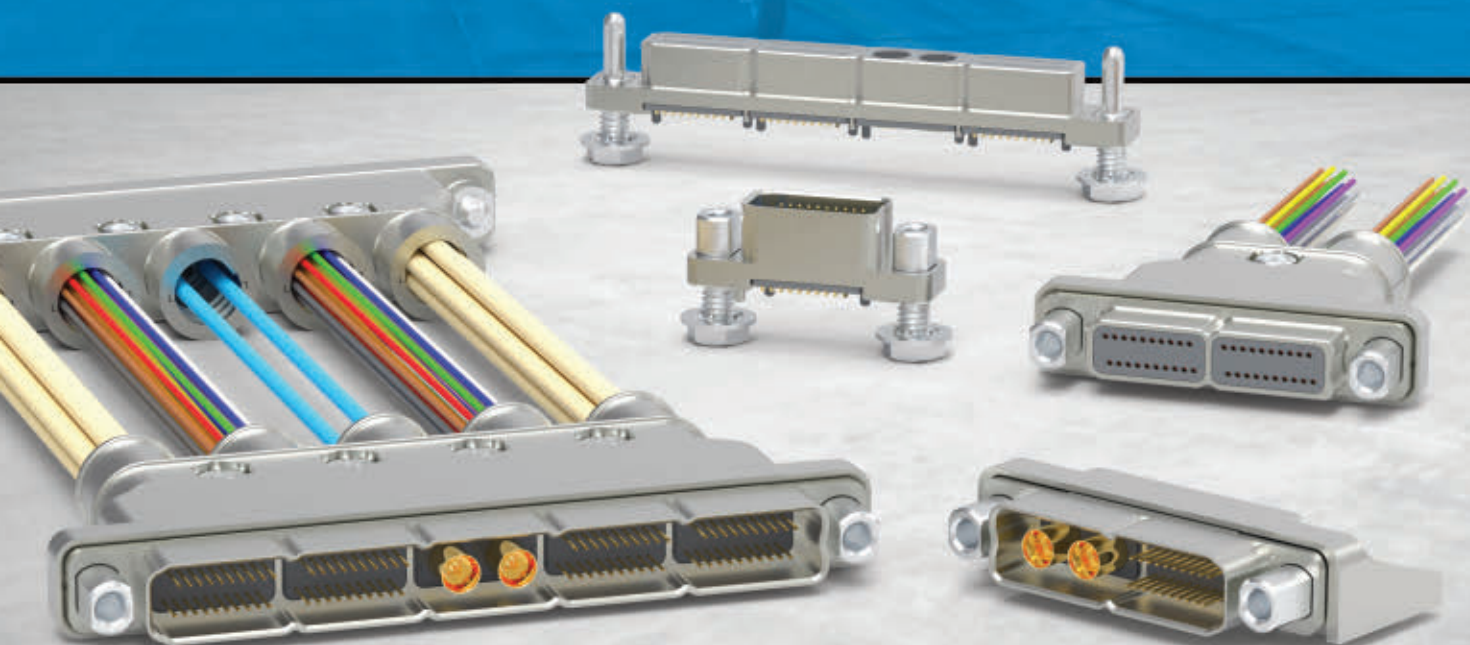
Polar orbits place sensors and electronics in hazardous environments because of high radiation levels, which require radiation-hardened electronic components, as well as other safeguards to protect orbiting electronics from the harsh environment of polar orbit.

The study will tell NASA about the feasibility and risks of current Polarimeter requirements and design concepts, and help improve requirements for a potential Polarimeter Instrument solicitation.

Not only will these projects involve sophisticated sensors development, but also will call for environmental hardening against the effects of space radiation, shock and vibration from satellite launches, and the temperature extremes of orbital space. ←

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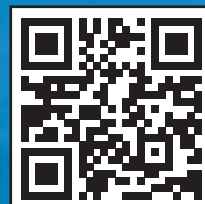


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Lockheed Martin to provide sonar signal processing for undersea surveillance system

BY John Keller



SAN DIEGO – Undersea surveillance experts at Lockheed Martin Corp. are enhancing technology to detect, classify, and track quiet enemy diesel attack submarines in shallow coastal waters.

Officials of the Naval Information Warfare Systems Command (NAVWAR) in San Diego announced an \$19.1 million contract to the Lockheed Martin Rotary and Mission Systems segment in Manassas, Va., for the Integrated Common Processor (ICP) program.

ICP provides a common Integrated Undersea Surveillance Systems (IUSS) signal processing and display system software and hardware suite for Surveillance Towed Array Sensor System (SURTASS) ships and IUSS shore sites.

The ICP is a component of the Navy's Maritime Surveillance Systems (MSS) system of fixed, mobile, and deployable acoustic arrays that help detect, localize, and track quiet diesel and nuclear submarines.

The IUSS is a large-area ocean basin surveillance system to track surface ships and submarines over large swaths of

▲ **The Integrated Common Processor (ICP) provides a common Integrated Undersea Surveillance Systems (IUSS) signal processing and display system for towed-array sonar.**

the world's oceans. It consists of fixed fields of hydrophones and sonar sensors such as the Sound Surveillance System (SOSUS) and Fixed Distributed System (FDS); the Advanced Deployable System (ADS) relocatable sonar sensor field; the Surveillance Towed-Array Sensor System (SURTASS) aboard long-endurance surveillance ships; and the Surveillance Direction System (SDS) that provides command, control, communications, and data fusion to combine the capabilities of SOSUS, FDS, and SURTASS. Navy anti-submarine warfare (ASW) experts are fine-tuning MSS technology to be effective against modern diesel and nuclear submarines in regional, littoral, and broad ocean areas of interest. That's where the ICP program comes in.



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ICP is developing the capability to process and display data from all fixed and mobile underwater systems to take advantage of automation advancement, array technology improvements, hardware insertions, and the common software components of the submarine and surface undersea warfare systems.

Eventually the ICP program is intended to provide processing power to support the Navy's low-frequency active (LFA) ASW bistatic sonar processing using the Lockheed Martin Twin-line 29A towed-array sonar for SURTASS submarine-hunting ships.

To optimize sonar signal-processing power and keep costs as affordable as possible, the ICP is capitalizing on the Navy's Acoustics-Rapid COTS Insertion (A-RCI) program, which uses the latest generations of commercially available computer server technology for sonar signal processing aboard Navy submarines and surface vessels.

The ICP has the capability to process and display data from all fixed and mobile underwater systems, and will be used for all new system installations and replace the legacy systems as they reach end of life and require upgrading.

Since 2011 Lockheed Martin engineers have been developing automation algorithms and techniques for addressing multi-array high beam count requirements in the ICP program, and have continued with sonar signal processing upgrades in coordination with the Submarine A-RCI program. ◀

On this contract Lockheed Martin will do the work in Manassas, Va., and should be finished by March 2024. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com/en-us/who-we-are/business-areas/rotary-and-mission-systems.html, or NAVWAR at www.navwar.navy.mil.

Homeland Security surveys industry for bistatic radar to detect and track unmanned aircraft

BY John Keller

WASHINGTON – U.S. Department of Homeland Security (DHS) researchers are surveying industry for stealthy bistatic radar systems able to detect and track small unmanned aircraft, with enabling technologies ranging from prototypes to flight-proven systems.

Officials of the DHS Office of Procurement Operations (OPO) in Washington have issued a request for information d(70RSAT23RFI000011) for the Passive Radar Systems for

Detecting and Tracking Small UAS project.

Bistatic radar seeks to conceal the locations of radar transmitters and receivers by processing RF and microwave reflections from commercial broadcast and communications signals, as well as from other non-cooperative sources of illumination.

The capabilities of today's small unmanned aerial vehicles (UAVs) are advancing more quickly than the ability to defeat them, officials point out. DHS wants to learn more about the availability of bistatic radar to detect and track these small unmanned aircraft.

Detecting bistatic radar performance; costs; mobility and maneuverability; level of maturity; system size, weight, and power consumption (SWaP); detection and tracking range; time to deploy and calibrate; and number of operators required.

Companies interested were asked to email responses by 9 April 2023 to cuasprogramsupport@hq.dhs.gov, with 70RSAT23RFI000011 in the subject line. Submissions with sensitive or proprietary information are discouraged. ◀



Bistatic radar seeks to conceal the locations of radar transmitters and receivers by processing RF and microwave reflections from commercial broadcast and communications signals.

Email questions or concerns to DHS at cuasprogramsupport@hq.dhs.gov. More information is online at <https://sam.gov/opp/dc03960af9464cdd8013e4570d6b2bd7/view>.

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BAE Systems to build 44 amphibious armored combat vehicles with modern vetronics

BY John Keller

QUANTICO, Va. — U.S. Marine Corps amphibious warfare experts are ordering another 44 amphibious armored combat vehicles and accompanying vetronics to replace the Corps's ageing fleet of amphibious assault vehicles (AAVs).

Officials of the Marine Corps Systems Command at Quantico Marine Base, Va., announced a \$256.9 million order to the BAE Systems Platforms & Services segment in Sterling Heights, Mich., for 27 Amphibious Combat Vehicle (ACV) personnel variants and 17 ACV command variants. The total cumulative value of the contract is \$1.7 billion.

In 2018 the Marine Corps chose BAE Systems as the prime contractor for the ACV and its vetronics suite over competitor Science Applications International Corporation (SAIC) in Reston, Va.

ACVs are wheeled armored combat vehicles able to move Marine infantry warfighters from ships offshore to fight their way onto invasion beaches. Marine Corps leaders cancelled the expensive expeditionary fighting vehicle (EFV) program in 2011.

The Marine Corps could end up purchasing as many as 204 vehicles over the next few years to outfit some of its 10 amphibious

assault companies — the first phase of an incremental approach to replacing the AAV, which entered service in 1972.

The ACV is designed to accommodate new capabilities in the future as technology evolves, such as reconnaissance sensors, electronic warfare (EW) equipment, anti-air sensors and weapons, and integration with uncrewed aircraft.

BAE Systems delivered the first vehicles in November 2019 to the 1st Marine Division. The first batch of 18 ACVs went to a platoon of the 1st Marine Division's 3rd Assault Amphibian Battalion at the Marine Corps Air Ground Combat Center in Twentynine Palms, Calif.

BAE Systems engineers are basing their ACV design on the Superav 8x8 amphibious armored personnel carrier developed by the Italian company Iveco Defence Vehicles.

ACV systems are designed to operate through enemy direct fire, indirect fire, and land mines with low-profile visual and infrared signatures, modular protection, and other armored vehicle technologies.

The vehicles can swim to shore from as far as 12 miles out to sea, switch from operating in the water to ground operations without pause, and then maneuver with M1 Abrams main battle tanks in a mechanized task force. The ACV can destroy relatively light enemy combat vehicles similar to itself.

The ACV will provide direct fire support for Marine infantry, and can carry 17 Marines at speeds of at least eight knots at sea amid three-foot waves with waves as large as three feet.

On shore, the ACV has high-ground clearance and a V-shaped hull to resist the effects of land mine blasts, and can operate with a wheel blown off.

Each ACV has a crew of three, an M2 .50 caliber machine gun in a remote weapons station, with the potential to install a stabilized dual-mount M2/Mark 19 grenade launcher turret. ◀



ACVs are wheeled armored combat vehicles able to move Marine infantry warfighters from ships offshore to fight their way onto invasion beaches.

On this order BAE Systems will do the work in York, Pa., Aiken, S.C.; San Jose, Calif.; Sterling Heights, Mich.; and Stafford, Va., and should be finished by July 2025. For more information contact BAE Systems Platforms & Services online at <https://www.baesystems.com/en-us/our-company/inc-businesses/platforms-and-services>.

U.S. Coast Guard selects Honeywell for helicopter weather radar

The U.S. Coast Guard sought a weather radar upgrade for its existing systems on its Sikorsky MH-60 Jayhawk and Eurocopter MH-65 Dolphin multimission helicopters. They found their solution from Honeywell in Phoenix. The Coast Guard selected Honeywell's IntuVue RDR-7000 radar system with automated tilt and gain controls, weather return display, and advanced surveillance of maritime vessels. The reduced size, weight, and power will reduce operational cost, improve fuel efficiency and enhance mission readiness, Honeywell says. The RDR-7000 uses 3D volumetric scanning across an extensive detection range to create a complete, real-time view of weather from 0 to 60,000 feet vertically and up to 180 nautical miles in front of the aircraft for typical helicopter applications utilizing a 12-inch antenna. For large helicopter and fixed-wing applications, the radar range can be extended up to 320 nautical miles by utilizing a larger antenna. The radar is also fully automated and does not require active pilot adjustments of tilt and gain controls for operation, reducing workload in the cockpit. The RDR-7000 will enable Coast Guard pilots to focus less on radar operation and more

on mission execution while operating in challenging weather conditions. Additionally, the RDR-7000 provides an advanced "Real Beam" maritime surveillance mode for detecting seaborne targets on the radar display.

FAA awards Verizon \$2.4 billion contract for telecommunications networking

The U.S. Federal Aviation Administration (FAA) has awarded the Verizon Communications business networking unit a contract worth as much as \$2.4 billion over 15 years to modernize civil aviation communications. The Federal Aviation Administration Enterprise Network Services (FENS) contract calls for Verizon to build the FAA a dynamic, highly available, and secure enterprise network to support all of the agency's mission critical applications across the National Airspace System (NAS), which includes providing air traffic management to more than 45,000 flights and 2.9 million airline passengers. FENS is the successor to the FAA Telecommunications Infrastructure (FTI) contract from 2002 to provide consolidated telecom services for the 5,000 facilities and 30,000 circuits in the NAS. By extension, FENS will serve as the *Continued on page 11*

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General Dynamics moves ahead with light tank and vetronics to support infantry

BY John Keller

WARREN, Mich. — Armored combat vehicles designers at General Dynamics Corp. will perform additional development work on a new U.S. Army light battle tank designed to support infantry brigade combat teams under terms of a \$15.6 million order.

Officials of the Army Contracting Command Detroit Arsenal in Warren, Mich., are asking General Dynamics Land Systems in Sterling Heights, Mich., to work on the Mobile Protected Firepower (MPF) system — a scaled-down version of the venerable Army M1A2 Abrams SEPv3 main battle tank.

The MPF has a 105-millimeter cannon, a 7.62 millimeter coaxial machine gun, externally mounted .50 caliber machine gun, and a 12.7 millimeter heavy machine gun. It also has an enhanced thermal viewer from Safran Optics 1 in Bedford, N.H.

The tank has a lightweight hull and turret, and a modern diesel engine, transmission, and suspension system. It is smaller and lighter than the Abrams main battle tank, and is easier to transport by aircraft.

The MPF has a four-person crew, and will target and destroy fortifications, bunkers, buildings, and light-to-medium armored vehicles. The lighter weight of the combat vehicle makes it more transportable and maneuverable.

▲ **The MPF has a four-person crew, and will target and destroy fortifications, bunkers, buildings, and light-to-medium armored vehicles.**

The vehicle has a range of 190 miles and can operate for 24 hours off the ramp or on arrival at drop zone. It can move over steep hills, valleys, cities, and ford rivers.

U.S. Army leaders say they plan to create an MPF battalion at the division level, from which

MPF companies will be allocated to infantry brigade combat teams. Each infantry brigade combat team will have 14 MPFs.

The light tank's vetronics will include the Safran PASEO commander's independent tactical viewer to provide long-range panoramic targeting and enhanced situational awareness.

General Dynamics won a \$1.14 billion contract last June to build as many as 96 MPF combat vehicles. Ultimately the Army is expected to buy more than 504 MPF combat vehicles through 2035. ←

On this order General Dynamics will do the work in Sterling Heights, Mich.; Anniston, Ala.; and Lima, Ohio, and should be finished by March 2024. For more information contact General Dynamics Land Systems online at www.gdls.com, or the Army Contracting Command Detroit Arsenal at <https://home.army.mil/detroit/index.php/units-tenants/acc-dta>.

Continued from page 9 primary means for FAA's telecommunications services and forms the basic infrastructure for the Next Generation Air Transportation System, or NextGen.

BAE Systems and Heart Aerospace collaborate on battery for electric airplane

BAE Systems in Falls Church, Va., and Heart Aerospace in Göteborg, Sweden, are working together to define the battery system for Heart's ES-30 regional electric airplane. The battery will be integrated into an electric conventional takeoff and landing (eCTOL) regional aircraft, enabling it to operate with zero emissions and low noise. The program will leverage more than 25 years of BAE Systems' expertise in electrifying large, heavy-duty industrial vehicles. BAE has over 15,000 power and propulsion systems operating in service across the globe. Work on the program will be conducted at the company's facility in Endicott, N.Y. The ES-30 airplane will be powered by four electric motors, and has an all-electric range of 200 kilometers, an extended reserve hybrid range of 400 kilometers with 30 passengers and ability to fly up to 800 kilometers with 25 passengers. The ES-30 will also have a scalable upgrade path as future battery technology matures. The battery upgrade roadmap allows for increased usable energy at the same weight, resulting in longer flight durations and expanded route options. Heart Aerospace has a total of 230 orders and 100 options for the ES-30, along with letter of intent for an additional 108 airplanes.

Swiss hypersonic hydrogen-powered jet could cut flights from Europe to Australia to four hours

Flying across the world from Europe to a destination such as Australia takes around 20 hours in a regular passenger jet. But a Swiss start-up is looking to cut that journey time down to just over four hours - with a hypersonic, hydrogen-powered

passenger jet. Destinus has announced a 12 million Euro grant from the Spanish government to help develop hydrogen-powered supersonic flights. "With these grants, hydrogen-based solutions for aeronautical mobility will be one step closer to becoming a reality," says David Bonetti, vice president of business development and products for Destinus. The company says its technology will enable long-haul flights to be about a quarter of the time as current passenger jets. ←

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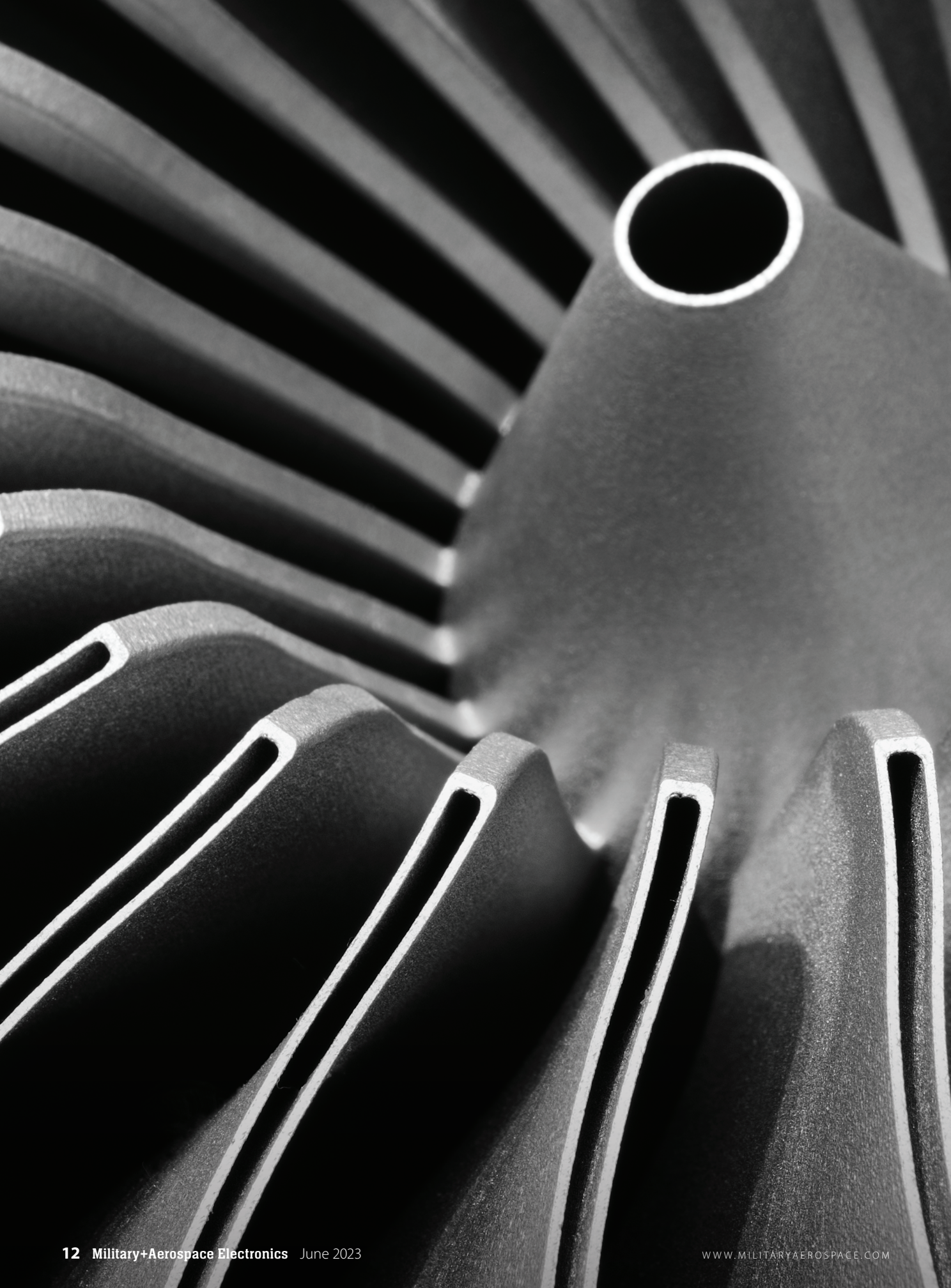
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The evolution of 3D printing and additive manufacturing

Military aviation and electronics systems stand to benefit from 3D printing as the technology matures and continues to be widely adopted throughout the defense industry.

BY Jim Romeo

3D printing and additive manufacturing are disrupting many industries, including military aviation, electronics, and the broader defense industry as its use continues in many ways.

3D printing eases prototyping by enabling engineers to prototype parts, components, and other forms rapidly to expedite development. It also may help produce tools and jigs for maintenance, assembly, and fabrication of parts and systems. It also may be used for actual production of parts by providing users a unique self-sufficiency to produce parts and forms that would otherwise have a long lead time, be costly to acquire, and impose risk of the part not working well or being useful.

Whereas a 3D printed part may be produced in rapid time, it allows for the experimentation of printing a part with various types of materials, and may produce parts and components in-house, without relying on costly and time-consuming production contracts.

Jeff DeGrange is the chief commercial officer at Impossible Objects Inc., a composite 3D printing company in Chicago. He views 3D printing as an advantageous technology with many benefits. "Aerospace and defense system components now can be designed to optimize air flow, minimize weight and consolidate parts into one integrated part for prototype, production and spare parts," he says. "Additive manufacturing processes have been used for years to make tooling that enables production of spare parts and other non-structural and structural components."

Add to the increased production capability of additive manufacturing, other technologies such as artificial intelligence (AI) and advanced printing techniques, and many more things are possible. Douglas Krone is the CEO of Dynamism Inc., a global supplier of next-generation 3D printing technology in Chicago. Krone has specific expertise in military, warfare, aeronautical, and space operations.

Matveev, Aleksandr/Stock/Getty Images Plus/Getty Images



He notes that 3D printers have increased capability stemming from advances in AI, precision, repeatability, and LED technology. Dynamism uses resin-based 3D printers to drive advances in panel resolution. He says such innovations enable 3D printers to deposit more energy, faster and at a given point. This allows faster printing and opens the capability to print in more advanced materials with a cost reduction in many ways.

“Military units can print replacement parts or equipment directly in the field or on naval vessels, reducing the need to carry large inventories of spare parts and allowing for faster repairs,” Krone says. “Ships at sea increasingly use 3D printers for temporary replacement parts, vastly reducing the number of spare parts that need to be carried on board.”

Ian Ferguson is the vice president of marketing at Lynx Software Technologies in San Jose, Calif. He notes the value of 3D printing in conserving time and schedule in producing parts and forms.

“Thinking big picture, I think the main challenge in this sector is decreasing time-to-system deployment,” Ferguson says. “With the headwinds of additional system complexity, supply chain, and hiring challenges, this is critical, and challenging. In this context, 3D printing is helping pilots familiarize themselves with new

▲ **With additive manufacturing, the range of design is expanded, and its potential is limitless. additive manufacturing delivers agility, consolidation and savings on lead-times, costs, and resources.**

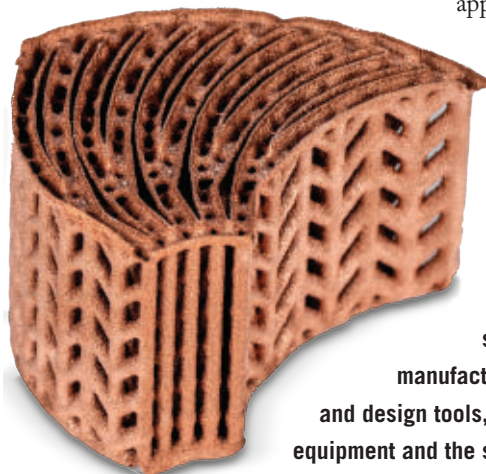
cockpit layouts significantly faster than would have previously been the case. At least in our area of the industry, this has been the impact we have seen so far.”

3D printing for defense

Krone adds that 3D printing fabricates parts with favorable characteristics, which often is necessary in defense applications. “The landscape is shifting towards smaller, more cost-effective platforms such as autonomous drones with differing levels of capabilities,” he says. “For systems that don’t need to fly for thousands of hours, there are opportunities to combine the most cost-effective electronics and physical enclosures that create a ‘good enough’ categorization.”

These systems, Krone explains, must be securely connected with other intelligent platforms for effective coordination of missions, and this leads to all sorts of new challenges related to cyber security. Competition is a great catalyst for innovation, and we believe that this will cause the traditional suppliers to respond with new approaches on delivering traditional materials, coupled with advanced modeling solutions, to support the overall theme of improved time to market.”

Additive manufacturing, with a myriad of materials selections, opens new possibilities for sourcing. Donald Gough is the senior manager of advanced manufacturing technology for Lockheed Martin Corp. in Orlando, Fla. He says 3D printing also can enable new capabilities.



◀ **3D printing is about enabling the entire system of capabilities surrounding additive manufacturing from materials and design tools, to manufacturing equipment and the supply chain.**

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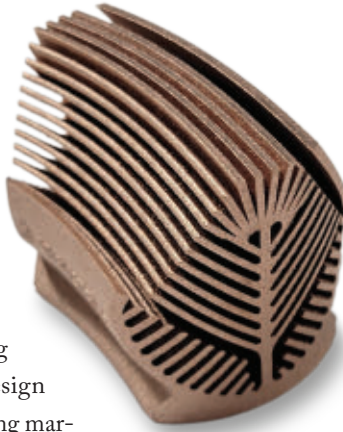


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“Additive manufacturing provides a new capability to help tackle the increasing complexity and affordability demands of the next generation of aerospace and defense products,” Gough explains. “While not without challenges, the benefits of 3D printing electronics extend beyond manufacturing methods by enabling new materials, design trades and sourcing strategies. This emerging market offers opportunities to streamline development cycle with rapid prototyping, enhance performance of new products with design for additive methodologies, and enable increased scalability in manufacturing.”

Gough points out that this opens up more possibilities and opportunities that otherwise would be constrained by the limitations of legacy manufacturing methods and processes.

“The use of 3D printed hardware continues to increase because it provides engineers with more latitude to explore new design trades without the traditional limitations from legacy manufacturing processes,” Gough says. “Rapid development cycles, advanced packaging concepts, and the ability to increase component complexity without the equivalent increases in manufacturing all contribute to the benefits surrounding additive manufacturing. Today we see common-use cases on products like antenna, sensors, and printed circuit boards for prototyping and



◀ **The use of 3D printed hardware continues to increase because it provides engineers with more latitude to explore new design trades without the traditional limitations from legacy manufacturing processes.**

production applications where complex geometries, multi-material applications, and optimized SWaP are all driving design trades.”

Another potential benefit of 3D printing is quality assurance. Kerim Genc is a product manager at design automation company Synopsys Inc. in Mountain View, Calif. He says that despite the many obvious advantages of 3D printing, experts still are trying to iron-out some of the quality quirks in its use.

“Although there has been significant investment in additive manufacturing, there is still a lot of uncertainty around build quality, especially for load bearing parts,” Genc says. “The industry is still developing the proper techniques for quality assurance and has even more work ahead to scale these techniques to production levels.”

The next few years, he adds, will see a slow transition to a more inward-looking industry, where quality and scalability are a bigger focus. “With this, we will see more and more critical components come to market via additive manufacturing. As research groups within government labs and industry figure out the best applications for additive manufacturing where the quality assurance is consistent and meets the required regulatory standards, they will be able to scale.”

Form follows function

When it comes to 3D printing, its versatility validates the expression “form follows function.” Mike Shepard is the vice president of aerospace and defense for 3D Systems Corp. in Rock Hill,



Additive manufacturing processes has been used for years to make tooling that enables production of spare parts and other non-structural and structural components.



Aerospace and defense system components now can be designed to optimize air flow, minimize weight and consolidate parts into one integrated part for prototype, production and spare parts.

S.C. He says additive manufacturing best enables form to follow function in developing designs for parts and components.

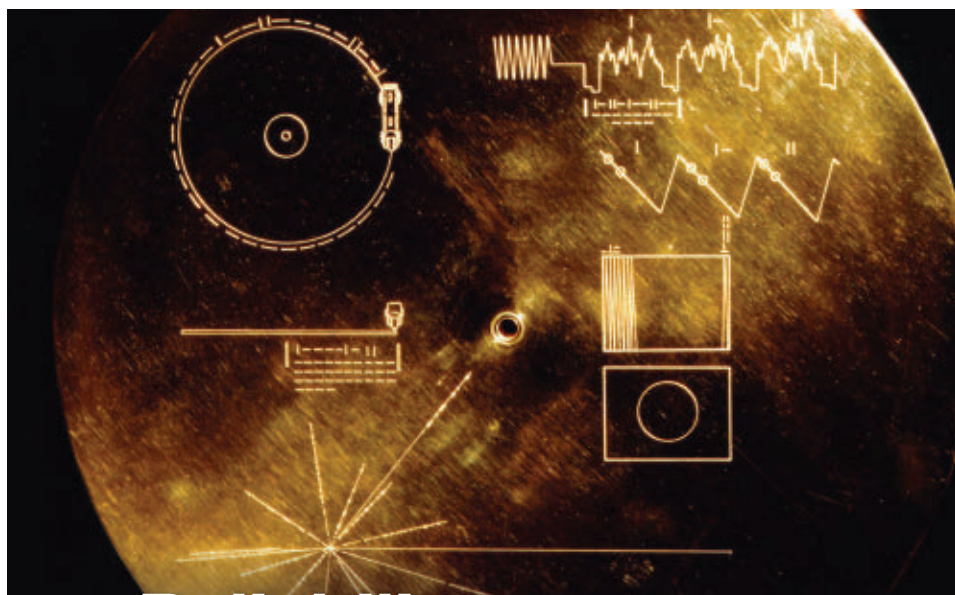
"New defense platforms are always looking for technology that can improve performance; 3D printing is an ideal tool for that," Shepard says. "It really unlocks your ability to manufacture complex and creative designs. Now, with many of the limitations of conventional manufacturing relaxed, components can be more closely tailored to suit the physics of the application. Form can closely follow function. An excellent example of this is what we see happening with 3D printing in electronics. We don't do direct printing of electronics commercially, but for us, we see tremendous activity in 3D printing to remove heat from electronics - heat sinks, heat pipes, and heat exchangers."

Shepard says that 3D printing has much versatility in what materials and feedstocks may be used for printing. This greatly increases the possibility of creating more favorable properties in printed forms, just by varying the materials.

"It has been so much fun to see what creative designers are doing with metal additive manufacturing for heat transfer," Shepard says. "In fact, we've had so many partners coming to our Application Innovation Group (AIG) to consult on heat transfer, that we've added some additional copper alloys to our materials portfolio. We've added pure copper, which is excellent for thermal conductivity, and the CuCr2.4 copper alloy, which still has very good thermal conductivity and added strength for added strength and durability.

"The heat exchangers that we can print on our direct metal printing (DMP) systems are remarkable, and because of our low oxygen printing environment (<25PPM O₂), the parts come out of the printers with an excellent surface finish," Shepard continues. "The metal has little to no additional oxygen pickup during printing, preserving conductivity. The low oxygen levels in our systems also let you reuse the powder to exhaustion."

Shepard says that using the design freedom you have with the direct metal printing process and the materials we have in the toolkit, you can move much more heat for a given volume/weight in the use case of the heat exchanger. "Increases can be on the order of hundreds of percent," Shepard says. "Oqton [a company that offers manufacturing software solutions for additive manufacturing applications] is even adding dedicated heat exchanger design tools to its 3DXpert software that we use for



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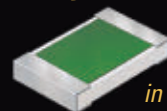
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Looking ahead

Heather Wickman is a manager at BAE Systems Electronic Systems in Nashua, N.H. She is the company’s defense materials engineering capability group lead, and says the future potential for additive manufacturing is tremendous.

“Additive manufacturing, though it is not new, is nowhere near fully mature and thus, has great growth potential of new materials in polymers and metals,” Wickman says. “Polymer improvements that will displace the use of metal for certain applications. The evolution of metals will continue to yield more “tailorable alloys” for performance in addition to expanded manufacturing capabilities using hybrid manufacturing where the build life cycle of a part becomes greatly economized and condensed. Additionally, the application of generative design coupled with the maturing of AI are vectors that will make great strides in influencing the advancements of thermal management and structural innovations.”

The potential benefits for electronics applications will range from maturing the fidelity and complexity of circuit cards, direct write metal and dielectric traces, antennas in addition to playing a significant role in heterogeneous integration, Wickman says.

She also notes that additive manufacturing is still in a growth and adoption phase, there are still some hurdles to cross. “Additive manufacturing is like any technology that is maturing in its



Additive manufacturing processes has been used for years to make tooling that enables production of spare parts and other non-structural and structural components.

application and has the hurdles of validation and qualification which, is not trivial and with the aerospace and defense qualification requirements,” she says. “However, challenging these hurdles may be worth the investment. It’s clear that additive manufacturing is wrought with opportunities for the industry and when applied judiciously can yield systems that accommodate the ever-increasing sophistication and demands of technology, like electronic warfare, that can facilitate a platform’s overall performance.”

William Downing is a design engineer for the Weapons System Test Engineering Branch of the Integrated Engagement



Photo (left): Lockheed Martin Corp. uses 3D printing and additive manufacturing to create complex shapes quickly for systems design and maintenance. Photo (right): Production assembly areas derive lead-time and cost saving benefits using additive manufacturing for consumable fixtures and tools.



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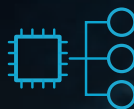
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Systems Department at Naval Surface Warfare Center Dahlgren Division in Dahlgren, Va. "One of our technologies, additive manufacturing, is a great tool when used properly with conventional machine processes. You need to use a slightly different way of thinking and design process to get the most out of additive manufacturing. Printed scaled down models can make a positive impact in meetings and presentations. It is helpful to actually see a part and be able to point out and see all the features."

The great thing about 3D printing is that it is always about inventing and moving forward, says Mark Menninger, director of U.S. government business, for 3D printer manufacturer Stratasys Ltd. in Rehovot, Israel. "Whether you are talking about new hardware, software or materials, there is a huge opportunity to take additive manufacturing to new levels. Beyond that, additive manufacturing will take on new heights when it comes to mass production, making additive manufacturing even more common." ←



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Additive manufacturing parts have been used for decades for environmental control parts for maintaining strict air flow and temperature control of avionics and flight control electronics.

Additive manufacturing and 3D printing at Northrop Grumman

Northrop Grumman Corp. is leveraging 3D printing to innovate and enhance its products and services. The company has been using this technology for more than two decades to produce parts and components for aircraft, satellites, and other systems.

Additive manufacturing enables Northrop Grumman to produce parts and components with complex geometries that cannot be achieved through traditional manufacturing methods, such as casting or forging. The technology also enables the company to produce parts and components with reduced weight and improved durability, as well as lower lead times and costs.

Northrop Grumman also has invested more than \$70 million in additive manufacturing, and has integrated more than 5,000 additive manufactured parts into their aeronautical platforms, all sourced from small- and medium-sized suppliers. Additionally, the company collaborates with universities and colleges. A notable additive manufacturing process they employ is direct metal laser sintering, which utilizes a laser to melt powdered metal and create complex parts.

One notable example of their advancements in additive manufacturing (additive manufacturing) has been applied

space applications. Specifically, they were involved in NASA's Artemis I mission, where they designed twin solid rocket boosters for the Space Launch System (SLS) rocket.

In 2020, Northrop Grumman transported 10 rocket motor segments from Promontory, Utah, to the Kennedy Space Center. At the center, these motor segments were assembled into two separate solid rocket boosters. The assembly process of these boosters incorporated 3D printing and computer modeling. These technologies were utilized to modify existing component designs from the shuttle program and create new components that are compatible with the existing assembly processes.

They use a variety of additive manufacturing processes, including powder bed fusion, directed energy deposition, and polymer 3D printing. The company also has developed its own proprietary processes and materials to meet specific requirements and applications.

Like many other engineering and technology companies, they are putting additive manufacturing to work to enhance engineering and design processes. The company uses 3D printing to produce prototypes and models of its products, enabling quick design iterations and more efficient testing. ←

Department of Defense 3D printing and additive manufacturing strategy

The U.S. Department of Defense (DOD) is bullish on the future of 3D printing and its value to defense applications. DOD leaders have unveiled an additive manufacturing strategy to bolster warfighter readiness and secure a competitive edge in military operations.

The strategy serves as a roadmap for the adoption of additive manufacturing technology within the DOD, pinpointing key areas that require development and investment. The strategy document, Department of Defense Additive Manufacturing Strategy, is online at <https://www.cto.mil/dod-additive-manufacturing-strategy/>.

Recognizing additive manufacturing as a critical capability for maintaining technological superiority on the battlefield, the DOD highlights its potential to facilitate rapid production of parts and components, ultimately reducing the logistical burden of stockpiling a vast inventory of spare parts. Moreover, additive manufacturing enables the design and production of intricate, customized components that are often challenging or even impossible to manufacture using traditional methods.

To harness the potential of additive manufacturing, the DOD's strategy encompasses several crucial focal points:

- Strengthening the additive manufacturing workforce and infrastructure within the DOD. Acknowledging the need for a highly skilled workforce capable of designing, producing, and maintaining additive manufacturing systems, the strategy calls for increased investment in educational and training programs. Additionally, the development of additive manufacturing-centric facilities and infrastructure is deemed essential.
- Establishing standards and specifications for additive manufacturing materials and processes. Ensuring the quality and consistency of additive manufacturing-produced parts and components is a priority for the DOD. Consequently, efforts are underway to establish industry standards and specifications for additive manufacturing materials and processes, enabling interoperability across various additive manufacturing systems while ensuring the reliability and safety of additive manufacturing-produced components.
- Investing in additive manufacturing research and development. The DOD plans to allocate resources to additive manufacturing research and development initiatives, aiming to advance

the state of the art in additive manufacturing technology. This encompasses the exploration of new additive manufacturing materials, processes, and systems, as well as the discovery of novel applications for additive manufacturing technology.

- Integrating additive manufacturing technology into DOD supply chains. The DOD aims to seamlessly integrate additive manufacturing technology into its existing supply chains, empowering the rapid production of critical parts and components in the field. By doing so, the burden of maintaining a substantial spare parts inventory will be alleviated, while the DOD gains the agility necessary to respond swiftly to emerging threats and operational requirements.

The strategy further outlines specific initiatives that the DOD intends to pursue as part of its additive manufacturing adoption efforts. These include:

- Establishment of an additive manufacturing community of interest (COI) to foster collaboration and information sharing among DOD stakeholders involved in additive manufacturing.
- Investment in additive manufacturing-centric infrastructure, encompassing the creation of additive manufacturing centers of excellence and the development of additive manufacturing-centric software and data systems.
- Development of additive manufacturing-specific certification programs to ensure that DOD personnel involved in additive manufacturing operations possess the requisite training and qualifications.
- Formation of partnerships with industry, academia, and other government agencies, thereby leveraging their expertise and resources in the realm of additive manufacturing technology.

The DOD's additive manufacturing strategy represents a significant stride forward in the military's embrace of advanced manufacturing technologies. By embracing additive manufacturing, the DOD seeks to enhance its readiness and agility on the battlefield, while concurrently bolstering its competitiveness and technological advantage. Supported by industry, academia, and other government entities, the DOD is poised to assume a leadership role in the development and adoption of additive manufacturing technology, guaranteeing that the military remains at the vanguard of technological innovation and excellence. ◀



The quest for commercial-performance electronics in space

Satellite and spacecraft designers seek to apply state-of-the-art capabilities of commercial electronics components for short- and long-duration missions in the radiation environments of space.

BY John Keller

The sharply growing number of space applications today is driving innovation in radiation-tolerant and radiation-hardened electronics for tasks ranging from signal processing, digital conversion, power management and control, and solid-state data storage.

The primary trend is to design rad-hard and rad-tolerant electronics affordably enough and with sufficient performance to accommodate the widest possible range of space missions, from short-duration low-Earth-orbit commercial small satellites to deep-space missions such as exploration of Jupiter and its moons.

That's not an easy task. Rad-hard electronics parts historically have been expensive and lag in performance behind their commercial counterparts. For today's booming space industry, that's no longer acceptable.

Today's rad-tolerant and rad-hard electronics parts must offer performance comparable to state-of-the-art commercial components, must offer at least some level of resistance to space radiation, and offer unprecedented levels in small size, weight, power consumption, and cost (SWaP-C). Achieving these goals is among the biggest challenges in the space industry today.

▲ Electronics designers are leveraging commercially developed chip technologies to bring state-of-the-art capabilities to space.

Rad-hard design

On the high and somewhat-expensive end, some rad-hard suppliers are designing parts specifically to operate reliably long term in radiation environments like space, high-altitude aviation, and the nuclear power industry. "Our enabler is the radiation-hardened by design methodology," explains Jens Verbeeck, CEO of rad-hard parts supplier Magics Technologies nv in Geel, Belgium.

"We use multiple technology nodes from commercial foundries where they also build state-of-the-art components," Verbeeck says. "We have developed libraries and simulations with a design library, and we can make state-of-the-art components that have unmatched performance. We are working on AI [artificial intelligence] accelerator cores for next-generation optical payloads to be used in space, which are used for mapping everything that happens on Earth."

In addition to starting with commercial designs, Magics also can provide custom designs for radiation-hardened electronics. "We can make the chip really bottom-up," he says. "By knowing the specifications of our customer, we make the schematics and lay out the chip, which then goes to a commercial foundry. We can use any foundry; that's the neat thing about it."

Magics' Verbeeck points out that his company's design approach "is not based on upscreening of COTS [commercial off-the-shelf] parts. It is based on state-of-the-art components, and we also can bring that semiconductor evolution to the space domain."

VPT Inc. in Blacksburg, Va., takes a different approach, and relies on testing commercial parts to determine which ones could meet the needs of many different space missions, depending on the radiation environment.

VPT specializes in radiation-hardened power control and conditioning parts for space applications in a wide variety of radiation environments. "There are lots of ways to deal with radiation. Shielding is one, but you can't completely get rid of the problem with shielding," says Leonard Leslie, vice president of engineering at VPT.

"The solution involves parts selection, and determining which parts can withstand the radiation with parts testing. We have several lines of our power converters that are designed for the space environment.

Using commercial fabs

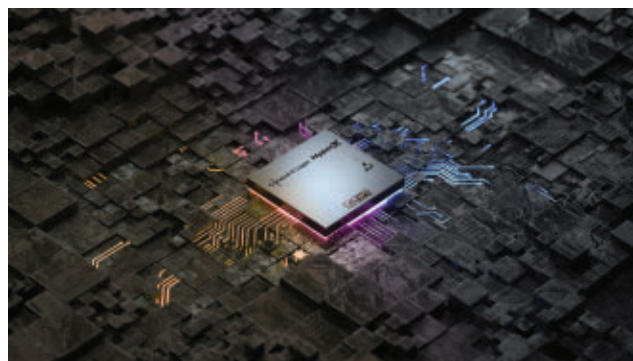
Apogee Semiconductor in Plano, Texas, also relies on using commercial semiconductor technology as a baseline for their space components designs. "We have a rad-hard process to fabricate in commercial foundries to develop lower-cost components," says Anton Quiroz, CEO and founder of Apogee Semiconductor.

"Our process works with commercial foundries to take their standard circuits and improve their radiation performance by an order of magnitude," Quiroz explains. "We leverage equipment the fab already has to develop a transistor with the performance of a standard transistor. We proved our process. We then used the process and IP blocks to develop a pulse width modulation [PWM] controller for power management for different voltage domains. It is an hybrid analog and a digital controller."

Apogee also can radiation-harden plastic encapsulated semiconductors for space applications to provide high-performance parts at relatively low costs. "Our main release is in plastic packages," Quiroz says. It offers better performance and is less expensive. These parts tend to be smaller and weigh less."

The company also relies on extensive parts testing and upscreening based on statistical process control monitoring. "This helps us take some tests out of our screening flow and really reduce the cost of the components," he says. "We look at statistics of our products from lot to lot, and identify outliers."

Offering one of the widest selections of radiation-hardened and radiation-tolerant parts is Microchip Technology Inc. in Chandler, Ariz. "We have rad-tolerant enhancements not designed originally for space," says Nicholas Ganri, senior product manager



The Coherent Logix HyperX family of radiation-hardened software-defined processors offers the ability to do on-orbit processing at data plane rates, and is for low-, medium-, geosynchronous orbits.

for aerospace and defense at Microchip. "On top of that, we have rad-hard devices especially designed for aerospace and defense and space market."

Ganri explains that Microchip experts seek to avoid expensive complete device redesigns to qualify them for space in some, if not all, radiation environments. "If we can introduce some radiation hardened designs without redesigning everything it is better for performance and time to market." He says a large scope of radiation-tolerant devices for aviation and space can start from parts designed originally for commercial or automotive uses.

So called "new space," which involves the emergence of private space industry companies involved in applications such as private launch endeavors, small satellite constellations, or sub-orbital tourism, is driving innovation in radiation-tolerant and radiation-hardened electronics.

"Players in new space are starting to think in a different way," Ganri explains. "They are using commercial devices as much as they can, challenging the level of the component according to the missions they have to manage. Radiation impact is linked to duration. This involves not only technological expertise, but also new levels of risk management. If you have a large satellite constellation, you can take the risk of losing one, but with one large satellite in geosynchronous orbit, you can't take risks with the components."

Just how well electronic parts resist the effects of space radiation is up to the customer, Ganri explains, "according to the profile of the mission, they can leverage the hardness of the device. We don't drive the choice of the customer; we offer what we have, and then it is up to each customer to select the right device for the application."

Microchip often can select or tailor rad-hard and rad-tolerant parts to specific target environments "We can take a commercial part, raise it to radiation-tolerant level, and put it in a ceramic

package, and qualify it for space,” he says. “For some we can keep the plastic package and add some additional qualification beyond automotive-grade where we improve some life tests, impose some qualification reports that we propose around our rad-plastic flow for our customers. It is an additional solution. On top of traditional ceramic solution.”

Rad-hard solutions

Coherent Logix Inc. in Austin, Texas, offers the HyperX family of radiation-hardened software-defined microprocessors. One of the family’s early models, the hx2100, has seen design-ins in a variety of space projects, says Michael Doerr, CEO and chief technology officer at Coherent Logix.

“Satellite payloads, communications, or critical control systems in a spacecraft historically have been built stove-piped with one function and one use case,” Doerr explains. “That’s not the case anymore. Satellites are multi mission capable, and evolve their missions over time, and need reliability. “Today you Need a fully programmable solution up there. Traditional solution is FPGAs, but are high power, and are not friendly to reprogram from a mission standpoint. To build an ASIC would be very expensive. Our solution provides the performance of an ASIC or FPGA, but has the power consumption of an ASIC. Now getting the best of both worlds. Used to be a pure hardware solution and now is a software solution.

The Coherent Logix HyperX family of programmable space processors offer “a fully software-defined platform for communications, video imaging, AI, and adaptive processing on the satellite, with software-defined networking, and active cyber security. Now you have the ability to do that.”

The HyperX family offers the ability to do on-orbit processing at data plane rates,” Doerr says. “It’s an absolute game-changer

with what we can do with cyber security and software-defined networking. The HyperX family, he says is a different type of fabric. “Some call it polymorphic, others call it multiprocessor fabric. It’s a blend of all of those. Its heritage is looking at biologically inspired systems of how our brain works. It is digital neuromorphic processing -- a unique architecture that is now being accepted into the marketplace.”

HyperX can be designed for low-, medium-, geosynchronous orbits -- for short- and long-duration missions, Doerr says. The company’s latest offering is the radiation-hardened HyperX: Midnight system on chip (SoC) processor for commercial space applications like communications satellites. HyperX: Midnight offers as much as four times the computing throughput, half the power consumption, and a 40 percent lower price compared to leading radiation-hardened field-programmable gate arrays (FPGAs), company officials say.

Software-defined space processors

This enables greater capabilities to be packaged in smaller satellite bus sizes to help lower launch costs and accelerating industry growth. HyperX: Midnight also brings software-defined operations, C-programmability, and simplified software debugging to commercial space. Combined with Coherent Logix’s HyperX Studio design suite, these features offer full on-orbit re-programmability, so improvements can continue long after launch. HyperX SoCs support market solutions across several sectors, including consumer electronics, 5G mobile infrastructure, video/broadcast infrastructure, machine vision, sensor processing, and artificial intelligence.

Renesas Electronics America in Palm Bay, Fla., offers radiation-hardened power conditioning and control components for space applications. Driving power innovation for space are increasingly power-hungry components for space systems such as the Versal field-programmable gate array (FPGA) from Xilinx Inc. in San Jose, Calif. “The Xilinx Versal FPGA is getting a lot of traction, yet with its feature set it requires so much more power, so you need to design new solutions around it,” says Josh Broline, senior director of product marketing applications at Renesas.

“We have a full solution set for Versal and every other FPGA out there today,” Broline says, explaining that satellite electronics designers are minimizing the amount of data uplinks and downlinks to Earth today, and increasingly use on-board processing that the Versal offers.

“They have to do real-time acquisition of fast-moving projectiles, and make decisions in real time. That’s the real deal when it comes to applications,” Broline says. We also are pushing the



Microchip Technology offers a wide variety of electronics components for space applications, ranging from upscreened inexpensive components to chips designed from the ground up to be radiation hardened.



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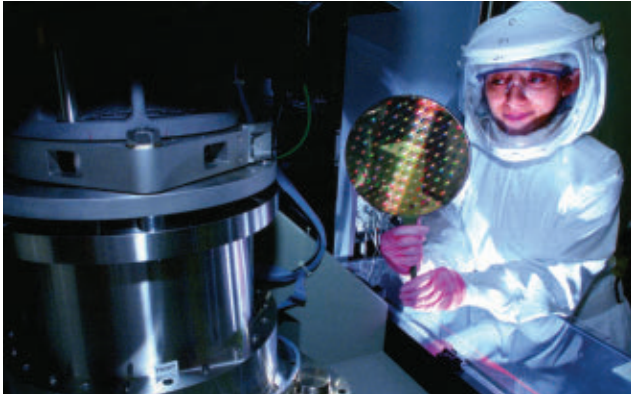
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Chip fabs still are manufacturing processors and other electronic components specifically for radiation environments in space, but commercial satellite constellations are encouraging chip makers to upscreen commercial chips for specific environments.

envelope in precision A-D converters to optimize the resolution and what you can get off of sensors aboard a spacecraft or rover.”

Demands for on-satellite data processing are expected to grow into the foreseeable future. “At the systems level, what happens in the optical communications area for satellite-to-satellite communications, and satellite to ground? “We need to plan for multi-orbit strategies and capabilities, and to move and adapt to the customer’s needs.”

The future will bring new generations of reconfigurable and flexible satellites, software-defined communications and functionality, and similar on-orbit capabilities. “I expect innovation to come out of system level, and that will pull the component suppliers to meet customer needs.

Influential space programs

Microchip is involved in the High-Performance Spaceflight Computing (HPSC) processor project of the U.S. National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory in La Cañada Flintridge, Calif. Microchip is developing a space processor that will provide at least 100 times the computational capacity of current spaceflight computers.

Microchip will build the HPSC processor over three years, with the goal of employing the processor on future lunar and planetary exploration missions. Microchip’s processor architecture will improve the overall computing efficiency for these missions by enabling computing power to be scalable, based on mission needs. The work is under a \$50 million contract, with Microchip contributing significant research and development costs to complete the project.

“We are making a joint investment with NASA on a new trusted and transformative compute platform that will deliver comprehensive

Ethernet networking, advanced artificial intelligence and machine learning processing, and connectivity support while offering unprecedented performance gain, fault-tolerance, and security architecture at low power consumption,” says Babak Samimi, corporate vice president for Microchip’s Communications business unit.

“We will foster an industrywide ecosystem of single-board computer partners anchored on the HPSC processor and Microchip’s complementary space-qualified total system solutions to benefit a new generation of mission-critical edge compute designs optimized for size, weight, and power,” he says.

Current space-qualified computing technology is designed to address the most computationally intensive part of a mission, which leads to overdesigning and inefficient use of computing power. Microchip’s new processor will enable the device’s processing power to ebb and flow depending on current operational requirements. Certain processing functions can also be turned off when not in use to reduce power consumption.

“Our current spaceflight computers were developed almost 30 years ago,” says Wesley Powell, NASA’s principal technologist for advanced avionics. “While they have served past missions well, future NASA missions demand significantly increased onboard computing capabilities and reliability. The new computing processor will provide the advances required in performance, fault tolerance, and flexibility to meet these future mission needs.”

The U.S. Space Force has kicked-off a program to design next-generation radiation-hardened non-volatile memory chips for future military applications in space in the Advanced Next Generation Strategic Radiation hardened Memory (ANGSTRM) project. The U.S. Air Force Research Laboratory’s Space Vehicles Directorate at Kirtland Air Force Base, N.M., issued an ANGSTRM solicitation on behalf of the Space Force last January to develop a strategic rad-hard non-volatile memory device with near-commercial state-of-the-art performance by



Microchip is developing the NASA High-Performance Spaceflight Computing (HPSC) processor that will provide at least 100 times the computational capacity of current spaceflight computers.



RADIATION-HARDENED

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using advanced packaging and radiation-hardening techniques with state-of-the-art commercial technology.

Advanced rad-hard memory

Advancing strategic rad-hard non-volatile memory technologies is critical to support strategic missiles, missile defense, and military space systems, researchers say. Non-volatile memory devices retain their data even when they lose power. Ideally, the DoD would have access to non-volatile memories with the performance and density of commercial state-of-the-art devices; unfortunately today's commercial technologies are not able to withstand the radiation and thermal environments where the military deploys systems. Many military systems, moreover, must use trusted on-shore electronics manufacturing.

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

Researchers want to industry to develop rad-hard memories with monolithic memory densities of 4 to 16 gigabits, and with multichip module densities of 32 to 128 gigabits that will last without refresh for 10 to 15 years. Memory devices should operate with no more than 10 milliwatts of power, with 1 milliwatt performance preferred. Total standby power requirements are no more than 10 milliwatts, and as little as 10 milliwatts. These devices should operate in temperatures from -40 to 125 degrees Celsius, and eventually down to temperatures of -55 C. Companies interested were asked to submit white papers by February.

Last October the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a broad agency announcement for the Space Power Conversion Electronics (SPCE) project to develop radiation-tolerant high-voltage transistors with high performance and small size to enable compact, high-conversion-ratio point-of-load power converters for space applications.

SPCE seeks to develop high-performance integrated radiation-tolerant high-voltage transistors that perform better

than today's advanced wide bandgap semiconductor (WBGs) high-voltage devices for non-radiation environments. Researchers seek to demonstrate a 48 V-to-1 V radiation-tolerant point-of-load converter with better than 85 percent power at 50 amps of output current, with power density greater than 500 Watts per cubic inch.

To do this, researchers have laid out two key technical challenges: achieving a high-performance high-voltage transistor that is radiation-tolerant; and achieving a low-loss, high-voltage integrated circuit that is radiation tolerant. Today's most advanced space point-of-load systems use discrete radiation-hardened silicon lightly doped-drain MOSFET (LDMOS) transistors, which limit the overall point-of-load efficiency to less than 60 percent. To avoid single-event burnout, these LDMOS transistors operate at a maximum voltage substantially lower than the device breakdown voltage, which leads to degradation in performance. The SPCE project focuses on two technical areas: radiation-tolerant high-performance high-voltage transistor and high-efficiency point-of-load DC-DC converter; and fundamental device exploration. Companies interested were asked to submit proposals by last December. ←

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Wanted: diamond semiconductors for RF, microwave, and power electronics

BY John Keller

ARLINGTON, Va. – U.S. military researchers are asking industry find new ways of fabricating device-grade, large diameter, single crystal diamond substrates for radio-frequency (RF) and power electronics that must operate in harsh environmental conditions.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a solicitation (DARPA-PA-21-05-03) for the Large Area Device-Quality DIamond Substrates (LADDIS) project.

LADDIS seeks to develop techniques for substrates for diamond semiconductors with diameters larger than 50 millimeters, dislocation density below 103 square millimeters, surface roughness below 0.2 nanometers, and good electrical, thermal, and mechanical properties.

Diamond is an ultra-wide bandgap semiconductor that offers a path for developing harsh-environment power electronics and

▲ **Diamond helps power electronics and RF and microwave components operate at high power levels and at high temperatures.**

RF and microwave components that are able to operate at high power levels and at high temperatures.

At the same time, conventional electronics built on silicon, gallium arsenide, or wide band-gap materials are limited in breakdown voltage, power handling, and operating temperature. Diamond's large bandgap and thermal conductivity can overcome these limitations.

Semiconductor fabrication technologies, however, remain a challenge. Reproducible large-diameter device-quality diamond substrates have hindered the demonstration of electronics with higher breakdown voltage or current compared to existing technology.

Diamond substrates today are no larger than 5 to 10 square millimeters and have dislocation density as high as 105 square millimeters, which degrades device performance and manufacturability.

Commercially available substrates also have large variability in material quality such that previous attempts at wafer size scaling exhibited dislocation density as high as 109 square millimeters, and can crack due to stress.

Some chip fab technologies have been promising. Seed tiling, for example, has been used to incrementally scale the diameter of diamond substrates. Seed tiling is a variation of homoepitaxy in which individual diamond seeds are arrayed together, followed by lateral overgrowth using CVD to connect the individual seeds into one larger, single crystal seed.

This technique requires optimizing growth conditions to minimize defects at the tile boundary. In addition, new heteroepitaxial growth approaches have been developed, in which diamond grows from nucleation layers deposited on a different substrate.

Innovations in reactor design, substrate holders, and growth processes also have been shown to minimize thermal gradients and ensure a uniform growth rate, which lowers the built-in stress of the diamond material.

Exploration of these techniques will provide insights into creating viable approaches for the manufacturing of large-diameter single-crystal diamond substrates.

The LADDIS program will provide the basis for developing a domestic, commercial source for diamond substrates to enable manufacturing of high power and high temperature microelectronics. These devices would support several U.S. Department of Defense (DOD) platforms and arrays by enabling kilowatt-class low-loss front end receiver protect circuitry, as well as 10-kilovolt-class low-loss switches necessary for future electric ship power systems.

The total award value for the 18-month LADDIS program is limited to \$1 million. The program has one technical area developing diamond growth and polishing techniques. Proposals are limited to a single growth and polishing method, yet proposers may submit several standalone proposals for different growth approaches.

Proposers will develop growth approaches such as homoepitaxial or heteroepitaxial to fabricate diamond substrates and demonstrate more than 30 millimeters diameter, single crystal substrates with low dislocation density. ←

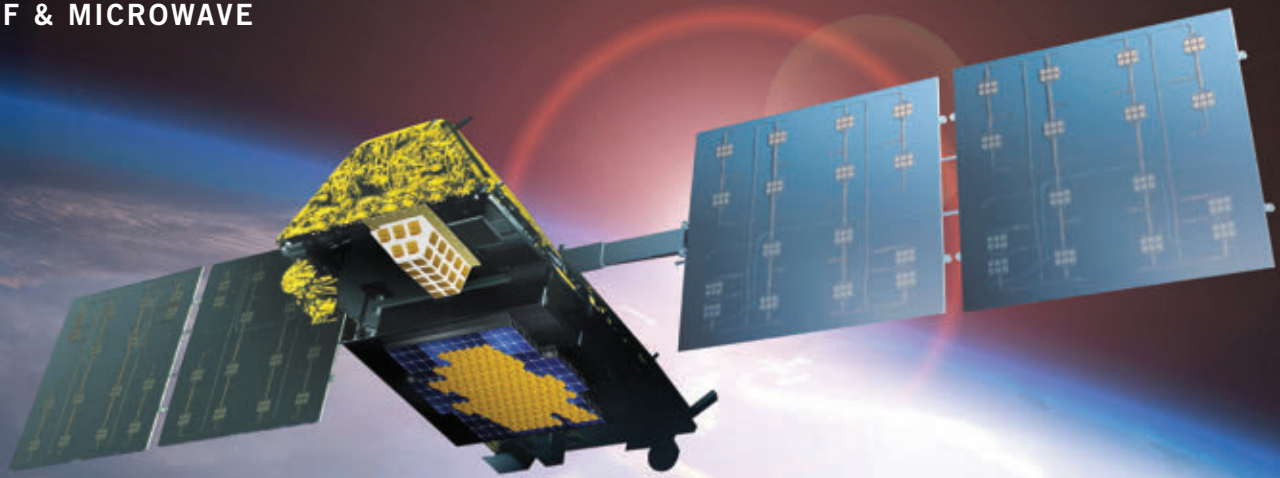
Companies were asked to submit proposals by 14 April 2023. Email questions or concerns to Thomas Kazior, the LADDIS program manager, at LADDIS@darpa.mil. More information is online at <https://sam.gov/opp/45fd25a01b9949c4bddff3f35a6e3291/view>.

Aviation groups lobby for 5G delay

A total of 24 aviation industry groups and prominent manufacturers have sent an open letter to all federal departments that regulate radio communications imploring them to delay the full rollout of 5G cellular services while they expedite codifying a comprehensive set of mitigations against potential avionics interference. The letter, signed by virtually all aviation groups, says the industry isn't ready for the planned July 2023 end of restrictions on 5G transmitters and stakeholders and the flying public will bear the brunt of disruptions that occur if action isn't taken now. "It is critical to extend these mitigations through the end of 2023 to allow airlines time to complete the retrofit," the letter to the FAA said. "Air carriers will likely be unable to meet either the December 2022 deadlines for smaller regional aircraft and many large transports, nor the July 2023 retrofit deadline." The letter continued, "Our aviation coalition strongly believes that instead of once again waiting until the eleventh hour, now is the time for the leadership at federal agencies and the White House to implement a solution that allows 5G to move forward and avoid further flight delays and cancellations."

Rugged waveguide frequency multiplexers introduced by Pasternack

Pasternack, an Infinite Electronics brand in Irvine, Calif., is introducing waveguide frequency multipliers for 5G, test and measurement, mobile and satellite communications, radar systems, research and development, and weather and Earth observation applications. These waveguide frequency multipliers cover 26.5 GHz to 110 GHz, including popular mm-Wave waveguide bands: Ka, U, V, E and W. The RF and microwave devices feature output power from 10 dBm to 20 dBm and DC voltages from 6 to 15 volts DC. They provide input frequency multiplication ranges from 2x to 6x the output, and support female SMA connectors. The line of waveguide frequency multipliers are designed with gallium arsenide (GaAs) and gallium nitride (GaN) monolithic microwave integrated circuit (MMIC) semiconductor technology for low conversion loss. Pasternack's frequency multipliers are rugged and compact with military-grade gold-plated aluminum waveguide package designs. They also guarantee all-weather performance with operational temperatures from -10 to 60 degrees Celsius, exposure to 95 percent relative humidity, and an altitude of 10,000 feet. For more information contact Pasternack online at www.pasternack.com.



Space Force asks industry for surveillance and communications satellite payloads

BY John Keller

CHANTILLY, Va. — U.S. Space Force satellite experts have reached out to industry for new orbiting surveillance and communications payloads that will be part of the Iridium NEXT satellite constellation that tracks hundreds of thousands of aircraft flying over the Earth.

Officials of the Space Force's Space Development Agency (SDA) in Chantilly, Va., issued a solicitation (SDA-PS-23-02) for the Sabre project to add electromagnetic surveillance; position, navigation, and timing (PNT); and communications relays to Iridium NEXT satellites.

This solicitation is to design, build, demonstrate, and support three prototype Sabre satellite sensor and communications payloads for NEXT satellites.

The Sabre payload has three functions:

- collect and relay telemetry from ballistic hypersonic test missiles at U.S. missile test ranges;
- act as an alternative positioning, navigation, and timing system; and
- provide electronic support (ES) to gather military intelligence using electronic surveillance and collection devices aboard NEXT satellites that will help U.S. forces carry out electronic warfare (EW) attacks.

Iridium NEXT, which entered service in February 2019, tracks hundreds of thousands of aircraft operating over the Earth to help improve how air traffic is managed. The constellation of 75 satellites also provides telecommunication coverage all over Earth. Iridium NEXT can help report the location, speed, and altitude

▲ **Iridium NEXT entered service in February 2019, and tracks hundreds of thousands of aircraft operating over the Earth to help improve how air traffic is managed.**

of aircraft flying out of reach of land-based air traffic control receiver towers.

Space Force plans call for deploying the Sabre constellation by commercial launch services from Ball Aerospace & Technologies Corp. in Boulder Colo. — the NEXT program prime contractor. The first launch is set for December

2024. Major subsystems of Sabre will include antenna, radio, signal processor, power amplifier, and payload ground support.

Sabre satellites will communicate via Ka-band RF uplinks and downlinks, optical uplinks and downlinks, and in-plane and cross-plane optical intersatellite links.

Sabre satellite payloads will consist of hardware, software, firmware, control, data processing, onboard data storage, encryption, and cyber security. Proposers should describe how the compromise of one Sabre payload will not affect the NEXT host satellite and the larger NEXT data network.

The Alternate PNT Sabre subsystem must broadcast an unclassified signal to legacy receivers in the field that are not equipped with encryption devices.

Space Force officials prefer body steering of the NEXT satellite for pointing Sabre payload antennas. Nominal steering rates are insufficient to track fast-moving test missiles, which limits the Sabre Telemetry Relay system to capturing a snapshot of telemetry as the test missile transits the payload antenna field of view. ◀

Companies were asked to respond by 17 April 2023. More information is online at <https://sam.gov/opp/383fd34667384149abbba6a4730e19e3/view>.

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Raytheon providing command and control for sensors and weapons in air-defense networking

BY John Keller

REDSTONE ARSENAL, Ala. – U.S. Army air- and missile-defense experts needed a way to enable several sensors and weapons to communicate with battlefield command and control systems. They found their solution from Raytheon Technologies Corp.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced a \$31.4 million order to the Raytheon Missiles & Defense segment in Huntsville, Ala., to provide the Army Integrated Air and Missile Defense (AIAMD) Plug & Fight A-Kit.

This kit is part of the AIAMD, which integrates current and future air and missile defense sensors, weapons, and mission command technologies into an integrated fire-control system, which provides one integrated air picture for battlefield commanders.

The Integrated Battle Command System (IBCS) is the fire control and operational center that handles integrated air defense command and control. IBCS develops composite tracks from sensor, and helps aim anti-air weapons based off the composite track data.

The IBCS provides a common engagement operations center and data-sharing capability for the Army. The plug-and-fight kits

▲ **The AIAMD distributes fire-control data, commands, and messaging among air-defense components in near real-time to respond to enemy complex synchronized air attacks.**

network enables several sensor and weapon to communicate with the IBCS engagement operations center.

The AIAMD distributes fire-control data, commands, and messaging among air-defense components in near real-time

to respond to enemy complex synchronized air attacks.

Data for air- and missile-defense systems is self-healing with automatic fail-over and rapid reconfiguration, and enables extended-range and non-line-of-sight engagements of attacking air forces.

The AIAMD engagement operations center provide common integrated fire control. It includes a fire control network radio, and common software that fuses data, creates an integrated air picture, chooses weapons to fight-off air threats. ◀

On this order Raytheon will do the work at locations to be determined with each order, and should be finished by March 2024. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa/>.

Raytheon to provide RF and microwave hardware for destroyer warship radar

Shipboard radar experts at Raytheon Technologies Corp. will build hardware for the new AN/SPY-6(V) Air and Missile Defense Radar (AMDR), which will be integrated into late-model Arleigh Burke-class (DDG 51) Aegis destroyers under terms of a \$619.2 million U.S. Navy order. Officials of the Naval Sea Systems Command in Washington are asking the Raytheon Missiles & Defense segment in Marlborough, Mass., for AN/SPY-6(V) shipboard radar RF and microwave hardware. The Raytheon AN/SPY-6(V) AMDR will improve the Burke-class destroyer's ability to detect hostile aircraft, surface ships, and ballistic missiles, Raytheon officials say. The AMDR will supersede the AN/SPY-1 radar, which has been standard equipment on Navy Aegis Burke-class destroyers and Ticonderoga-class cruisers. The new shipboard sensors will go aboard Flight III Burke-class destroyers. The AN/SPY-6(V) AMDR will provide greater detection ranges, increased discrimination accuracy, higher reliability and sustainability, and lower costs, compared to the AN/SPY-1D(V) radar onboard today's Burke-class destroyers. The system is built with individual building blocks called radar modular assemblies (RMAs), Raytheon officials say. Each RMA is a self-contained radar in a two-cubic-foot box; RMAs can stack together to form any size array to fit ship mission requirements. The inherent scalability of the AN/SPY-6(V) AMDR also could enable new instantiations, such as backfits on existing Burke-class destroyers and installation on aircraft carriers, amphibious warfare ships, frigates, the littoral combat ship, and Zumwalt-class land-attack destroyers without significant new radar development costs, Raytheon officials say. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Sea Systems Command at www.navsea.navy.mil.

Power line filters to protect shielded rooms from EMI introduced by AstrodyneTDI

AstrodyneTDI in Hackettstown, N.J., is introducing the F series facility and shielded room power line filters to enhance safety and block unwanted electromagnetic interference in shielded aerospace, defense, and industrial facilities. The F series facility and shielded rooms power line filters features several design configurations including multi-line cabinet-style filter solutions and compact box-style single and dual-line filters. With attenuation of 100dB at 14 kHz to 10 GHz by MIL-STD-220, these facility filters comply with the requirements of MIL-PRF-15733 and MIL-STD-810 and are safety approved to UL 1283, CE, and CSA C22.2 #8-13. Astrodyne TDI's F series filters also can

achieve extended insertion loss performance to 40 GHz when installed with proper electromagnetic interference shielding and isolation. Bleeder resistors are built into each filter line to discharge the capacitor voltage to ground potential during power shutdown. Designed to operate continuously at rated currents and voltages. Withstand a 40 percent current overload for 15 minutes without degradation. The output compartment comes with a non-corrosive EMI-environmental gasket to prevent RF leakage and accommodate maximum isolation between input and output compartments. The input compartment is provided with a moisture-resistant gasket. These devices have current ratings of 20 to 2500 amps for cabinet style design, 20 to 400 amps for single-line compact design, and 20 to 100 amps for dual-line compact design. For more information contact AstrodyneTDI online at www.astrodynetdi.com.

Serco eyes space surveillance system to track satellite sensor payloads to space junk

Electronics experts at Serco North America in Herndon, Va., will sustain an important U.S. space surveillance system under terms of an \$8.7 million order. Officials of the U.S. Space Force Space Acquisition and Integration Office at Peterson Space Force Base, Colo., are asking Serco for option year three from 1 June 2023 through 30 April 2024, for operations and maintenance support for the Ground-based Electro-optical Deep Space Surveillance System (GEODSS). The GEODSS tracks space objects such as high-orbit satellites from its three global sites in Socorro, N.M.; Maui, Hawaii; and the island of Diego Garcia in the Indian Ocean. The system tracks more than 2,500 objects like geostationary communication satellites, which vary in altitude in space from 6,214 miles to nearly 28,000 miles above the Earth's surface. GEODSS tracks space objects ranging from active satellite sensor payloads like weather monitoring satellites or Global Positioning System satellites, to space junk like rocket bodies from previous satellite launches or debris from past satellite breakups. Each GEODSS site uses three one-meter telescopes with sensitive digital cameras to keep track of high-altitude space objects. These telescopes can see objects 10,000 times dimmer than the human eye can detect. The GEODSS electro-optical telescopes take rapid electronic snapshots of satellites in the night sky, which show up on the operator's console as tiny streaks. Computers then measure these streaks and compute the position of satellites in their orbits. Star images, which remain fixed, function as reference or calibration points for each of the three telescopes. For more information contact Serco North America online at www.serco.com, or the Space Acquisition and Integration Office at www.safsq.hq.af.mil. ◀



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FAA aims to evaluate using small unmanned aircraft for facility maintenance

BY Jamie Whitney

WASHINGTON - The U.S. Federal Aviation Administration (FAA) in Washington is aiming to evaluate the viability of using small unmanned aircraft systems (sUAS) in augmenting maintenance operations.

Unmanned aircraft would handle troubleshooting, restoration, emergency response activities, as well as evaluating potential risks and impacts in and around National Air Space (NAS) facilities and infrastructure. The selected contractor will work with the FAA's AJW-124 UAS operations team in the sUAS evaluation.

The sUAS service provider will assist the FAA in testing, planning, capturing, transferring, and assessing datasets of several types, such as standard and high definition 2D/red green blue (RGB), light detection and ranging (lidar), in order to develop methods to inspect and survey NAS facilities and infrastructure.

These efforts require a contractor to provide sUAS services

▲ **FAA officials want to use unmanned aircraft in the future to augment maintenance operations.**

to the FAA. The contractor must operate under Part 107 using NDAA and EO 13981 compliant sUAS to perform required mission services. The contractor shall furnish and make available all necessary professional, technical, administrative, and management services to accomplish the requirements set forth in the statement of work (SOW). Such services will support the FAA's goal to integrate sUAS operations on and off airports in a safe and repeatable manner.

The contractor must furnish and make available all necessary professional, technical, administrative, and management services to accomplish the requirements set forth below in accordance with SOW. ◀

Companies interested were asked to respond by 9 March 2023. Email questions to the FAA's Karina Espinosa at Karina.espinosa@faa.gov.

Woods Hole researchers to develop swarming capabilities for unmanned underwater vehicles (UUVs)

BY John Keller

NEWPORT, R.I. – U.S. Navy unmanned underwater vehicle (UUV) experts needed a company to develop swarming technologies to enable many UUVs to work together for battlespace awareness, mine warfare, surveillance, and anti-submarine warfare (ASW) countermeasures. They found their solution from Woods Hole Oceanographic Institution in Woods Hole, Mass.

Officials of the Naval Undersea Warfare Center Division Newport in Newport, R.I., have announced their intention to award a sole-source contract to Woods Hole for the Low Cost Unmanned Undersea Vehicle Mine Sweeping Swarm project.

This unmanned project seeks additional research in UUV swarming, including methods for localization, navigation, and communications for coordinated multi-UUV swarming operations. The value of the upcoming contract has yet to be negotiated.

Woods Hole will test the acoustic navigation subsystem stack, including electronics, timing, and acoustic processing, and test autonomous behaviors for multi-UUV capabilities.

The organization also will build two acoustic navigation subsystem receiver payloads and integrate them aboard two MK 39 Mod 2 expendable mobile antisubmarine warfare (ASW) training targets (EMATT) from Lockheed Martin Sippican Inc. in Marion, Mass.

These small UUVs are designed to emulate the behavior and sensor signatures of enemy submarines to help Navy ASW experts practice their skills from surface warships, submarines, helicopters, and fixed-wing aircraft.

Woods Hole will develop algorithms for multi-UUV behaviors for swarming mine sweeping, with a goal of developing robust autonomous behaviors that demonstrate advanced multi-UUV capabilities for convoying, cooperative seafloor surveying, and rigid formation-keeping for non-cooperative acoustic source localization.

The MK 39 small UUV is 3 feet long, 5 inches in diameter,



Researchers are using the MK 39 Mod 2 expendable mobile antisubmarine warfare (ASW) training targets (EMATT) from Lockheed Martin Sippican Inc. in Marion, Mass., for swarming UUV development.

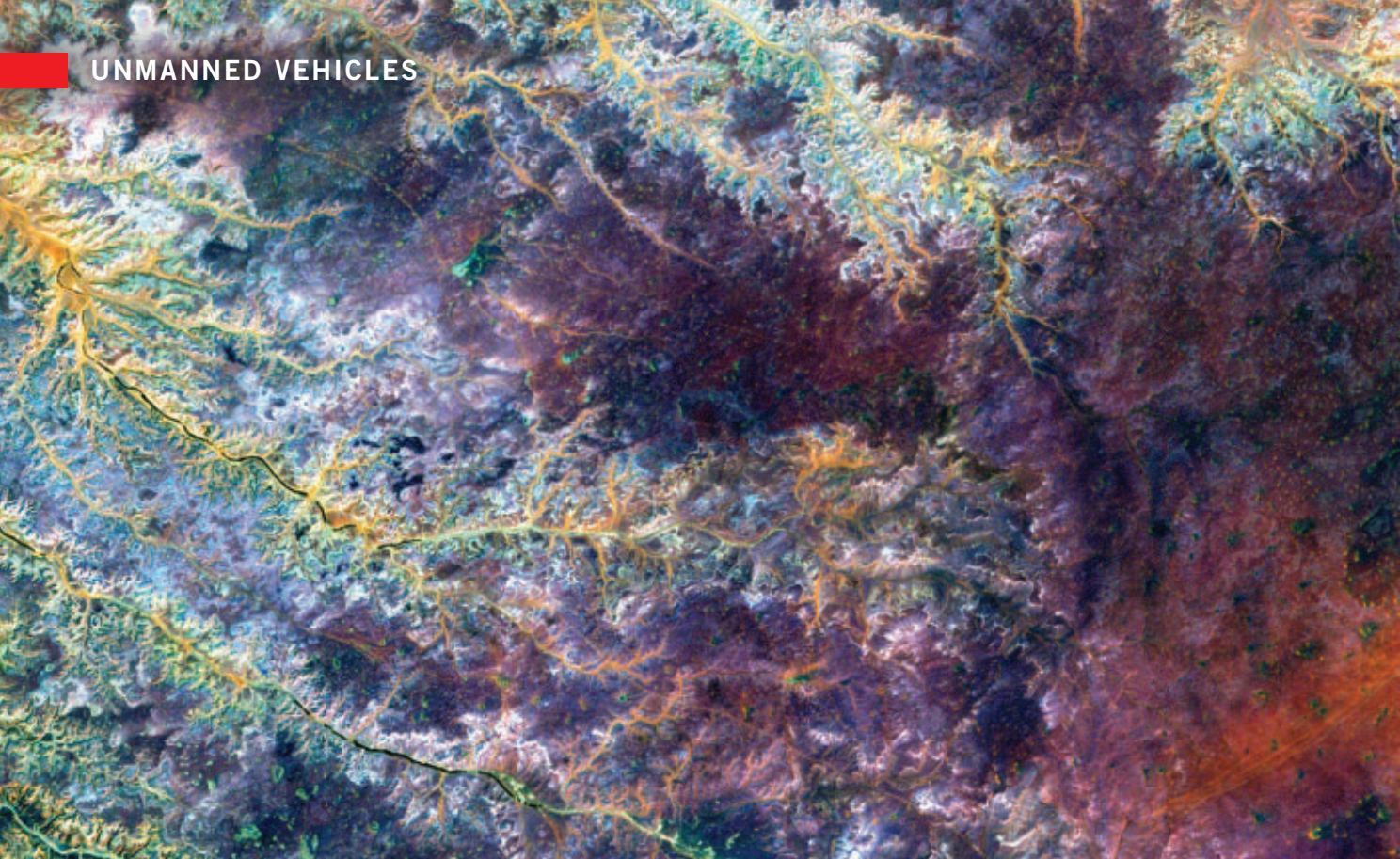
weighs 22 pounds, and can operate for as long as eight hours on one battery charge. the UUV is small enough to be dropped into the ocean by hand from ships or helicopters.

Sippican also offers a version of EMATT that can be launched from submarines called the Submarine Mobile Acoustic Training Target (SUBMATT).

Control software for the Sippican EMATT runs on a Windows PC or laptop computer, and can program the target's course, depth, speed, time, and passive tonal changes. The software also can program the EMATT to maneuver automatically in response to active sonar pings.

Lockheed Martin engineers are designing the latest version of EMATT to be more affordable than previous generations of ASW training targets. The latest version has programmable acoustics, better representation of hostile submarines than previous versions, and acoustic communications links that Navy forces can use in daytime, at night, and in rough seas, company officials say. ◀

For more information contact the Woods Hole Oceanographic Institution online at www.whoi.edu, or the Naval Undersea Warfare Center Division Newport at www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport.



Princeton Infrared to develop shortwave infrared (SWIR) sensors for hyperspectral imaging

BY John Keller

ARLINGTON, Va. – U.S. Air Force researchers needed a company to develop extended-wavelength shortwave infrared (SWIR) sensors for hyperspectral imaging aboard unmanned aircraft. They found their solution from Princeton Infrared Technologies Inc. in Monmouth Junction, N.J.

Officials of the Air Force work project office called AFWERX in Arlington, Va., has announced a \$749,961 small business innovation (SBIR) phase-two contract to Princeton Infrared to investigate the potential of SWIR sensing for hyperspectral imaging aboard unmanned aerial vehicles (UAVs) to fill capability gaps in Air Force programs.

Hyperspectral imaging in the SWIR wavelength range from 900 to 1700 nanometers, and can be used for applications such as agricultural crop health monitoring and humanitarian aid and logistics. Current hyperspectral systems are expensive because of their large-format arrays and complicated optical components.

▲ **Hyperspectral imaging from unmanned aircraft helps reveal details of a scene not visible to the human eye.**

Princeton Infrared researchers will fabricate a micro-lens array into the detector array substrate in attempts to improve sensors alignment accuracy and structural integrity.

This approach is conducive to wafer-scale processing techniques for large-volume production at a significantly reduced cost, Princeton Infrared officials say.

Researchers will develop and demonstrate imagers with detection capabilities from 900 to 2500 nanometers using thermoelectric cooling to support operation. This will enhance the number of material types that can be identified and detected using SWIR hyperspectral imaging. ◀

For more information contact Princeton Infrared Technologies online at www.princetonirtech.com, or AFWERX at www.afwerx.af.mil.

Stellantis beefs up commitment to electric flying vehicle company Archer Aviation

SANTA CLARA, Calif. - Stellantis N.V. in Hoofddorp, The Netherlands, is working with Archer Aviation in San Jose, Calif., to produce electric flying vehicles by 2025. Stellantis will work with Archer to stand up Archer's manufacturing facility in Covington, Ga., at which the companies plan to begin manufacturing the Midnight aircraft in 2024. Midnight is designed to be safe, sustainable, quiet and, with its expected payload of over 1,000 pounds, can carry four passengers plus a pilot. With a range of 100 miles, Midnight is optimized for back-to-back short distance trips of around 20 miles, with a charging time of approximately 10 minutes in-between. "We've been working closely with Archer for the past two years, and I am continually impressed by their ingenuity and unwavering commitment to deliver," said Carlos Tavares, Stellantis CEO. "Deepening our partnership with Archer as a strategic investor with plans for growing our shareholding demonstrates how Stellantis is pushing the boundaries to provide sustainable freedom of mobility, from the road to the sky. Supporting Archer with our manufacturing expertise is another example of how Stellantis will lead the way the world moves." For more information contact Stellantis online at www.stellantis.com, or Archer Aviation at www.archer.com.

Georgia Tech to perform U.S. Army research into technologies for next-gen missiles

Georgia Tech Applied Research Corp. in Atlanta won a \$1.6 billion U.S. Army order for research into state-of-the-art enabling technologies for U.S. missile systems. Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking Georgia Tech for research, engineering, science and technology, analysis, test and fundamental technology research for state-of-the-art systems, operations, hardware and software, and associated technology creation and transition efforts. This order brings the total value of this 10-year effort to \$2.5 billion for research for the U.S. Army Aviation and Missile Center at Redstone Arsenal, Ala., which formerly was named the U.S. Army Aviation and Missile Research, Development and Engineering Center (AMRDEC). These awards are to complete the state of the art technology research within Georgia Tech Research Institute's unique capabilities for missiles research, Army officials say. This award is a modification to a \$910.6 million contract announced in January 2018 for Georgia Tech research, engineering, science, and technology development for state-of-the-art systems. On this order Georgia Tech will do the work at locations to be

determined with each order, and should be finished by January 2028. For more information contact Georgia Tech Applied Research Corp. online at <https://gtrc.gatech.edu>, or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa/>.

Kea Aerospace launches solar-powered stratospheric unmanned aircraft from electric vehicle

The Kea Atmos Mk 1 uncrewed aircraft has taken flight from the top of an Audi e-tron Sportback electric vehicle, says the aircraft's manufacturer, Kea Aerospace in Christchurch, New Zealand. The stratospheric unmanned aerial vehicle (UAV) is designed for stratospheric flight testing; it has a wingspan of 12.5 meters, weighs less than 40 kilograms, and will fly at altitudes to 50,000 feet. Kea Aerospace has been building and flying a range of electric-powered aircraft and high-altitude balloons as part of its program to build a global fleet of solar-powered uncrewed aircraft that will fly in the stratosphere for months at a time. Their X10 aircraft flew in February 2022 for 36 hours non-stop and proved perpetual flight capability at low altitudes. Each aircraft will carry aerial imagery equipment to collect data for environmental monitoring, precision agriculture, disaster management, and maritime awareness.

Sikorsky's long-range hybrid VTOL to inform future of commercial and military missions

Sikorsky, a Lockheed Martin company in Stratford, Conn., is producing a hybrid-electric demonstrator (HEX) autonomous hybrid-electric vertical-take-off-and-landing (eVTOL) prototype. With a maximum gross weight of more than 7,000-pounds, the uncrewed aircraft will serve as a flying test-bed to evaluate large aircraft design, novel propulsion systems and control architectures for sustained hover, and ranges greater than 500 nautical miles/ For the HEX project, GE Aerospace will offer a CT7 turboshaft engine combined with a 1MW-class generator and associated power electronics, building on hybrid electric propulsion systems being developed by GE Aerospace for both NASA and the U.S. Army. The Sikorsky Innovations rapid prototyping group will lead the HEX program. Led by its director, Igor Cherepinsky, the Innovations team will design, build and integrate the HEX airframe and electric motors with the company's MATRIX autonomy flight control system. Depending on insights learned from the flight test program, and assessment of customer applications, the HEX program could lead to a family of eVTOL vehicles scaled to carry passengers and payload for both military and commercial applications. ←



AURA selects Federated Wireless for UHF spectrum management

BY Jamie Whitney

MCLEAN, Va. - AURA Network Systems in McLean, Va., needed a spectrum management system for its nationwide aviation network. They found their solution from Federated Wireless in Arlington, Va.

The partnership will assist AURA in delivering connectivity links for crewed and uncrewed applications via its greenfield aviation-dedicated spectrum in the ultra-high frequency (UHF) band at 450 MHz.

AURA is deploying a Federal Aviation Administration (FAA)-compliant network using Federal Communications Commission (FCC)-licensed spectrum to provide dedicated data and voice communication channels enabling integration of uncrewed aerial vehicles (UAVs) into the National Airspace System (NAS).

This also enables communications between autonomous and traditional aviation on a secure private network. The spectrum management system the partners are developing together will leverage AURA's spectrum and advanced technologies to deliver low latency, reliable, secure connectivity and to enable commercial

▲ **Unmanned aircraft from AURA Network Systems will be connected over a spectrum-management network from Federated Wireless.**

beyond visual line of sight (BVLOS) flight in controlled airspace.

"Gaps in command and control cannot occur during BVLOS flights. Reliable, secure, and robust communication is critical

to ensure safety between the pilot on the ground and the uncrewed aircraft," says Bill Tolpegin, CEO of AURA Network Systems.

"We selected Federated Wireless as our spectrum management partner because of its expertise in building reliable, high-performance management systems at scale. Our collaboration is instrumental to AURA's delivery of deterministic command-and-control links at the right time and in the right place for crewed and remotely piloted aircraft," Tolpegin says.

While the partnership with AURA is the pair's first jointly developed spectrum management system, it's the third such project for Federated Wireless, underscoring its ability to bring innovative spectrum management to new industry sectors. ←

For more information contact Federated Wireless online at www.federatedwireless.com, or AURA Network Systems at auranetworksystems.com.



Navy orders 26 TH-73A training helicopters and glass cockpit avionics from Leonardo

BY John Keller

PATUXENT RIVER NAS, Md. – U.S. Navy helicopter pilot training experts are ordering 26 TH-73A trainer helicopters from Leonardo Helicopters U.S. in Philadelphia under terms of a \$110.6 million order announced in December.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking Leonardo Helicopters, a wholly owned subsidiary of Leonardo S.p.A. in Rome, to provide the TH-73A lot-4 helicopters to replace the Navy's Bell TH-57B/C Sea Ranger training helicopters, which have been in service since the 1980s.

The TH-73A is based on the Leonardo Helicopters AW119M Koala single-engine jet-powered multi-role helicopter, which accommodates a crew of one or two, and can carry as many as six or seven passengers. The Navy took delivery of its first TH-73A in June 2021.

The AW119M has Garmin G1000H glass avionics, with a cockpit design to enhance situational awareness to reduce

▲ **The Leonardo TH-73A trainer helicopter has Garmin G1000H glass avionics, with a cockpit design to enhance situational awareness to reduce pilot workload.**

pilot workload. This order is in support of the Advanced Helicopter Training System program.

The helicopter can carry internal loads as heavy as 6,283 pounds, or external loads as heavy as 6,945 pounds. It can fly as fast as

131 knots, at distance to 515 nautical miles, and for as long as five hours and 20 minutes.

The aircraft with its glass cockpit is 42 feet, 5 inches long; 11 feet, 10 inches high; and has a rotor diameter of 35 feet, 6 inches. It can hover in ground effect at altitudes as high as 11,000 feet, and can hover out of ground effect at altitudes to 7,300 feet. ◀

On this order Leonardo Helicopters will do the work in Philadelphia; Mineral Wells, Texas; and other locations outside the U.S., and should be finished by December 2024. For more information contact Leonardo Helicopters online at <https://helicopters.leonardo.com/en/products/aw119m>, or Naval Air Systems Command at www.navair.navy.mil.

Industry eyes new electro-optical and electronic materials for electronic warfare (EW)

BY John Keller

WRIGHT-PATTERSON AFB, Ohio – U.S. Air Force researchers are asking industry to develop new electronic, photonic, electro-optical, and quantum materials for intelligence, surveillance and reconnaissance (ISR), and electronic warfare (EW).

Officials of the Electronic Materials Branch of the Air Force Research Laboratory's Materials and Manufacturing Directorate at Wright-Patterson Air Force Base, Ohio, issued a solicitation (FA865023S5012) for the Materials for Integrated Nano-electronic and Optoelectronic Structures (MINOS) project.

MINOS seeks to enhance electronic, electro-optical, photonic, magnetic, ferroic, and quantum materials; wide-bandgap and ultra-wide-bandgap semiconductors; digital and analog switching materials; electronic materials integration; and hybrid systems to enable next-generation ISR and EW systems for Air Force applications.

Air Force missions require sustained operations in extremely harsh environmental conditions, researchers explain. As a result,

researchers need material advances for electronic, photonic, electro-optical, and quantum materials.

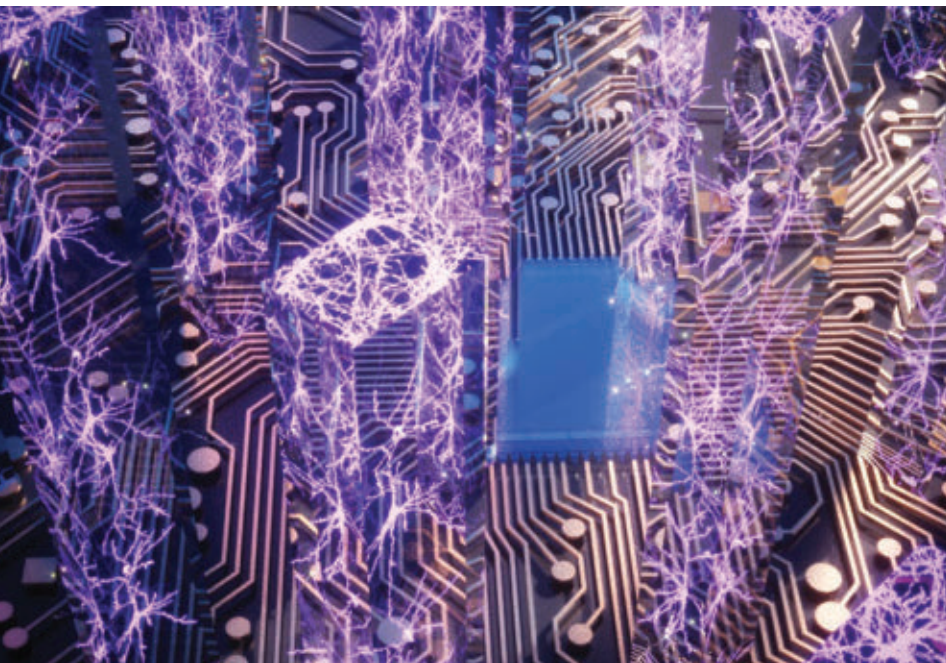
MINOS contractors will perform research in photonic, electro-optical, and quantum materials for ISR and EW applications. This includes solid-state qubits; optical, RF, and hybrid material technologies; modulator materials, RF magnetic materials and materials for integrated photonics; and electro-optical sensing.

MINOS seeks to develop and demonstrate electronic, photonic, electro-optical and quantum materials, including prototypes, models, and computational tools. Researchers want industry to develop new materials through physical vapor and chemical vapor deposition processes to grow magnetic, electronic, optoelectronic, and optical thin films for pulsed laser deposition, sputtering, molecular beam epitaxy, atomic layer deposition, and molecular layer deposition.

The contractors chosen will be asked to fabricate materials

into different shapes and sizes, and create areas that are conducting (like metals), semiconducting (like dichalcogenides) or insulating (like oxides and nitrides) using focused ion beam, ultra violet lithography, nano lithography, e-beam lithography, reactive ion etching, wet chemical treatment involving acids and solvents, metal vaporation and sputtering, ion implantation, and mechanical and electronic fixture arrangements. ←

Companies interested were asked to email responses by March to the Air Force's Mark Wade at Mark.wade.1@us.af.mil and Lorie Walther at Lorie.walther.2@us.af.mil. Companies that expect to submit proposals should email Lorie Walther by 10 March 2023 with the name of the contractor, the point of contact, and the contractor's intent to submit a proposal, at Lorie.walther.2@us.af.mil.



MINOS contractors will perform research in photonic, electro-optical, and quantum materials for ISR and EW applications.

Lockheed Martin to provide Arrowhead electro-optical targeting for attack helicopters

BY John Keller

REDSTONE ARSENAL, Ala. — U.S. Army aviation experts needed additional electro-optical targeting systems for the AH-64 Apache attack helicopter. They found their solution from Lockheed Martin Missiles and Fire Control segment in Orlando, Fla.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., have announced a \$95.8 million contract to Lockheed Martin for the Modernized Target Acquisition Designation Sight/Pilot Night Vision Sensor (M-TADS/PNVS) system, also known as Arrowhead.

M-TADS/PNVS provides Apache helicopter pilots with long-range, precision engagement and pilotage capabilities to meet mission goals and for flight safety during day and night and in bad weather.

The M-TADS/PNVS has several sub-components. The lower M-TADS turret contains the targeting system, which has day and night electro-optical sensors. The Arrowhead targeting sensor suite has forward looking infrared (FLIR) elements of the TADS and the PNVS to provide modern technological and precision engagement, and ensure the Army's Apache helicopters remains an effective attack helicopters well into the future.

The system's laser rangefinder designator includes an eye-safe rangefinder and day sensor electronics unit, which replaces the laser transceiver unit and related electronics in the Apache's legacy day sensor assembly.

The new day sensor structure assembly offers fields of view that match the Arrowhead FLIR fields of view to accommodate image blending. The modernized TV sensor incorporates color and low-light sensitivity. A modern inertial measurement unit replaces three spinning-mass gyros, and the new laser spot tracker uses a four-quadrant detector and improved processing. A laser pointer marker helps enhance coordination with ground and air units.



M-TADS/PNVS provides Apache helicopter pilots with long-range engagement and pilotage capabilities for flight safety during day and night and in bad weather.

These targeting components enable Apache helicopters to identify targets at long ranges through an additional field-of-view and extended-range picture-in-picture capability, as well as provide the ability to view high-resolution, near-infrared and color imagery on cockpit displays.

The system provides a new laser pointer marker that improves coordination with ground troops, and an updated multimode laser with eye-safe lasing capability that supports flight in urban environments and home-station training. ←

On this contract Lockheed Martin will do the work at locations be determined with each order, and should be finished by November 2027. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com/en-us/who-we-are/business-areas/missiles-and-fire-control.html, or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa>.

PRODUCT APPLICATIONS

SENSORS

► Leidos selected to upgrade Atlanta's Hartsfield-Jackson Airport's security checkpoints

Leidos in Reston, Va., was selected by New-South Synergy in Atlanta to upgrade U.S. Transportation Security Administration (TSA) checkpoints at Hartsfield-Jackson Atlanta International Airport.

The upgrades are part of a larger initiative to expand and enhance the airport's security checkpoints by leveraging the latest technologies, while also improving the passenger experience.

The upgrade will update security lanes at the Domestic Terminal Main Security Checkpoint with Leidos' Advanced Imaging Technology (AIT). These upgrades include replacing the existing Pro:Vision 1 scanners with 10 new Pro:Vision 2 systems. Some of the benefits include a compact design and footprint, and continued safe millimeter wave technology.

The Leidos AIT technology was selected under TSA's Capabilities Acceptance Process (CAP). This is designed to ensure that Transportation Security Equipment (TSE) and related services meet the highest standards for quality and effectiveness.

The Pro:Vision 2 scanners are on the Acceptable Capabilities List (ACL) and available for use within TSA operations. For more information contact Leidos online at www.leidos.com, or New South Synergy at <https://www.nssjv.com>.



EMBEDDED COMPUTING

► North Atlantic to provide communications, embedded computing, for missile-defense radar

Missile-defense experts at Raytheon Technologies Corp. needed high-density I/O, communications, Ethernet switching, and embedded computing capability for the Lower Tier Air and Missile Defense Sensor (LTAMDS). They found their solution from North Atlantic Industries Inc. in Bohemia, N.Y.

Officials of the Raytheon Missiles & Defense segment in Andover, Mass., are choosing the North Atlantic SIU35 3U CompactPCI sensor interface unit for the LTAMDS, which is to replace the U.S. Army Phased Array Tracking Radar to Intercept on Target (Patriot) missile system.



LTAMDS is the next generation, 360-degree missile-defense radar that ultimately will replace the current U.S. Army's PATRIOT missile radars. The radar has gallium nitride components, and was scheduled to reach initial operational capability with the Army in 2022.

The North Atlantic SIU35 is a configurable rugged subsystem with five 3U CompactPCI slots, and accommodates as many as 15 I/O and communications modules. The SIU35 supports stand-alone operation via Ethernet connection to mission computers.

For LTAMDS, Raytheon is taking advantage of the flexibility and modularity of North Atlantic's Configurable Open System Architecture (COSA) to consolidate several interface functions into two off-the-shelf chassis.

To meet platform requirements, Raytheon configured the pair of North Atlantic SIU35 rugged boxes to serve as a programmable logic controller and a cooling system controller aboard the next generation GhostEye radar system.

Raytheon designers sought to improve efficiencies in LTAMDS size, weight, and power consumption (SWaP) by combining many channels and dissimilar functions into dense multi-purpose solutions. LTAMDS relies on

Ethernet-based communications to monitor, manage, and control several I/O and communications interfaces without the need for custom electronics, says Lino Massafra, vice president of sales and marketing at North Atlantic.

The SIU35 uses the NXP PowerPC QorIQ P2041, Intel Core i7, and ARM Cortex-A9 microprocessors; meets MIL-STD-461F, MIL-STD-810G, MIL-STD-1275, and MIL-STD-704A standards for high reliability; has a 28-volt DC input, and measures 7.13 by 4.78 by 8.71 inches.

The I/O subsystem offers software support that

includes Wind River Linux and VxWorks, Xilinx PetaLinux, and Windows Embedded Standard 7 OS support; offers built-in test, and operates in temperatures from -40 to 71 degrees Celsius.

For more information contact North Atlantic Industries online at www.naii.com/model/SIU35, or Raytheon Missiles & Defense at www.raytheonmissilesanddefense.com.

SOFTWARE APPLICATIONS

▼ Pulse Aviation chooses Embraer-X's Beacon MRO software application

Pulse Aviation in Simi Valley, Calif., needed maintenance, repair, and overhaul (MRO) coordination software. They found their solution from Embraer-X in São José dos Campos, Brazil.

Embraer-X's Beacon is maintenance coordination software that helps connect resources and technicians for to return aircraft under maintenance to service quickly.

During the initial rollout, Beacon software will help Pulse Aviation, a business jet MRO company, to simplify coordination of their maintenance events and propel collaboration amongst their maintenance talent pool and providers to accelerate return-to-service.

Beacon enables crews to see real-time updates and save and access maintenance records. Machine learning capabilities help identify maintenance patterns for optimization and provide insights.

Through a digital web and mobile application (iOS and Android), Embraer-X's Beacon technology triggers a network of accredited providers, fostering real-time collaboration during unplanned maintenance activities, accelerating the return to service of aircraft.

"We are confident our support for Pulse Aviation will ensure their maintenance coordination stays ahead of the game in this ultra-competitive industry. Beacon's fleet agnostic approach improves coordination of any kind of



maintenance event, empowering all stakeholders working on maintenance events to get back time and energy, thereby boosting productivity while fueling customer satisfaction and profitability," says Marco Cesarino, Head of Beacon.

"We are strongly positioned in a very demanding market segment and partnering with Beacon supports more collaborative and efficient maintenance dynamics. Beacon is a game-changer solution designed to improve team awareness of critical events, consolidate fragmented communication, and ensure a swifter return-to-service for our customers," said Daniel Rios, CEO & Founder, Pulse Aviation.

RADAR

▲ Lockheed Martin to build GaN-based shipboard radar for Spanish Bonifaz-class frigate

U.S. Navy surface warfare experts needed a solid-state S-band radar for Spain's Navantia F-110 Bonifaz-class frigate surface warships. They found their solution from Lockheed Martin Corp.

Officials of the Naval Sea Systems Command in Washington announced an \$82.8 million order to the Lockheed Martin Rotary and Mission Systems segment in Moorestown, N.J., for Spain F-110 radar component production and ship integration and test.

The Spain F-110 shipboard radar is based on the Lockheed Martin SPY-7 radar, which uses gallium nitride (GaN) transmit and receive modules. Lockheed Martin initially developed the SPY-7 for the U.S. Navy's Air and Missile Defense Radar (AMDR) competition.

The company later adapted SPY-7 radar technologies into the Long-Range Discrimination Radar (LRDR) that the U.S. Missile Defense Agency (MDA) ordered as a sensor in the Ground-Based Midcourse Defense system at Clear Air Force Station, Alaska. The LRDR can discriminate between incoming warheads and decoys.

SPY-7 is a modular shipboard radar that enables Lockheed Martin to build different configurations for



land- and sea-based applications. The SPY-7 has been selected by the Spanish navy to integrate with the Aegis Combat System on Spanish F-110 Bonifaz-class frigates. The Canadian navy also is procuring the radar for its Halifax-class surface combatant.

SPY-7 is a scalable radar that provides ballistic missile defense, and provides several times the performance of traditional SPY-1 radars aboard U.S. Navy Burke-class destroyers and Ticonderoga-class cruisers.

SPY-7's GaN technology allows for improved cooling of the radar, which is made up of thousands of mini scanners, which make the radar easily upgradable as threats evolve. Spain's F-110 naval radar will go to sea in 2026 aboard the first F-110 frigate.

On this contract Lockheed Martin will do the work in Moorestown, N.J.; Ferrol and Rota Spain; Andover, Mass.; and Clearwater, Fla., and should be finished by December 2029. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, Navantia shipbuilding at www.navantia.es/en, or Naval Sea Systems Command at www.navsea.navy.mil.

MISSILES

▲ Raytheon to provide coastal defense system for Romania with anti-ship missiles

U.S. Navy coastal defense experts needed an anti-ship missile system for the Republic of Romania to help defend that nation's coast on the Black Sea. They found their solution from Raytheon Technologies Corp.

Officials of the Naval Sea Systems Command in Washington announced a \$208.7 million contract to the Raytheon Missiles & Defense segment in Tucson, Ariz., for the Naval Strike Missile Coastal Defense System (NSM CDS) for the Republic of Romania.

The NSM CDS has target recognition and a network-centric architecture that enables several simultaneous engagements and over the horizon (OTH) targeting. The system can be closely integrated and adapted to a country's weapons and command and control systems.

The NSM CDS has a fire-distribution center for battle management; the anti-ship and



land-attack Raytheon Naval Strike Missile (NSM); and sea surveillance and tracking radar. One of the primary NSM CDS systems integrators is Kongsberg Defence & Aerospace AS in Kongsberg, Norway.

The system's fire-distribution center has an open modular software architecture is based on the similar proven Kongsberg BMC4I

fire-distribution center used in the Norwegian Advanced Surface-to-Air Missile System (NASAMS), and is independent of vehicle types.

The system operates in a real-time network of sensors and missile launchers that establishes an integrated maritime picture that enhances situational awareness through data sharing.

Each fire-distribution centers can engage as many as 12 different targets or use as many as 12 missiles against the same target in a salvo. they can plan and control as many as 48 Naval Strike Missile engagements simultaneously against 48 different targets.

This contract has options that could increase its value to \$217.1 million. Raytheon and its partners will do the work in Work will be performed in Kongsberg and Raulfoss, Norway; Tucson, Ariz.; Schrobenhausen, Germany; and other locations, and should be finished by September 2028.

For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, Kongsberg Defence & Aerospace at www.kongsberg.com/kda, or Naval Sea Systems Command at www.navsea.navy.mil.

AVIONICS

◀ BAE Systems to provide IFF avionics transponders for U.S. and allied aircraft

Avionics experts at BAE Systems will provide Mode 5-capable common identification friend or foe (IFF) digital transponder systems and spare parts for U.S. Navy, Army, and allied fixed-wing aircraft and helicopters under terms of a \$15.4 million order.

Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., will provide IFF transponders for Navy, Army, and allied aircraft.

For the Navy, the order is for 20 AN/APX-117A



(V) IFF transponders; 10 AN/APX-118A (V) IFF transponders; 62 AN/APX-123A (V) IFF transponders; six integration of Mode 5 kits; 18 Mode 5 remote-control units; 20 Mode 5 upgraded remote controls; 19 IFF transponder mounting trays; 10 spare receivers and transmitters; 15 power supplies; 10 signal processors; five Mode 5 chassis; 10 Mode 5 spares; five repair - AN/APX-117(V)/117A(V); 10 repair - AN/APX-118(V)/118A (V); and 30 repair - AN/APX-123(V)/123A (V).

For the Army, the order is for 134 AN/APX-123A (V) IFF transponders; one RT-1835/RT-1836 to RT-1912A modification; 20 single-board computers; and 26 RT-1912 to RT-1912A modification kits. For U.S. allies, the order is for 32 AN/APX-123A (V) IFF transponders.

The AN/APX-117A(V), AN/APX-118A(V), and AN/APX-123A(V) avionics transponders are part of the BAE Systems common transponder (CXP) family that is the Navy's and Army's standard transponder for all new aircraft and aircraft upgrades.

The transponders are built on an open-system architecture and high-density field-programmable gate array (FPGA) technology that provides for system flexibility and future systems improvements through software-only upgrades.

The CXP family of IFF transponders is configured to replace all AN/APX-100, AN/APX-101, AN/APX-108, AN/APX-64, AN/APX-72 and AN/APX-28 transponders. All CXP transponders weigh less than 12 pounds with embedded cryptography, and measure 5.375 by 5.375 by 8.375 inches. Their radio control units measure 5.25 by 5.75 by 3 inches.

On this order BAE Systems will do the work in Greenlawn, N.Y. and Austin, Texas, and should be finished by December 2025. For more information contact BAE Systems Electronic Systems online at www.baesystems.com.

TEST AND MEASUREMENT

► Granite River picks Teledyne LeCroy oscilloscopes for networking test

Test and measurement specialists at Granite River Labs (GRL) in Taipei, Taiwan, needed electrical bench testing for USB4, DisplayPort 2.1, and Thunderbolt evaluation. They found their solution from Teledyne LeCroy in Chestnut Ridge, N.Y.

GRL experts are choosing the LabMaster 10 Zi-A oscilloscopes from Teledyne LeCroy for bench-testing USB4,

DisplayPort 2.1 and Thunderbolt computer interconnect and networking technologies.

The DisplayPort 2.1 specification supports 80 gigabit-per-second link speeds, while the USB4 Version 2.0 specification supports 120 gigabits per second using PAM3 signaling for fast data transfer in next-generation devices over the USB Type-C connector.

The high speeds and novel signaling introduce high complexity into the test process, requiring test labs to increase capacity, Teledyne LeCroy officials say.



The LabMaster 10 Zi-A oscilloscopes provides fast and efficient testing and calibration of physical layer transmitters and receivers by using the Anritsu MP1900A BERT.

The LabMaster 10 Zi-A oscilloscope contains an Intel Xeon Gold 6240R 24-core server-class CPU with as much as 192 gigabytes of RAM. The processing power in the oscilloscope enables engineers to perform the required compliance tests more quickly than by using a separate computer, Teledyne LeCroy officials say.

"The LabMaster has helped us to immediately expand capacity in our Taiwan lab, as additional testing will be required for the latest revisions to these standards," says Quintin Anderson, GRL's co-founder and chief operating officer.

For more information contact Granite River Labs online at www.graniteriverlabs.com, or Teledyne LeCroy at <https://teledynelecroy.com>. ◀

MOTION CONTROL

▼ Solenoids for motion control in cabinet locks introduced by Magnetic Sensor Systems

Magnetic Sensor Systems (MSS) in Van Nuys, Calif., is introducing the S-20-100X model of pull-type tabular solenoids for valve control, door controls, cabinet locks, disconnects, transmission shifting, fire suppression systems, medical dispensing, mixing, and sorting equipment. The



S-20-100X series of power electronics devices features 18 different solenoids based on voltage, duty cycle, force, and stroke. MSS Solenoids coils typically use class F 23-to-40 American Wire Gauge (AWG) windings with class

A insulation to protect the solenoid during long duty cycles. The S-20-100X solenoids for motion control applications feature a 1-inch-diameter by 2-inch-long housing and a 3/4 -16 UNF-2A thread for mounting. The noncaptive plunger or actuator has a diameter of 0.437 inches with a clevis end for load attachment. A low-friction brass guide and PTFE coating on the plunger assures long life. These clean, high efficiency, low cost, precise tubular solenoids can operate at 1/10, 1/4, 1/2, and continuous-duty voltage-dependent cycles. For more information contact Magnetic Sensor Systems online at www.magneticsensorsystems.com.

BOARD PRODUCTS

▼ Circuit board connectors with EMI noise protection introduced by TE

TE Connectivity in Harrisburg, Pa., is introducing the 369 shielded rectangular panel and circuit board connectors for environments that demand ambient electromagnetic interference (EMI) noise protection. The shielded panel and circuit board extensions offer additional weight savings and a small form factor application areas like Ethernet, power distribution, and mixed signal and power devices. TE's rectangular connectors have been tested to withstand indirect lightning strikes of 3.6ka and are rated to provide effective shielding of greater than 60 decibels at low frequencies and greater than 40 decibels at high frequencies. This EMI protection technology is wrapped



in a lightweight non-toxic RoHS-compliant composite nickel shell that can lead to as much as 75 percent weight savings. The 369 series shielded connectors enable various Ethernet protocols and speeds as much as 10 gigabits per second. They also are backward-compatible with current 369 product offerings. For more information contact TE Connectivity online at www.te.com.

EMBEDDED MODULES

► 3U OpenVPX embedded computing for assured PNT offered by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va., is introducing the VPX3-673A rugged 3U OpenVPX module for assured position, navigation and timing (A-PNT) with alternative navigation (ALTNAV) and the pntOS architecture. The VPX3-673A is a rugged 3U OpenVPX form factor module compatible with the U.S. Army's Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance, Reconnaissance (C5ISR)/Electronic Warfare Modular Open Suite of Standards (CMOSS) suite of standards and aligned to the Sensor Open Systems Architecture (SOSA) technical standard 1.0. ALTNAV, a space-based commercial system, is being evaluated by the U.S. Army as an alternative and complementary source of PNT information on the battlefield. As an open-source, government-owned plug-in architecture for building integrated PNT sensor-fusion applications, pntOS helps reduce the time and effort necessary to develop algorithms and add support for new sensors. At the heart of the VPX3-673A embedded computing module is a low-noise chip-scale atomic clock (LN-CSAC), with intelligence provided by a Xilinx Multiprocessor System On Chip (MPSoC). Complementing these devices is an ALTNAV receiver and a 10-degree-of-freedom inertial measurement unit (IMU). The board supports an internal GPS module for Selective Availability Anti-Spoofing Module (SASSM) and M-CODE, or an external GPS via a front panel connector. The VPX3-673A communicates PNT information using standard Vehicle Integration for C4ISR/EW Interoperability (VICTORY) data messages in compliance with the CMOSS Mounted Form Factor (CMFF) architecture. For more information contact Curtiss-Wright Defense Solutions online at www.curtisswrightds.com.



RF AND MICROWAVE

► **Military-grade programmable attenuators for EW introduced by Pasternack**

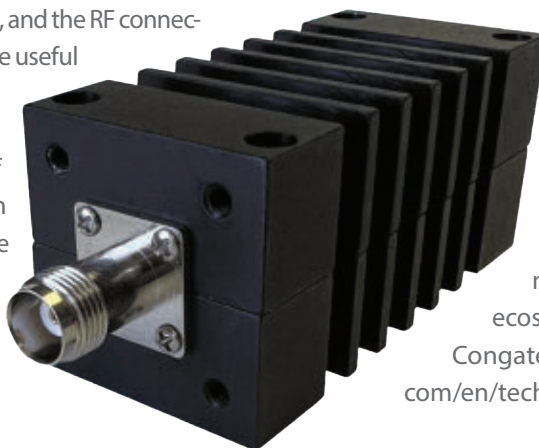
Pasternack, an Infinite Electronics brand in Irvine, Calif., is introducing a series of programmable attenuators for electronic warfare (EW), test and measurement, and electronic countermeasures applications. Pasternack's programmable attenuators produce different values of RF and microwave signal attenuation, and provide plus-or-minus 0.7-decibel attenuation accuracy and a switching speed of 0.35 microseconds. The programmable attenuators come in TTL, USB, or relay-controlled options, and include SMA, N-Type, and 2.92-millimeter female connector options. Pasternack's attenuators cover broadband RF, microwave, and millimeter-wave frequencies ranging from DC to 40 GHz. Their attenuation ranges from 31 decibels to 95 decibels with 0.5 decibels and 1 decibels step sizes. Additionally, these programmable attenuators are designed with compact and rugged military-grade coaxial packages and an operational temperature range from -40 to 85 degrees Celsius. For more information contact Pasternack online at www.pasternack.com.



POWER ELECTRONICS

▼ **Fixed attenuators for radar and communications introduced by BroadWave**

BroadWave Technologies Inc. in Greenwood, Ind., is introducing the model series 351-354-XXX line of 50-ohm fixed attenuators for aerospace and defense radar, base stations, telecommunications, and test equipment. The fixed attenuators are rated 30 Watts average power with a 1.20:1 maximum voltage standing wave ratio (VSWR). The operating frequency range is DC to 1 GHz, and standard attenuation values are 3, 6, 10, 20, and 30 decibels. The attenuators operate in temperatures from -55 to 70 degrees Celsius, and the RF connectors are TNC female. The devices are useful for analyzing harmonic signals or isolating a device under test, and can help reduce the amount of power delivered in a transmission line without introducing much noise or distortion. For more information contact BroadWave Technologies online at www.broadwavetech.com.



BOARD PRODUCTS

▼ **Embedded computing TSN boards for aerospace uses introduced by Congatec**

Congatec Inc. in San Diego is introducing embedded computing boards for time-sensitive networking (TSN) aimed at networked factories and critical infrastructures. The goal of the edge computing product for TSN is to ease building time-sensitive networks for smart factory and critical infrastructure operators. Such applications need secure real-time gateway technologies. The Congatec products are for low-latency communication at the edge and include real-time hypervisor software support for deterministic and secure data processing and data exchange between the devices and real-time clouds in harsh industrial environments.

Target applications of the TSN-enabled ecosystem include aerospace, government, public safety, industrial manufacturing, energy and utilities, transportation and logistics, and health



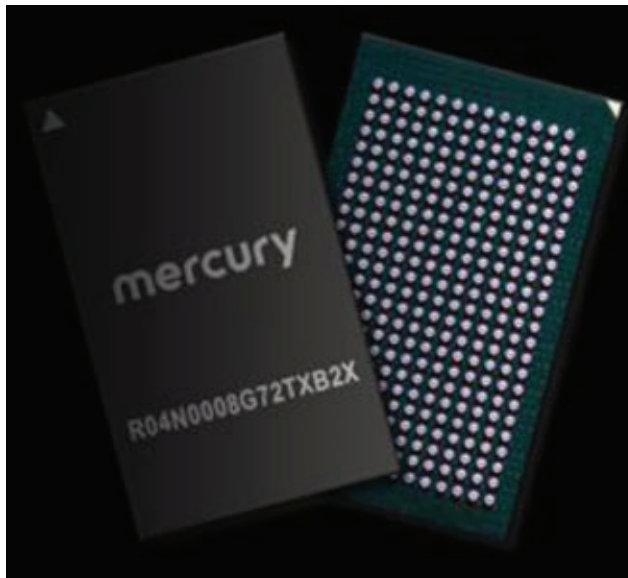
care. Congatec's TSN-enabled edge computing ecosystem spans computer-on-modules supporting real-time enabled 5G cellular connectivity for real-time 5G clients and gateways, as well as server-grade real-time cloud and base station server-on-modules. All those modules are TSN-enabled, support real-time hypervisor technology and are prepared to host third-party real-time enabled cellular 5G connectivity to deploy real-time applications in pre-configured

real-time virtual machines. For local wired infrastructures between servers and clients, TSN-enabled smart switching platforms also are available. Personal integration support and training programs on how to implement IEEE 802.1 Qbv-compliant TSN clock synchronization and time-triggered communication round off Congatec's TSN ecosystem. For more information contact Congatec online at <https://www.congatec.com/en/technologies/tsn-ecosystem/>.

SPACE ELECTRONICS

► Radiation-tolerant DDR4 memory for in space introduced by Mercury Systems

Mercury Systems Inc. in Andover, Mass., is introducing the radiation-tolerant 8-gigabyte DDR4 memory for data-intensive processing applications in space. Mercury's 8-gigabyte DDR4 memory components feature data transfer speed as fast as 2,666 megabits per second; operating temperatures of -55 to 125 degrees Celsius; dimensions of 13 by 20 by 2.36 millimeters; eutectic solder balls for board-level reliability; 100 percent



burn-in and electrical test; and DMEA-trusted facility manufacturing. Mercury's 8-gigabyte DDR4 components offer 75 percent space savings compared to alternative memory options. Military space satellites enable critical national security missions such as missile warning, communications, and Earth observation, while commercial satellites provide in-flight Wi-Fi connectivity, direct-to-home television and radio services, and global infrastruc-

ture and asset monitoring. For more information contact Mercury Systems online at www.mrcy.com. ◀

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Boeing to assess 19 technologies on its demonstrator aircraft

BY Jamie Whitney

SEATTLE - The Boeing Company will assess 19 technologies on a 777 widebody test aircraft and add "Explorer" airplanes as part of the company's ecoDemonstrator flight-test program to accelerate innovation for sustainability and safety.

The first ecoDemonstrator Explorer, a 787-10 Dreamliner, will conduct flight tests in June from Seattle to Tokyo, Singapore, and Bangkok to demonstrate how coordinating navigation across global airspace can improve operational efficiency, which can reduce an airplane's fuel use and emissions by as much as 10 percent.

Using today's onboard capabilities, Boeing and air navigation service providers in the U.S., Japan, Singapore, and Thailand collectively will sequence the airplane's routes to achieve the optimal flight path across several regions, factoring in conditions such as weather, air traffic, and airspace closures. The airplane will fly on the highest available blend of sustainable aviation fuel at each location.

In 2023, Boeing also will use the company's current flagship ecoDemonstrator airplane, a 777-200ER, to test 19 technologies including:

- sustainable wall panels in the cargo hold that are made of 40 percent recycled carbon fiber and 60 percent resin made from a bio-based feedstock;

- a fiber optic fuel quantity sensor compatible with 100 percent sustainable aviation fuel; and
- an electronic flight bag application featuring Smart Airport Maps, a component of Jeppesen FliteDeck Pro, that reduces operational costs and supports safe taxi operations with the depiction of contextual airport data.

For all flight tests, the airplane will fly on the highest available blend of sustainable aviation fuel locally.

"The industry will need continued fleet renewal, efficiency gains, renewable energy carriers such as sustainable aviation fuel, and advanced technology to meet the civil aviation industry's commitment to achieve net zero carbon emission by 2050," says Boeing Chief Sustainability Officer Chris Raymond.

"Our initial Explorer testing in partnership with aviation stakeholders in four countries is a great example of how we can work together to optimize operational efficiency and reduce emissions," Raymond says. ◀

▲ Boeing is using special test aircraft to test new enabling technologies for aviation sustainability and safety.

For more information contact Boeing online at www.boeing.com/commercial/

ZeroAvia to retrofit Alaska Airlines regional turboprop to hydrogen

BY Jamie Whitney

EVERETT, Wash. - Alaska Airlines in Seattle is donating a retired Q400 turboprop regional aircraft to ZeroAvia in Hollister, Calif., for research and development in retrofitting zero emissions technology in aviation.

ZeroAvia's hydrogen-electric engine uses fuel cells to generate electricity from hydrogen fuel, before using that electricity to power electric motors which turn the aircraft propellers. The certifiable ZA2000 system will include ZeroAvia's High Temperature PEM fuel cells and liquid hydrogen fuel storage, integral to delivering the necessary energy density for commercial operations of large regional turboprops.

The company has established an engineering partnership with De Havilland of Toronto, the original manufacturer of the Dash 8 family of aircraft, to enable exchange of data and expertise with the airframe.

In January, ZeroAvia flew a retrofitted 19-seat aircraft with its prototype 600-kilowatt ZA600 hydrogen-electric engine. This followed the demonstration flight of a 250-kilowatt system in 2020, which at the time of flight was the world's largest aircraft flown using a novel zero-emission power source.

At an event at ZeroAvia's Paine Field research and development site near Seattle, the companies were joined by high school students from Raisbeck Aviation High School, Washington State Governor Jay Inslee, Congresswoman Suzan DelBene and Snohomish County Executive Dave Somers to participate in the formal handover of the 76-seat Q400 aircraft that will be developed by ZeroAvia, the U.S.-headquartered leader in designing and building zero-emission, hydrogen-electric aircraft propulsion systems for aircraft.

ZeroAvia also debuted its multi-megawatt modular electric motor system in a 1.8-megawatt prototype configuration at the event - demonstrated with a propeller spin aboard the ZeroAvia's 15-ton HyperTruck ground-test rig.



This 76-seat retired Q400 turboprop regional aircraft is helping ZeroAvia perform research and development in retrofitting zero emissions technology in aviation.

The motor consists of two HyperCore motor modules, each a 900-kilowatt permanent magnet radial flux machine that operates at 20,000 rpm, matching the typical turbine engine power turbine speeds, providing a 15-kilowatt-per-kilogram motor power density.

Crucially, HyperCore's modular design enables the technology to address applications ranging from 900 kilowatts to 5.4 megawatts, meeting regional turboprop and regional jet requirements. The HyperCores were integrated with the stock Dash 8-400 engine gearbox and propeller.

The development and testing program will help experts understand and measure system dynamics, calibrate physical and electrical models, and validate thermal management systems.

The company also is developing silicone-carbide power electronics and the matching hydrogen fuel cell systems, which convert hydrogen to electricity, powering the electric propulsion system. These systems will be brought together to create the full hydrogen-electric propulsion system, tested on the ground and then in the air. ◀

NASA chooses projects for continued studies related to future air and space travel

BY Jamie Whitney

WASHINGTON - The National Aeronautics and Space Administration (NASA) in Washington has named six projects for continued study as part of the agency's Innovative Advanced Concepts (NIAC) program.

The new round of phase II awards are for six researchers to continue work on futuristic concepts designed to shape air and space travel decades in the future. The phase II awards continue to develop concepts and explore potential infusion options within and beyond NASA.

The projects explore potential future enabling technologies ranging from revolutionary propulsion systems for deep-space missions to advances in aviation for Earth travel, says Jim Reuter, associate administrator for NASA's Space Technology Mission Directorate (STMD).

Each of the six fellows will receive as much as \$600,000 over two years to develop their concepts. The researchers selected to receive NIAC Phase II grants in 2023 are:

Darmindra Arumugam, NASA's Jet Propulsion Laboratory in Southern California: Quantum Rydberg Radar for Surface, Topography, and Vegetation, which focuses on next-generation dynamically tunable quantum radar technology to improve remote sensing studies of Earth and other worlds using reflected ground signals from other orbiting spacecraft to eliminate the need for large antenna deployments;

Steven Barrett, Massachusetts Institute of Technology in Cambridge, Mass.: Silent, Solid-State Propulsion for Advanced Air Mobility Vehicles, which focuses on developing nearly silent

▲ **NASA is funding future enabling technologies designed to shape air and space travel decades in the future.**

electroaerodynamic thrusters for vertical takeoff and landing aircraft for transporting cargo and passengers over short distances in urban areas;

Philip Lubin, University of California, Santa Barbara, Calif.: PI – Planetary Defense,

which focuses on technologies that could provide Earth with a rapid-response capability to mitigate a disastrous impact from an asteroid or comet by pulverizing the object into pieces small enough to burn up in Earth's atmosphere;

Christopher Morrison, Ultra Safe Nuclear Corporation in Seattle: The Nyx Mission to Observe the Universe from Deep Space – Enabled by EmberCore, a High Specific Power Radioisotope Electric Propulsion System, which focuses on using the nuclear decay of a radioactive material in a radioisotope electric propulsion system to propel a spacecraft to extremely high speeds, enabling the intercept and study of distant and fast-moving objects in the solar system on relatively short timeframes;

Ronald Polidan, Lunar Resources, Inc. in Houston: FarView Observatory – A Large, In-Situ Manufactured, Lunar Far Side Radio Array, which seeks to construct a massive radio telescope array on the Moon's far side autonomously using resources extracted from the Moon's regolith; and

Lynn Rothschild, NASA's Ames Research Center in Mountain View, Calif.: A Flexible, Personalized, On-Demand Astropharmacy, which would use bacteria to create medical drugs on demand during extended spaceflight missions, including a class of drugs to treat radiation exposure or help protect astronauts' bone health in space. ←



JetBlue selects Collins Aerospace data retrieval IntelliSight and GlobalConnect

BY Jamie Whitney

ANNAPOLIS, Md. – Jet Blue in Long Island City, N.Y., needed technology to capture, store, and transmit data for its commercial passenger jet fleet. They found their solution from the Raytheon Technologies Collins Aerospace unit in Cedar Rapids, Iowa.

Jet Blue selected the Collins IntelliSight aircraft interface device for more than 200 of JetBlue's Airbus A320 passenger jets. The device captures, records, stores, encrypts, and securely transmits aircraft data to the Collins and secure cloud GlobalConnect.

Offloading the data after each flight makes data available for analysis, operational insights, and improvements. Collins Aerospace's IntelliSight helps flight crews, ground crews, and airline operations teams optimize cost and improve customer service.

Collins officials say IntelliSight can be customized using a modular structure, and are supported by a worldwide network. At

▲ **More than 200 JetBlue Airbus A320 passenger jets will receive avionics from Collins Aerospace to capture, store, encrypt, and securely transmit flight data.**

least one carrier has reported a substantial increase in their data capture rates, up to more than 99 percent after equipping its aircraft with IntelliSight solutions.

"After an extensive review process, we chose the Collins Aerospace solution," says JetBlue's Chuck Cook, director of communications, navigation, surveillance, and technical programs. "Real-time access to data will allow JetBlue to adjust service schedules and increase the sustainability of these select aircraft."

Adds Jennifer Schopfer, president of Connected Aviation Solutions at Collins Aerospace, "JetBlue will see immediate and quantifiable benefits from the digital transformation of these aircraft. The IntelliSight data, passed via GlobalConnect, will give JetBlue's flight operations, engineers, and maintenance teams the information they need to ensure an even more efficient travel experience for their passengers." ◀