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COMPLEX MISSILE DEFENSE TECHNOLOGIES

Systems blend high-performance radar, electro-optical sensors, and digital signal processing on land and in space. PG. 14



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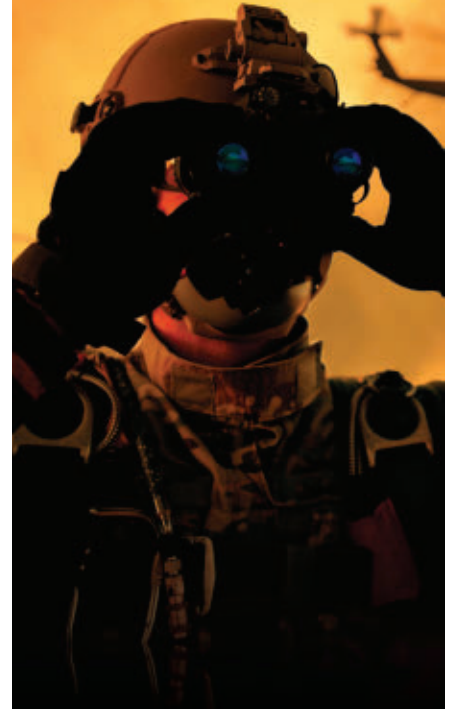
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High-performance embedded computing for sensor and signal processing aims at the 3D 360-degree picture of the battlefield to give commanders a leg-up determining enemy intentions.

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Active protection for armored combat vehicles moves toward widespread deployment



BY John Keller
EDITOR IN CHIEF

Active protection for armored combat vehicles — or the ability to destroy incoming anti-tank weapons before they hit — is on the verge of widespread deployment, as combat vehicle manufacturers start to consider active protection to be an essential part of modern design.

General Dynamics Land Systems in Sterling Heights, Mich., designer of the M1A2 Abrams main battle tank, took one of the latest moves toward active vehicle protection last month when the Army awarded the company a \$280.1 million order to procure kits for the Trophy expedited active protection system aboard M1A2 Abrams SEPv2 and SEPv3 tanks.

This action is part of a long string of U.S. military developments to integrate radar and computer processors into new and upgraded armored combat vehicles to enable these battlefield behemoths to defend themselves from rocket-propelled grenades, anti-tank guided missiles, and similar threats.

Quick-reaction active-protection systems use radar and potentially other kinds of sensors to detect incoming anti-tank weapons, and fire counter-weapons fast enough to destroy or deflect them before the anti-tank weapons can do serious damage.

General Dynamics relies on the Leonardo DRS Land Systems segment in St. Louis to provide the Trophy active-protection system for the Abrams tank. DRS is adapting technology developed by Rafael Advanced Defense Systems Ltd. in Haifa, Israel, to help shield Abrams tanks

DRS and Rafael are adapting the Rafael Trophy active protection system to the M1A2 Abrams tank. Rafael developed Trophy together with the

Elta Group of Israel Aerospace Industries Ltd. in Ashdod, Israel. The Trophy system intercepts and destroys incoming missiles and rockets with a shotgun-like blast.

The interceptor uses small shaped charges attached to a gimbal on top of the vehicle. The small explosives fire to a point in space to intercept and destroy the approaching round. Trophy locates and identifies incoming threats with radar that scans the tank's perimeter out to a known range. The on-board computer determines the optimal kill point for any incoming threat.

Trophy has been used in combat on Israeli Merkava tanks. In addition to locating and destroying incoming missiles and rocket-propelled grenades, the system also can locate and cue weapons to the positions enemy shooters.

The DRS-Rafael Trophy system can defeat known anti-armor shaped-charge weapons, like missiles, rockets, and tank-fired high-explosive anti-tank shells before they strike the tank.

Today the focus of active protection for armored vehicles is on relatively light infantry weapons like rocket-propelled grenades. It's not clear how enabling technologies for active protection may evolve to counter larger anti-armor weapons like the tube-launched, optically tracked, wire-guided (TOW) missile, aircraft- and helicopter-launched anti-tank weapons, or future hypersonic battlefield weapons.

It all comes down to what military systems designers have wanted to decades: faster computer processing, small size, weight, and power consumption (SWaP) components, and advanced radar small enough for battlefield vehicles. ◀

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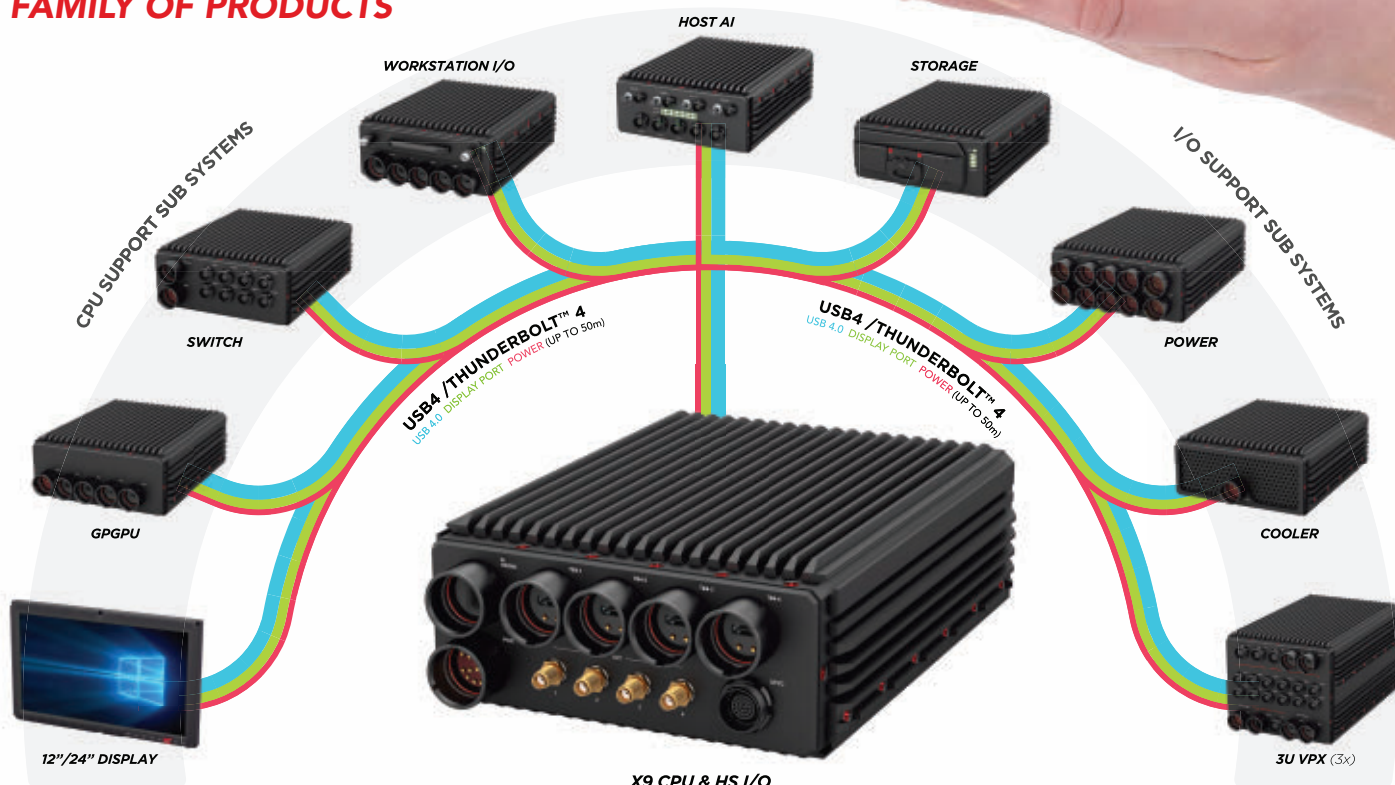
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Lockheed Martin to build EW systems to protect warships from anti-ship missiles

BY John Keller

WASHINGTON – U.S. Navy surface warfare experts are ordering additional advanced shipboard electronic warfare (EW) systems for surface warships like aircraft carriers, amphibious assault ships, cruisers, and destroyers under terms of a \$50.6 million order.

Officials of the Naval Sea Systems Command in Washington are the Lockheed Martin Corp. Rotary and Mission Systems segment in Liverpool, N.Y., for full-rate production of AN/SLQ-32(V)6 Surface Electronic Warfare Improvement Program (SEWIP) Block 2 units.

SEWIP Block 2 is an evolutionary acquisition and incremental development program to upgrade the existing AN/SLQ-32(V) electronic warfare system.

SEWIP provides enhanced shipboard EW for early detection, analysis, threat warning, and protecting surface warships from anti-ship missiles. SEWIP Block 2 will enhance the shipboard EW system's receiver and antenna group to meet the latest threats.

SEWIP Block 2 expands on the receiver and antenna group necessary to keep capabilities current with the pace of the threat

and to yield improved systems integration, Navy officials say. Lockheed Martin won a \$98.5 million order in March 2017 for full-rate production of AN/SLQ-32(V)6 SEWIP Block 2 subsystems.

The Lockheed Martin Block 2 SEWIP design for defense against anti-ship missiles is based on its integrated common electronics warfare system (ICEWS), which enables rapid reconfiguring of the system with commercial technology.

Mercury Systems in Andover, Mass., is providing advanced radio frequency microwave tuners and intermediate frequency products for SEWIP Block 2. Lockheed Martin chose the Mercury Echotek series microwave tuner and digital receiver, which are optimized for fast tuning and high performance. ◀

▲ SEWIP Block 2 is an evolutionary acquisition and incremental development program to upgrade the existing AN/SLQ-32(V) electronic warfare system.

On this order Lockheed Martin will do the work in Liverpool, N.Y.; and Lansdale, Pa., and should be finished by March 2024. For more information, visit Lockheed Martin online at www.lockheedmartin.com, or Naval Sea Systems Command at www.navsea.navy.mil.



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Wanted: AI and machine autonomy algorithms for military command and control

BY John Keller

ARLINGTON, Va. – U.S. military researchers are asking industry to develop reliable and trusted artificial intelligence (AI), machine learning, and systems autonomy technologies for future command and control, surveillance, and logistics systems.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued a broad agency

announcement (HR001122S0039) for the Assured Neuro Symbolic Learning and Reasoning (ANSR) project.

The ANSR program seeks breakthrough innovations in new hybrid AI algorithms for military command and control that deeply integrate symbolic reasoning with data-driven learning to create robust, assured, and trustworthy systems.

Researchers say hybrid AI algorithms able to acquire and integrate symbolic knowledge, and to perform symbolic reasoning at scale, will deliver robust inference, generalize to new situations, and provide evidence for assurance and trust.

Machine autonomy should be to hasten the tempo of military operations, reduce cognitive demands on the warfighter, and increase standoff distances to help keep warfighters safe, researchers say.

The prevailing trend in industrial machine learning research is towards scaling up to giga- and tera-scale models with hundreds of billions of parameters to improve accuracies and performance.

These trends are not sustainable, however, because of the extremely high computational and data needs for training such models, and the inability of data- and compute-starved military applications to access cloud-scale computer resources.

U.S. military applications, in addition, are safety and mission-critical, and so need to operate in unseen environments, need to be auditable, and need to

▼ The ANSR program seeks breakthroughs in hybrid AI algorithms for military command and control that integrate symbolic reasoning with data-driven learning.



be trustable by human operators. Instead, the ANSR program seeks to develop new hybrid AI algorithms that are more conducive for use in real-world military applications.

ANSR seeks to modify training and inference procedures to interleave symbolic and neural representations that will result in representations that are grounded in domain-specific symbols, and can include prior knowledge and domain-specific rules.

The program will demonstrate assured execution of an unaided intelligence, surveillance, and reconnaissance (ISR) mission to develop a common operating picture of a dense urban environment. The autonomous system will carry an effects payload to reduce sensor- to-effects delivery time.

The capabilities required of the autonomous system today are not achievable by state-of-the-art machine learning or stand-alone symbolic reasoning systems. The ANSR program has four technical areas: algorithms and architecture; specification and assurance; platforms and capability demonstration; and assurance assays and evaluation.

The guiding challenge for the program will be the assured execution of an unaided ISR mission in a dynamic dense urban environment.

Algorithms and architecture seeks to develop and model new AI algorithms and architectures that deeply integrate symbolic reasoning with data-driven machine learning. Specification and assurance will develop an assurance framework and methods for deriving and integrating evidence of correctness and quantifying mission-specific risks.

Platforms and capability demonstration will develop use-cases for engineering applications of hybrid AI algorithms for robust and assured performance. Assurance assays and evaluation will develop an assurance test harness with adversarial AI, and evaluate these technologies in systems.

The program will seek to demonstrate an autonomous ISR mission that requires the warfighter only to identify the area of interest, and enable AI to analyze the needs for navigation and actions against the threats. ←

Companies interested were asked to upload abstracts by 13 June 2022 and proposals no later than 26 July 2022 to the DARPA BAA Website at <https://baa.darpa.mil>. Email questions or concerns to Sandeep Neema, the ANSR program manager, at ANSR@darpa.mil. More information is online at <https://sam.gov/opp/0c28fb55fcb446dc95ed3337b385b36c/view>.

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Volocopter's four-seater unpowered urban air mobility aircraft takes first flight

BY Jamie Whitney

BRUCHSAL, Germany - Urban air mobility (UAM) company Volocopter GmbH in Bruchsal, Germany, has flown the company's fixed-wing autonomous passenger aircraft VoloConnect for the first time.

The unpowered VoloConnect, Volocopter's third product, offers a range of more than 60 miles and flight speeds faster than 155 miles per hour. The German company says the VoloConnect's passenger plane's range and payload will bring business travelers and commuters beyond the city center on routes like Burbank to Huntington Beach in Southern California.

Volocopter designed the VoloConnect and its other unpowered eVTOL aircraft to meet the highest aviation safety standards, according to the European Aviation Safety Agency (EASA).

The prototype completed its first flight in May 2022 after 17 months in the making and performed a few maneuvers for two minutes and 14 seconds during its first flight. The prototype planned aerodynamics and performance features of the future commercial product.

The VoloConnect's six rotors facilitate vertical takeoff, while two electric fans in combination with up-lift-creating wings ensure high forward speeds. Its prototype is passing flight tests to verify that the aircraft and its systems are in line with performance limits and prepared for the subsequent development.

This phase encompasses low-speed, transition, high-speed, and engine failure testing for automated and later autonomous flights – all standard-issue tests for eVTOL passenger aircraft manufacturers.

Within the first three test flights, the team was able to verify a significant portion of the eVTOL's performance envelope with forward speeds to 40 miles per hour forward flight and 28 miles per hour sideward flight speeds. ←

"Having a whole family of electric aircraft in the test flight phase is a pioneering feat," says Florian Reuter, Volocopter CEO. "Our technology platform is the foundation for our family of aircraft approach and has proven to deliver results at an astounding speed."

▼ The Volocopter VoloConnect unpowered urban air mobility aircraft is being designed to carry not only to destinations within cities, but also to carry passengers from city to nearby city.



EASA publishes the first regulations on urban air mobility in the world

The European Aviation Safety Agency (EASA) has become the first regulatory authority worldwide to publish a regulation for the operation of air taxis in the urban environment, which will be open for public consultation until September 30, 2022. Aviacionline has posted the 295-page document from the European Union Aviation Safety Agency, which “puts forward the establishment of a comprehensive regulatory framework to address new operational and mobility concepts that are based on innovative technologies, like unmanned aircraft systems (UAS) and aircraft with vertical take-off and landing (VTOL) capability and foster and promote their acceptance and adoption by European citizens. The group is looking to amend existing EU regulations and create new ones to address airworthiness and operational requirements in the burgeoning UAM field.

Global demand for military batteries to grow 30 percent in six years

Global demand for military batteries is expected to grow by 30 percent over the next six years, from \$2.1 billion this year to

\$2.75 billion by 28, predict analysts at market researcher Valuates Reports in Bangalore, India. This represents a combined annual growth rate of 4.5 percent during the review period. Analysts make their observations in the report Global Military Battery Market Insights, Forecast to 2028. Driving growth in the military battery market are changes in warfare techniques, demand for contemporary combat systems based on sophisticated technologies, increased demand for surveillance drones, and increased reliance on mobile technologies and remotely operated unmanned machinery, analysts say. A rise in military spending across the board because an increase in the number of international disputes, also will drive military battery market growth over the next six years, experts say in this market forecast. Demand for military batteries will grow because of a rise in demand for efficient portable equipment from changes in fighting strategies and growing reliance on mobile technologies on the battlefield. Due to the limitations of solar energy as a fuel source, there is increased demand for devices that can store energy and use it to operate electronics as needed. Increased reliance on remotely operated robotics to replace humans on the battlefield also is increasing demand for power storage devices. *Continued on page 11*

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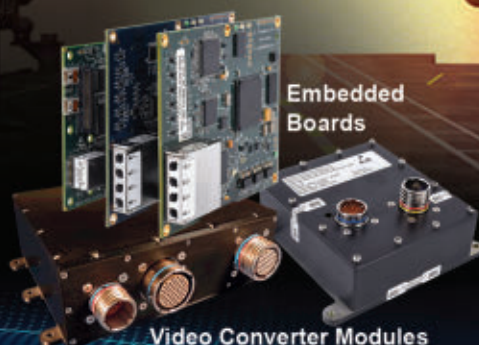


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SCAN ME



Wanted: handheld sensor to help care for military burn victims on the front lines

BY John Keller

FORT DETRICK, Md. – U.S. Army battle-field medicine experts are asking industry to develop a rugged handheld device that measures the severity of burns on wounded soldiers to help medical personnel determine the best triaging and treatment in field hospitals.

Officials of the Medical Technology Enterprise Consortium (MTEC) in Summerville, S.C., have issued a request for project proposals (MTEC-22-08-BDA) for the Burn Digital Assessment project.

The project seeks to develop a handheld rugged sensor able to measure burn severity by calculating burn size and depth, including how much of the victim's body is burned, and at what depths.

▲ **U.S. military experts want industry to develop a handheld sensor to measure the severity of burns to get wounded soldiers the care they need.**

This handheld device will be for Army battalion aid stations, brigade support aid stations, forward resuscitation and surgical detachments, and field hospitals to inform triaging, evacuation, and resourcing to help

reduce the surgical burden return injured soldiers to duty.

The MTEC is issuing this solicitation on behalf of the Army Medical Research and Development Command at Fort Detrick, Md. The MTEC is an organization of industry, academia, and non-profit groups that develop medical solutions that prevent and treat injuries and restore warfighters to full health.

Continued from page 9 The growing demand for rechargeable lithium-ion batteries in defense applications is expected to drive the growth of the military battery market. In the military, rechargeable batteries are becoming more popular as they become more durable, safer, and have a longer operating life. North America is expected to be the most lucrative region for military batteries, followed by Europe; Asia-Pacific; Latin America; and the Middle East and Africa. For more information contact Valuates Reports online at <https://reports.valuates.com/market-reports/QYRE-Auto-19B1280/global-military-battery>.

Boeing CEO says plane maker could be forced to cancel 737 MAX 10

Boeing Chief Executive Dave Calhoun says the plane maker could be forced to cancel the 737 Max 10 over potential regulatory issues. "If you go through the things we've been through, the debts that we've had to accumulate, our ability to respond, or willingness to see things through even a world without the -10 is not that threatening," Calhoun says, adding that he does not expect to cancel the 737 MAX 10 but said "it's just a risk." A Boeing spokeswoman confirmed the accuracy of Calhoun's quotes and reiterated the plane maker is "working transparently with the (Federal Aviation Administration) to provide the information they need, and

are committed to meeting their expectations and those of our customers to certify and deliver the 737-10."

NASA and ESA establish research group for Mars sample return program

NASA and the European Space Agency (ESA) have established a group of researchers to make the most of the scientific potential of Mars rock and sediment samples that would be returned to Earth for in-depth analysis. Called the Mars Sample Return Campaign Science Group, the 16 researchers will be a science resource for the campaign's project teams as well as for related Earth-based ground projects such as sample recovery and curation, NASA explains. NASA's Mars Sample Return Campaign offers to enhance the understanding of Mars by bringing scientifically selected samples to Earth for study using sophisticated instruments. The campaign would fulfill a solar system exploration goal, a high priority since the 1970s and in the last three National Academy of Sciences Planetary Decadal Surveys. This NASA and ESA partnership would be the first mission to return samples from another planet and the first launch from the surface of another planet. The samples collected by NASA's Perseverance Mars rover during its exploration of an ancient lakebed are thought to offer the best opportunity to reveal clues about the early evolution of Mars, including the potential for past life. ←

Future military engagements likely will result in higher numbers of casualties with significant burn injuries — including larger, more severe burns, Army researchers say. This will require medical providers to manage burn casualties for longer periods in the field close to the fighting.

Military medical personnel will face deciding how best to resuscitate those casualties and whom to prioritize for evacuation. Today's field hospitals have only minimal burn wound management tools, so determining resuscitation needs and evacuation priority can affect return-to-duty rates and survivability.

It is extremely challenging for far-forward medical providers to assess burn severity, because they can only estimate the depth and severity of burns. This is where a new digital assessment device comes in.

This handheld device could help medical personnel evacuate severe burn victims quickly, while preventing unnecessary evacuation for less severe burn casualties who could be treated closer to their units.

Such a handheld device for burn assessment should have FDA clearance for assessing burn size and depth; be able to measure burn size in terms of total body surface area; be able to measure the proportion of total body surface area for burn depths; be painless; simple to use; give output information within minutes; is compatible with other burn and lifesaving treatments; has minimal training requirements; follows military cyber security requirements; and could become a commercially viable product.

Those selected for the project will split as much as \$4.8 million over two years; several contract awards are expected. Companies interested must be MTEC members to submit white papers or formal proposals. ←

Those interested were asked to submit five-page white papers by 14 July 2022. Email MTEC to verify membership status at mtec-contracts@ati.org. Information on joining MTEC is online at www.mtec-sc.org/how-to-join-2. Email questions or concerns to MTEC at mtec-contracts@ati.org. More information is online at <https://www.mtec-sc.org/wp-content/uploads/2022/06/MTEC-22-08-BDA-RPP-Final.pdf>.



European Space Agency selects Airbus to measure heat emissions from Earth

BY Jamie Whitney

STEVENAGE, England – Airbus has been awarded a \$168 million contract for the European Space Agency's (ESA) FORUM satellite to measure heat emitted from the Earth into space.

FORUM, short for Far-infrared Outgoing Radiation Understanding and Monitoring, will be the first satellite to observe Earth in the far-infrared part of the spectrum. The onboard technology will measure the Earth's outgoing energy to help improve understanding of the climate system.

Measurements from FORUM's spectrometer will enable scientists to compile a high-resolution view of the Earth's greenhouse effect and the properties of ice clouds and water vapor in the atmosphere. Airbus is mission prime contractor with OHB System AG in Bremen, Germany, providing the infrared sensor.

Airbus in Stevenage, England, will lead development of the satellite, with Airbus in Germany responsible for the instrument signal detection chain, and Airbus in France providing platform product support.

Using in-orbit proven technology will considerably reduce risk and costs on the program. Avionics for the mission have been developed, validated and flown together on previous missions, which will enable savings in verification activities, software development and operating procedures.

▲ **The ESA FORUM satellite will measure far infrared energy to monitor heat emitted from the Earth into space to help scientists understand changes to the Earth's climate.**

The main instrument on FORUM will be a Fourier Transform Spectrometer operating in the far-infrared. The sun's incoming shortwave radiation is absorbed at the Earth's surface and re-emitted into space, through the atmosphere, at longer

infrared wavelengths. FORUM will measure the signature of this outgoing radiation, from which a crucial understanding of water vapor, ice clouds, surface snow and ice, carbon dioxide and other greenhouse gas characteristics can be derived. The satellite will also be equipped with a thermal imager for ground sample validation.

The FORUM satellite will fly in a loose formation ahead of the MetOp-SG A1 satellite for synergistic observations using MetOp-SG A1's infrared atmospheric sounding interferometer. Using MetOp's data at shorter infrared wavelengths will complement and further improve FORUM's own science. ◀

Procurement from small and medium-sized enterprises (SME) will be a key element of the FORUM mission to further enhance the space supply chain across ESA member states. The 1,947 lb. FORUM satellite will be in a polar orbit at an altitude of 516 miles and is scheduled to launch on a Vega-C launcher from Kourou, French Guiana in 2027. FORUM will be the 9th Earth Explorer mission of ESA's Future EO Program.



GNSS-denied navigation capability keeps Alpha helicopter UAVs flying

BY Jamie Whitney

MADRID — Alpha Unmanned Systems SL in Madrid, a designer of small unmanned aerial vehicles (UAVs), needed a flight-control system that resists RF and microwave signal jamming or degradation. They found their solution from UAV Navigation SL in Madrid.

Alpha Unmanned selected UAV Navigation as its flight control system provider due to their requirement to include Global Navigation Satellite Systems (GNSS) technology able to operate through attempts to jam the UAV's control signals.

Alpha Unmanned designers needed a robust GNSS-denied capability in their UAV helicopters Alpha-800 and Alpha-900 systems.

The majority of uncrewed aerial systems (UAS) rely on GNSS for correct timing, to maintain a stable position, and to navigate between waypoints.

Any small drone that relies exclusively on microelectromechanical systems (MEMS) sensors to estimate aircraft attitude and which does not fuse data from other types of sensor may be vulnerable to GNSS jamming attacks.

Officials of UAV Navigation SL in Madrid, Spain, says their design philosophy is that no UAV can depend solely on the availability of a GNSS signal; the system must continue the mission even when GNSS signals are degraded or jammed.

▲ **The Alpha Unmanned Systems unpiloted aircraft can say on their designated flight paths even amid attempts to jam their control signals**

A jammed flight control system denies the UAS access to positional information. The only alternative is for the remote pilot to take manual control, which can put the whole mission in jeopardy. Some systems

may not even be able to maintain UAV stability and the aircraft will fall out of the sky.

This is a major weakness of many commercially available drone systems, and it is what has made jammers and other counter-UAV measures so popular in the industry.

With UAV Navigation's VECTOR-600 autopilot, Alpha's UAVs are able to continue a mission if the GNSS signal becomes unavailable or is jammed; the autopilot is able to estimate the UAV's position and follow a flight plan, or alternatively receive a command to fly to a designated area - including the landing site, even if the UAV is beyond line of sight.

The autopilot's sensor suite also uses MEMS inertial navigation technology, so the system will accumulate navigation errors as large as 30 meters per minute; wind conditions may alter this figure, but the key point is that platform stability and control is maintained and the aircraft can be recovered. ◀

For more information contact Alpha Unmanned Systems online at <https://alphaunmannedsystems.com>, or UAV Navigation at www.uavnavigation.com.

The technological ch MISSILE

Systems designers are blending high-performance radar, electro-optical sensors, and the latest digital signal processing on land and in space to counter advanced ballistic and hypersonic missile threats.

BY Megan Crouse

Today's long-range missiles require long-range defenses. Missile defense is a broad term for a wide variety of technologies and techniques. With some differences in place depending on the altitude of the threat, today's missile defense is in effect an electronic blanket over ally nations. It consists of enabling technologies in four roughly divided use cases:

- detection
- interception
- tracking
- destruction

With so many moving parts, the number of enabling technologies also is large and complex. Much of the framework for missile defense is rooted in systems originally created to defend against nuclear-armed intercontinental ballistic missiles, but it also applies to defending against conventional warheads and against a new generation of enemy hypersonic munitions.

Naturally, part of the challenge of missile defense the speed at which it must operate; it is a matter of split-second decisions. Defenders have exactly as much time as attackers. Missiles can travel across the world quickly, so detection must occur just as

quickly. Detection and tracking both bring to bear electro optical sensors, radar, and more.

Interception, then, involves launching an anti-ballistic missile from a ground system, surface warship, or airplane. All can be differentiated based on range. The relatively well-known American Terminal High Altitude Area Defense (THAAD) system from Lockheed Martin Corp. has a range of several hundred kilometers and is suitable for a contested area or for underground military operations, while Raytheon's PATRIOT anti-missile system has a relatively short range of 12 to 50 miles.

A multitude of enabling technologies are brought to bear here. Taken into consideration are the intercept vehicles themselves, their telemetry, high- and low-frequency radar, air and space-based sensors, infrared sensors, low-Earth orbit satellites, weather imaging, on-board processing, software, other sensors, and, potentially, artificial intelligence (AI).

The altitude of the threat also will depend on the situation. Different defenses account for the attacking missile at every

challenges of complex DEFENSE



phase of its flight, near the ground at launch and descent or in space during glide flight. The same system may be able to intercept at one or more of these altitudes. THAAD, for example, can do both, targeting short-, medium-, and intermediate-range ballistic missiles in their terminal phase with a kinetic warhead.

Another important factor: adversaries and allies alike are aware of defensive measures and try to counter them. Dummy missiles and signal-jamming techniques can confuse defensive strikes. If an ally aims for what appears to be a warhead only to hit an inert decoy instead, the defense will have failed.

THAAD and PATRIOT projects

The U.S. THAAD destroys incoming missiles using the kinetic energy of the interception impact, as opposed to an exploding warhead. This Army project is still well within its support lifetime, with Lockheed Martin Corp.'s Missiles and Fire Control segment in Dallas receiving a \$74.1 million order from the U.S. Missile

▲ **GhostEye MR medium-range radar is for defending against incoming ballistic missiles, as well as against fighter aircraft, cruise missiles, and UAVs.** Raytheon photo.

Defense Agency (MDA) in Huntsville, Ala. this April to build six launchers, THAAD Fire Control and Communication (TFCC) systems, and support equipment. THAAD has five major components carried on a four-axle heavy expanded mobility tactical truck:

- the launcher;
- the radar;
- the interceptor;
- support equipment
- THAAD fire control and communications (TFCC) units; and

Inside that vehicle sit two mobile tactical operations centers (TOCs) and the system's AN/TPY-2 ground-based radar (GBR). Each launcher takes about 30 minutes to reload.

Like other organizations we've talked about this year, the MDA is looking for projects to capitalize on Modular Open

Systems Approach (MOSA), other open-systems standards, and COTS hardware and software.

The Army also uses the MIM-104 PATRIOT system (developed in collaboration between Raytheon, Lockheed Martin, and Boeing), which has served throughout U.S. and allied military operations since the 1980s. Originally intended primarily to shoot down aircraft, it now operates as an anti-ballistic missile system. PATRIOT is short for Phased Array Tracking Radar to Intercept on Target.

Army leaders are seeking a replacement for the PATRIOT system's sensor, the Integrated Air and Missile Defense system. Specifically, Raytheon is contracted to provide the Lower Tier

Air and Missile Defense Sensor (LTAMDS) radars. The Army will make a production decision in late 2023.

The Army also is reevaluating schedules for replacing the Lockheed Martin-made PATRIOT missiles, with a contract award to one vendor expected next year.

Aegis

Another major MDA project making headlines today comes from the Navy's Aegis system. On July 1, MDA declared Lockheed Martin the recipient of a sole-source contract for Guam defenses, which also include Raytheon Technologies Standard Missile (SM)-3 and SM-6 missiles, and the Northrop Grumman Integrated Air and Missile Defense Battle Command System (IBCS) and the THAAD.

MDA officials say they do not anticipate revealing any more information about the project that might open it up to other possible contractors, but did hold an open call for interest until July 15.

The project will include the current Aegis weapon system common source library (CSL) software and production suites. It also involves developing a new launcher interface and non-recurring engineering and integration of a new launcher.

The GMD

The Army also fields the somewhat controversial Ground-Based Interceptor (GBI), a system which has been in place against potential attack on U.S. soil since the 1990s. GBI is part of the Ground-Based Midcourse Defense (GMD) system in place. It recorded a 50% kill rate in tests throughout its lifetime as of 2017. The interceptor component, known as the Exoatmospheric Kill Vehicle, fires a ramming missile into space to smash the target, with no warhead required. Its arsenal is generally regarded as having a sufficient number of missiles to defend against potential attacks from North Korea or Iran, while not enough to counter a wide-spread move by Russia or China.

MDA is supplementing the 44 currently deployed GMD interceptors. The



Demonstration of the THAAD weapon system. Image credit: Lockheed Martin



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Next-Generation Interceptor project, intended to be fielded by 2027 or 2028, will require building 21 three-stage Next Generation Interceptors.

One stepping stone to the next generation is the 2- and 3-Stage selectable GBI, which enables the vehicle to be released earlier than the previous version could be and saw a successful non-intercept test in September 2021.

Designs for the Next-Generation Interceptor passed a significant milestone in December 2021, with competing teams Lockheed Martin and Northrop Grumman both submitting systems requirements reviews. While details are slim on the requirements, Lockheed Martin talked up its digital twin system that aids in providing transparency and flexibility throughout the engineering process.

“This ‘fly-before-you-buy’ has already seen success in other military domains and we can leverage ‘e-fly-before-you-buy’ on NGI,” said Janica Cheney, director of Capability Implementation Management for Lockheed Martin.

Tracking missiles from space

Space-based early warning systems do not shoot down missiles but provide the first pieces of information when a missile reaches cruising altitude. Meanwhile, L3Harris is working on the Space Development Agency’s missile tracking project, a group of four satellites for Tracking Layer Tranche 0 under a \$193 million firm, fixed-price contract.

The Tracking Layer Tranche 0 project, also developed with input and technology from SpaceX, is a Wide Field of View (WFOV) array intended to be able to provide missile tracking

▲ **The Raytheon GhostEye family of missile defense radars is based on a project that Raytheon competed in the 2019 Army LTAMDS competition.** Raytheon photo

data for hypersonic glide vehicles and the next generation of advanced missile threats, according to Space Development Agency director Derek Tournear in Air Force Technology.

“They take data from multiple tracking systems, fuse those, and are able to calculate a fire control solution, and then the transport satellites will be able to send those data down directly to a weapons platform via a tactical data link, or some other means,” Space Development Agency director Derek Tournear said.

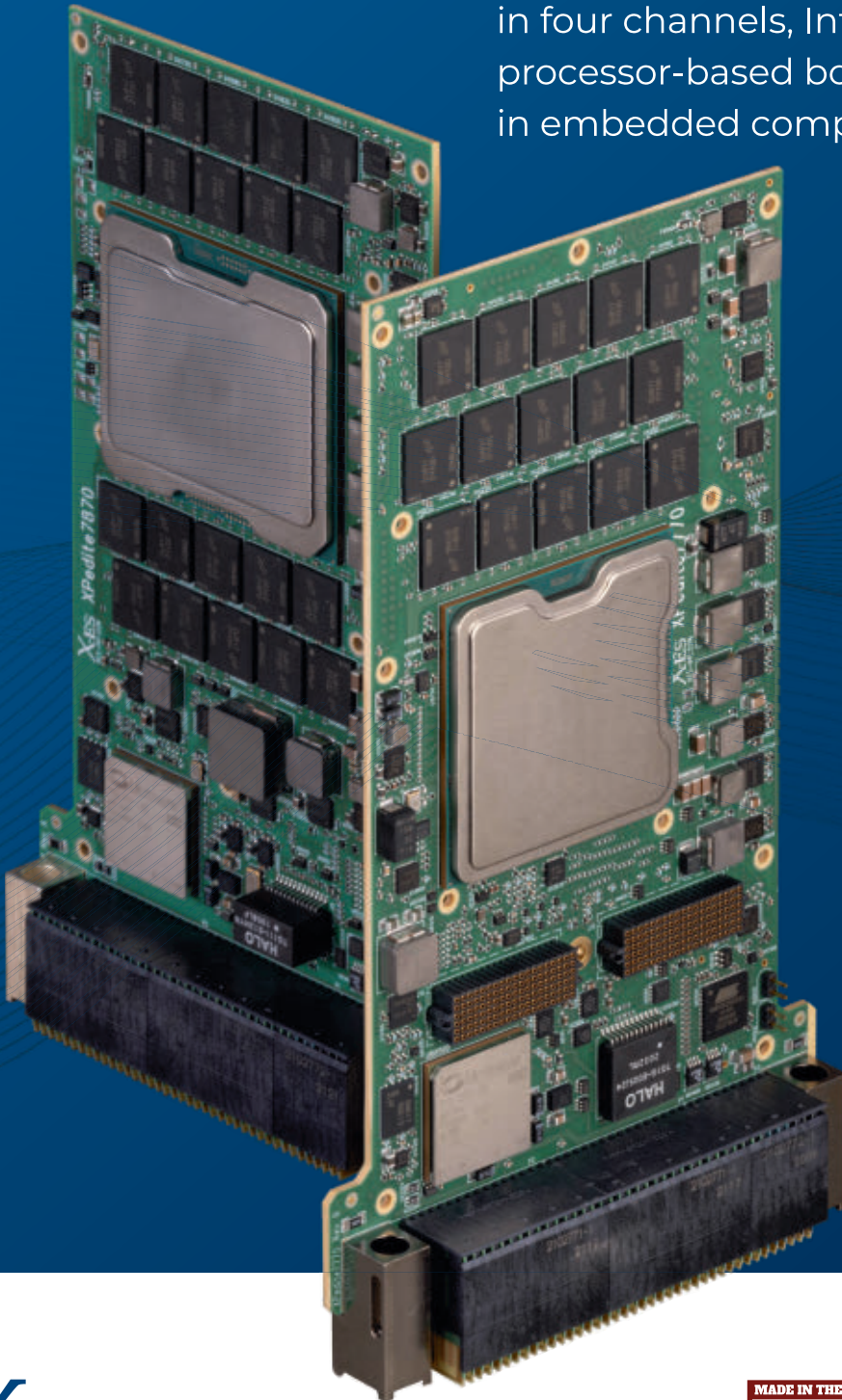
In particular, they’re looking for high-tech defense against hypersonic glide vehicles, which travel at speeds faster than Mach 5 and have low-heat signatures that make them hard to detect. Hypersonic glide vehicles also don’t follow the typical deterministic trajectory as other ballistic missiles, and can stymie software designed to predict missile targets based on their initial launch trajectories. A third challenge: how to handle simultaneous enemy missile launches.

“Rapid deployment programs, such as this one, demonstrate early missile warning and tracking missions can be efficient, affordable, and developed at a pace that keeps up with emerging threats,” said Ed Zoiss, president, L3Harris Space & Airborne Systems in a December 2021 press release. “L3Harris purchased subsystems and other material and began building while completing the design to demonstrate speed to deployment.”

Top-priority investments included enabling technologies such as spacecraft, payloads, ground software and advanced

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The Terminal High Altitude Area Defense (THAAD) missile-defense system from Lockheed Martin Corp. has a range of several hundred kilometers.

Missile Defense Agency photo.

algorithms. L3Harris also is separately working on a prototype for the Missile Defense Agency's Hypersonic and Ballistic Tracking Space Sensor (HBTSS).

L3Harris' work on this technology builds from their history of building geosynchronous and low earth orbiting weather and climate instruments, the company wrote.

"We observed that these instruments had the sensitivity and performance capability of detecting launches from orbit," said John Holder, Missile Warning and Defense (MWD) chief systems engineer, L3Harris, in a press release. "This led to significant company investment to develop accompanying on-orbit algorithms that supported detection and tracking of these missiles through the multiple stages of flight and potential atmospheric conditions."

Recently, L3Harris has been focusing on the detection and tracking phases of the MWD system architecture. This requires drawing from four main areas their enabling technologies need to cover:

- continuous global coverage;
- high sensory sensitivity and dynamic range, specifically in detecting light from dim to very bright;
- real-time, on-board processing that is capable of immediately detecting and tracking threats under a multitude of different geometries and atmospheric conditions; and
- open design architecture that supports rapid evolving performance in a schedule-driven, cost-constrained environment.

L3Harris engineers also are working on spinning out a proliferated low Earth orbit (pleo) technology centered around the MWD algorithm.

Northrop Grumman also is working on space-based missile tracking satellites to detect long-range, high-altitude threats. Company engineers can draw on a decade of experience with the demonstration Space Tracking and Surveillance System satellites, which were put in place in 2009 and retired in March 2022. Company officials say they plan to use the information learned from this early warning system for the company's next similar project, the Hypersonic and Ballistic Tracking Space Sensor (HBTSS) satellites.

Studies and criticism

There has been some public debate within agencies about whether space-based missile defense is the best course of action. A February 2022 report from the American Physical Society (APS) claimed that "system thus far developed has been shown to be effective against realistic ICBM threats" to the United States. The APS declared the GMD would not be effective against "more than the simplest attacks" within the 15-year scope of the report.

The MDA and the Pentagon have pushed back against this idea. In particular, they suggest that external studies tend to rely on outdated information and cannot take classified data into account.

Hypersonic interceptor

Despite the concerns, the Missile Defense Agency is going ahead with plans to design and build a defensive hypersonic vehicle called the Glide Phase Interceptor, which would destroy adversary hypersonic missiles at speed during the unpowered portion of their flights. As of the contract announcement December 2021, the participating companies have until September 2022 to submit concept designs for prototypes.

This system would connect to the Navy's Aegis cruisers, and will be designed to take advantage of the short window in which hypersonic missiles are in space, as well as to react to their ability to maneuver. While the radar on the Navy's Aegis ships and the Sea-Based X-band Radar are suited for terminal defense, the HBTSS will cover tracking them through space after the boost phase.

On June 27, the MDA indicated only Northrop and Raytheon remain in the running for this project.

GhostEye

The Raytheon GhostEye family of missile defense radars is based on a project that Raytheon competed in the 2019 Army LTAMDS competition, which resulted in the company's selection

by the Army to produce a next-generation sensor for lower tier air and missile defense. From there, the organization expanded variants of that radar into different products called the GhostEye C-band spectrum family of radars.

GhostEye MR is a medium-range sensor that focuses on missile defense and air-breathing targets, which include fighter aircraft, cruise missiles, and unmanned aerial vehicles (UAVs), says Jeffrey Pellenz, Raytheon's associate director for GhostEye X and capabilities.

It connects to the National/Norwegian Advanced Surface to Air Missile System (NASAMS), a collaboration between Raytheon and Kongsberg Defence and Aerospace begun in the 1990s and now deployed in 12 countries.

Another one of the benefits of GhostEye NR is that it extends the kinematic range of those missile NASAMS fires, including the AMRAAM-ER, AIM-9X Sidewinder. It takes better advantage of those capabilities, which are also produced in-house, Pellenz says.

The NASAMS system has a longer view with these sensors, which gives the operator longer time against whatever mix of threats are coming their way. It's giving them the tactical advantage

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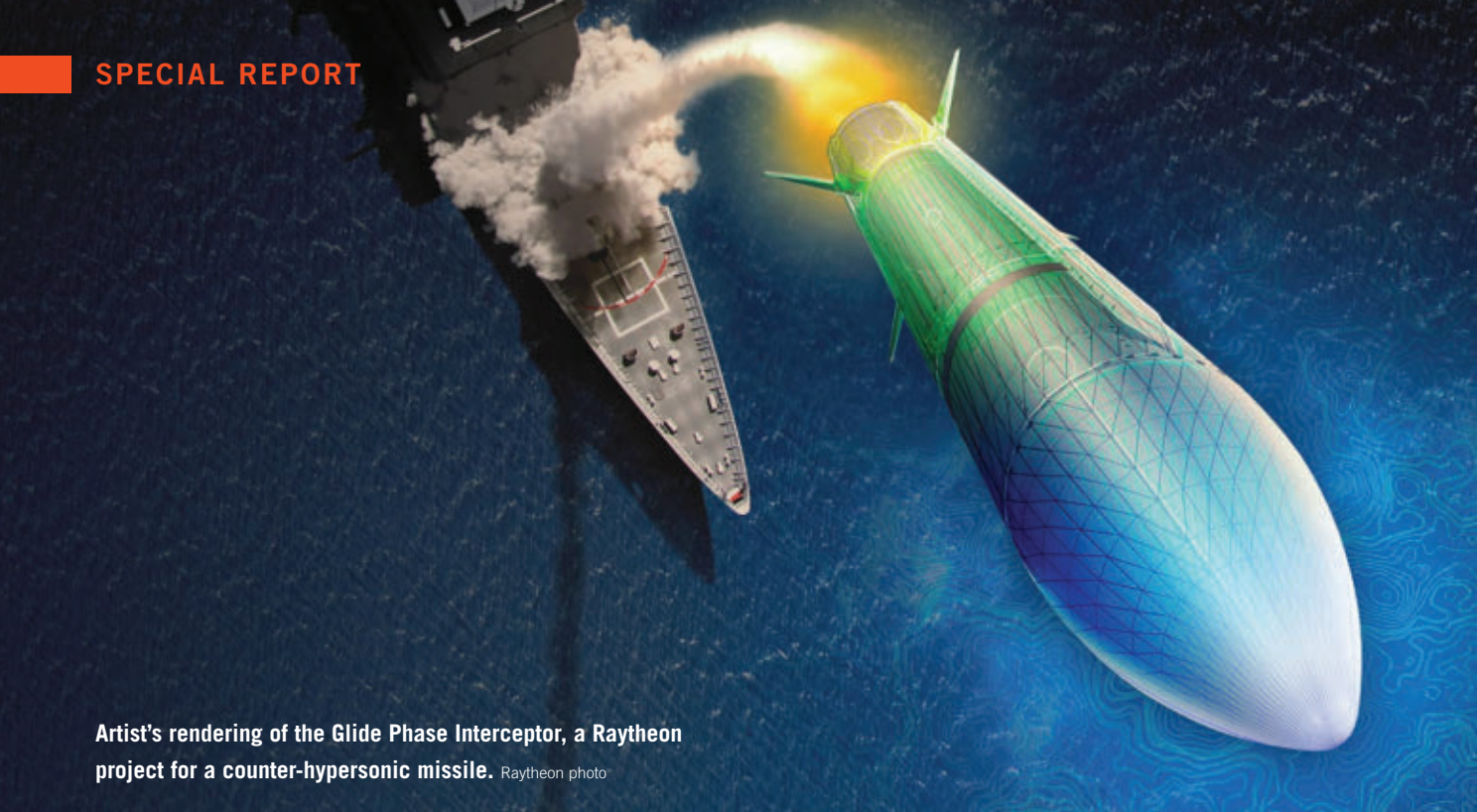
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Artist's rendering of the Glide Phase Interceptor, a Raytheon project for a counter-hypersonic missile. Raytheon photo

by having that extended range. "There's flexibility in what we can do because of the way we've designed the sensor," Pellenz says.

Some of that comes from Raytheon's ability to produce key components in-house. Company engineers make gallium nitride (GaN) chips, the component "at the heart of it all," as Pellenz says, at a facility

co-located with the rest of Raytheon's manufacturing in Massachusetts.

"GaN allows us to improve our energy efficiency, so as much input power to output power as we can convert at a cleaner and more efficient rate. It allows us to improve range and sensitivity of the radar," Pellenz said.

Making them in-house insulates this particular component from commercial market sources. It isn't going to be influenced by shortages in the same market as laptop providers or other commercial tech.

"The reason we kept it in house was to ensure the high reliability our customers need. These radars go into diverse climates and are operating 24/7 around the world because of what they do and what they do it against. Having higher reliability and higher peak power is key," Pellenz says.

Some of Raytheon's work on LTAMDS and the GhostEye family of products is built on the organization's experience with the PATRIOT system. They took what they already knew about more than 30 years of sensors in missile defense systems. Increasing the capability of the PATRIOT system in recent year has involved more hardware than it might in newer systems, but it also takes software updates in regard to the software-defined radars similar to the ones in the newer systems.

Currently, Raytheon is testing their first GhostEye NR system at the integration facility in New Hampshire after producing the first unit last year.



The two MDA CubeSat Networked Communications Experiment (CNCE) Block 2 space vehicles shown here were deployed into orbit last May. Missile Defense Agency photo.

Electronics industry trends

In terms of the industry in general, Raytheon says organizations are looking for ready-now solutions in today's world. "Past the capability of the system they're looking for the ability to maintain it," Pellenz says.

For Raytheon, that means developing augmented reality solutions to connect warfighters in the field to the organization's experts to troubleshoot problems.

"It helps training, assists in keeping the readiness level up and is consistent with the users as the user community is very much of the gaming generation, so having training systems and sustainment technologies that mimic a gaming environment is something they're familiar with and allows them to ramp up quickly," Pellenz says.

Supply chain issues impact multiple industries

Supply chain issues are making headlines across industries. No one company took the brunt of the pandemic's follow-on effects. Raytheon faced delays in the delivery of the LTAMDS program due to COVID-19-related system integration challenges and supply chain issues, but this is by no means an experience unique to the organization. Demand outpaces supply across the board, impacting suppliers' ability to ramp up manufacturing, Raytheon representatives said in an email.

Meetings and partnerships seek to balance consumption and demand based on resource availability. Related U.S. Department of Defense initiatives also give organizations initial leverage when it comes to investing in domestic suppliers.

Semiconductors, steel and aluminum continue to be among the wide variety of materials and components affected by the ongoing effect of the COVID-19 pandemic on the supply chain.

The aerospace industry lost about 4 percent of its 2019 employees in 2020, more

than 87,000 jobs, according to the Aerospace Industries Association. That means not enough people and not enough products.

John Mollard, acting chief financial officer for Lockheed Martin Corp., pointed out in an October 2021 earnings call that larger-than-expected supply chain problems stemmed from multiple

suppliers — particularly those that serve military and commercial aircraft. Fewer flights during the pandemic meant less cash for those companies. In response, Lockheed sent out accelerated payments to small- and medium-sized suppliers.

"We need our supply chain to be successful for us to be successful," Mollard said. ◀



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Sensor and signal processing embedded computing at the speed of battle

BY John Keller

High-performance sensor and signal processing today is all about the ability to distill information and make crucial military decisions at the speed of battle. This is more complicated than it sounds, but the rewards are great, and often can tip the balance between victory and defeat in any armed conflict.

Sensor and signal processing at the speed of battle relies on a host of new and emerging enabling technologies, ranging from high-performance microprocessors; secure tactical networking; advanced sensors; software algorithms; small size, weight, and power consumption (SWaP) components; sensor fusion, artificial intelligence (AI), machine automation, and more.

“Today you have a platform with high-resolution sensors and high-performance computing to get a 3D 360-degree picture of the battlefield,” explains Chris Ciufo, chief technology officer at embedded computing specialist General Micro Systems in Rancho Cucamonga, Calif.

“A human can’t make predictions of what’s important in those battlefield pictures,” Ciufo points out. “Now we need computers that bring together multiple platforms, each with multiple sensors, and make some quick rapid-fire decisions on what’s the highest



The General Micro Systems X9 module has the NVIDIA Jetson AGX Xavier or Orin CPU/GPU, and five 10 Gigabit Ethernet ports for inter-box communications, and multiple sensor inputs.



The General Micro Systems X9 Spider Host small form factor chassis is part of a distributed architecture, in which modules can be stacked like bricks, and are interconnected via Thunderbolt 4.

threat, how do we deal with this quickly to take-out the most important things. We have more sensors, we are fusing these platforms together where they share data, and now you have 30 fire hoses of data all at once.”

Sensor processing with different kinds of sensors

“You can use sensor fusion computing to create a 3D picture through optical sensing and optical imaging of a warfighting scene,” says Rodger Hosking, director of sales of Mercury Systems Inc. in Upper Saddle River, N.J. “You are taking those different sensors and combining them into an image that could be presented to a pilot or operator to give him a much richer view of the warfighter scene. Those can be high-lighted graphically in different ways that can enhance certain things the operator wants to see, to help him make a decision on what to do.”

Typically this kind of capability requires several different kinds of digital processors. “You have multiple types of processors in the processing chain,” explains Denis Smetana, senior product manager at the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va.

“At the front end, where you have sensor data coming in, you typically have FPGAs [field-programmable gate arrays]



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for front-end filtering to find the signals of interest that might need additional processing, Smetana says.

“FPGAs are flexible and are good at massive amounts of signal processing,” Smetana continues. “After FPGAs do that front-end processing, the processed data goes to a more general-purpose processor to do next-level analysis and decides what to do with the signals of interest.”

A different kind of processor — the general-purpose graphics processing unit (GPGPU) — often is involved in advanced sensor and signal processing. “GPGPUs also can do parallel processing, acting as a co-processor,” Smetana says. “GPGPUs can do some of the signal processing. The front-end processor must interface directly with the sensor, and the GPGPUs don’t typically have the interfaces to the processors, so signals usually go to FPGAs first.”

Processor technology itself also is evolving quickly toward integrated technologies on the same chip — often called systems on a chip. “At the silicon level we are seeing a merging of technologies ... processors in FPGAs and GPU cores,” says Curtiss-Wright’s Smetana.

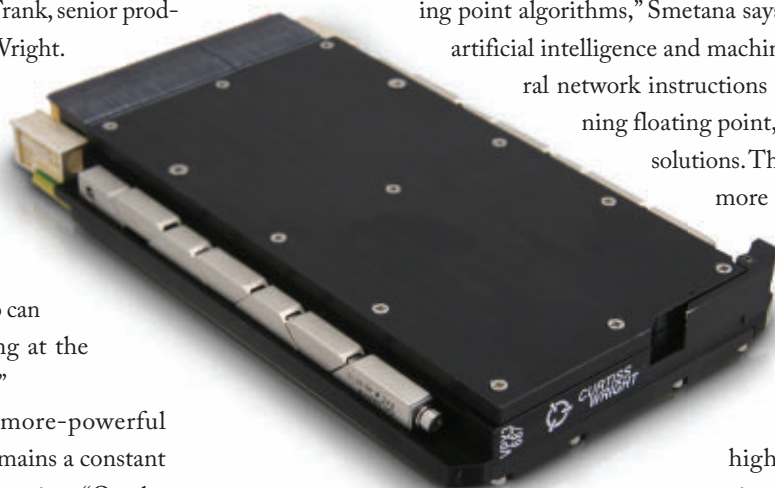
“We have low-to-mid-range processing that make use of traditional single-board computers as they are using six- and eight-core processors,” says Aaron Frank, senior product manager at Curtiss-Wright.

“We have our tiger Lake H 11th-generation single-board computers on our VPX6-1961 6U VPX Intel Xeon W-11000E processor card, which also can do some DSP processing at the low-to-mid-range level.”

Demand for ever-more-powerful embedded computers remains a constant in sensor and signal processing. “On the platform itself we need more powerful computers with smaller size, lighter weight, and low power consumption,” points out General Micro Systems’ Ciuffo.



Two General Micro Systems Venom 3U OpenVPX boards, on the left a VPX-HS, a dual-slot 3U OpenVPX single-board system with four Thunderbolt 4 ports on the front panel, and on the right the VPX-S single-slot 3U OpenVPX single-board system with four Thunderbolt 4 ports.



The Curtiss-Wright VPX3-687 3U VPX 10 Gigabit Ethernet Switch provides as many as 32 10 Gigabit Ethernet interfaces at line-rates up to 320. gigabits per second.

Other important processor technologies for modern signal and sensor processing, experts say, include the Versa FPGA from Xilinx Inc. in San Jose, Calif.; the NVIDIA Jetson GPGPU from NVIDIA Corp. in Santa Clara, Calif.; The Thunderbolt 4 networking interface; and direct RF digitizing, which uses fast analog-to-digital and digital-to-analog converters.

Intel Ice Lake D

Still, perhaps the most important technology breakthrough in sensor and signal processing over the past few years is the so-called Ice Lake D general-purpose

processor from Intel Corp. in Santa Clara, Calif. Ice Lake D is an enhancement of the company’s Xeon D processor, which evolved from server-class chips.

“At high end Intel has its Scalable Processor (SP) product line for data centers, but the real challenge with using server-class processors is they tend to be very high power — many hundreds of Watts —so they are very difficult to cool and handle all of that power,” says Curtiss Wright’s Smetana.

“The Xeon D really is targeted at the mil-aero market, because it has lower numbers of cores, and is easier to cool. With Ice Lake, the new features it brings are the AVX 512 floating-point engine to double the bandwidth of that processor to run floating point algorithms,” Smetana says. “The other is targeting at artificial intelligence and machine learning, and vector neural network instructions (VNNI). Rather than running floating point, can run lower-level integer solutions. These are optimized to do that more efficiently within the processing architecture.”

It is the Ice Lake D with its additional capabilities that have gained the attention of many designers of high-performance embedded computing systems. “A lot of our customers are looking to see how they can apply that technology to radar and signal processing,” Smetana says. “The other key to the Ice Lake D is it has faster I/O and PCI Express

on it, but also adds memory banks for a lot of signal processing algorithms, and to do parallel processing with multiple cores. To do that you need a lot of memory because memory can be a bottleneck.”

Part of what separates the Ice Lake D from previous-generation or low-end processors is the number of processor cores the new chip has. “The primary difference is ice lake class processors have more cores, so they are better for applications that need signal processing,” says Curtiss-Wright’s Frank. “Lower-end processors have fewer cores, but run at higher speeds; it depends on the software architecture if you can use all those threads.”

As an example, The Curtiss-Wright Tiger Lake-class-based single-board computer is for mission processing, data center type virtualization, mission command, and command-and-control applications, while the newer Ice Lake D-based products are more for intelligence, surveillance, and reconnaissance signal processing, Frank says.

General Micro Systems has been providing Intel Xeon D embedded computing products for several years, for systems such as the U.S. Army Warfighter Information Network-Tactical (WIN-T) Increment 2. Improvements of the Ice Lake D over the Xeon D, however, are striking, says General Micro’s Ciufu.

“Ice Lake D now goes up to 20 cores, and it has native Ethernet 100 Gigabit Ethernet pipes directly onto the processor itself, as well as PCI Express Gen 4, and the ability to connect disk drives directly to the processors,” Ciufu explains. “NVMe drives can be connected directly to the processors to create RAID processor arrays directly to the processor.”

Says Mercury’s Hosking, “The Intel Ice Lake D will bring more horsepower because it is a multicore high-performance engine, for things that are being done today in scalar processors. You just need more and more of these resources, and these multicore processors, with really good memory access, offer built-in memory blocks — parallel cores running at very high rates — to solve some of those high channel-count compute-intensive processing applications.”



The General Micro Systems LightBolt cables plug into the connectors on the X9 Host and X9 AI chassis. The middle of each of these connectors is a standard COTS connector.

Networking and sensor fusion

A significant technology trend in sensor and signal processing today is a transition from traditional sensor interfaces to network-centric interfaces, says Curtiss-Wright’s Frank. “In the future, sensors will go to gigabit speeds and beyond. Network interfaces can now distribute signal processors in parallel; it’s not a serial processing

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chain, but now designers can do parallel processing more easily. Still, you need a change in the architecture when you distribute the signal for processing.

"We also are seeing a resurgence of the network architecture," Frank says. "We are looking at the entire signal flow, and designing with a network architecture for data distribution."

The number of processors necessary and the networking approach also depends on the application, says Curtiss-Wright's Smetana. "It also may depend on the number of sensors you need to use. Search and rescue, for example, may need fewer radar processors, where tracking hundreds of targets on the battlefield will require more parallel processing. Sensor fusion needs multiple types of sensors working together to create a better and more composite picture."



The Curtiss-Wright VPX6-1961 Intel Xeon W-11000E 8-core processor card features Intel Advanced Vector Extensions, Intel Virtualization Technology, Intel AI Acceleration with Deep Learning Boost, Intel UHD Gfx-32 Graphics, and Intel Total Memory Encryption.

One of the most important transformational technologies in high-performance sensor and signal processing is 100 Gigabit Ethernet, says General Micro's Ciufio.

"100 Gigabit Ethernet requires fiber optics, or short distanceS over copper, and can connect processors together over Ethernet," Ciufio explains. "It's fast enough to move data from one processor's memory set to another processor's memory set, and you can just use; you don't need RapidIO or InfiniBand to move data between processors and memory. You don't need those esoteric technolo-

gies; you can just use 100 Gigabit Ethernet.

One of 100 Gigabit Ethernet's design advantages is its ubiquity. "Everybody understands Ethernet and how to connect Ethernet," Ciufio says. "It has acceptable latency for hard real-time systems."

Where 100 Gigabit Ethernet really shines is in sensor and signal processing in front-line military applications. "On the battlefield, cameras and sensors are looking everywhere, they can't tell from what the foliage and dirt look like if there is an enemy

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Systel Inc.

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

Xilinx Inc.

San Jose, Calif.
<https://www.xilinx.com>

or a vehicle nearby. With high-end signal processing, the camera takes all that information in, applies filters, changes contrast, does edge detection, and says I see here that area of grass has been tamped down, or the dirt is slightly darker. It can do that in real time, using visible light sensors, thermal sensors, and signal processing.”

Ciufo says he predicts the next generation of military combat vehicle will have several different sensors to enable the vehicle crew to look at their surroundings, enable the vehicle to drive itself, and scan for threats. “To do this you need more processing per time unit,” Ciufo says.

“The next step will be adding more sensor processing on the platforms, with the need to connect them together. We need to fuse all this data into an integrated picture and make decisions in real time on what we should do. We can network all of these sensor platforms together to see what is happening, and what will happen next. It will offer much more rapid decision making and much better outcomes.”



The Curtiss-Wright CHAMP-XD3/ is a 3U OpenVPX Intel Ice Lake Xeon D-1700 DSP processor card that features high-speed DDR4 memory, 10 Gigabit Ethernet, 40 Gigabit Ethernet Data Plane, and Xilinx Zynq UltraScale+ MPSoC FPGA for enhanced security.



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AI and machine learning

A primary goal of sensor and signal processing technology development is incorporating artificial intelligence and machine learning into high-end systems.

“One area where we see AI machine learning is in signal identification,” says Curtiss-Wright’s Smetana. “A lot of algorithms can be used to distinguish one signal from another, what the target is, and what the aircraft is out there. Doing this depend on a very clean reception of that signal, and in real life there is a lot of noise that can distort that signal. AI can help train signal processing in noisy environments to find signals that might not otherwise be identified because of the

signal distortion. It has to be something you can train the algorithms to learn, and to do that you need a lot of data to train it with.”

The kinds of sensor fusion necessary to form a 3D 360-degree picture of the battlespace, even today, requires a great deal of human effort, from intercepting and determining the sources of signals, to interpreting signal behavior that might indicate the presence of an enemy. “A lot of machine learning and AI processing can be automated to assist a human operator,” says Mercury’s Hosking. ◀

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Lockheed Martin to build radar- and infrared-guided missile defense interceptors

BY John Keller

HUNTSVILLE, Ala. – Missile defense experts at Lockheed Martin Corp. will build radar- and infrared-guided missile-defense rocket interceptors for the U.S. and Saudi Arabia to protect against incoming ballistic missiles under terms of a \$304.9 million order.

Officials of the U.S. Missile Defense Agency (MDA) in Huntsville, Ala., are asking the Lockheed Martin Missiles and Fire Control segment in Dallas to build Terminal High Altitude Area Defense (THAAD) interceptors and associated one-shot devices.

THAAD is designed to shoot down short-, medium-, and intermediate-range ballistic missiles in their terminal phase using a

hit-to-kill kinetic warhead. The THAAD interceptor missile relies on the kinetic energy of the impact to destroy the incoming missile.

THAAD uses the AN/TPY-2 ground-based X-band radar from Raytheon Technologies Corp. for guidance and navigation, and the interceptor has an indium-antimonide imaging infrared sensor seeker from the BAE Systems Electronic Systems segment in Nashua, N.H.

The Raytheon AN/TPY-2 radar is one of the largest air-transportable X-band radar systems in the world. It searches, tracks, and discriminates objects and provides updated tracking data to the interceptor.



▲ **THAAD interceptors use X-band radar for guidance and navigation, and indium-antimonide imaging infrared sensors to guide the missiles to their targets.**

The BAE Systems infrared seeker head, meanwhile, is an integral part of the THAAD guidance system. It uses advanced electro-optical sensors to seek and lock onto incoming enemy ballistic missiles that are moving as fast as 17,000 miles per hour. The radar and infrared seeker work together to route the THAAD interceptor to the threat.

BAE Systems is the original manufacturer of the THAAD interceptor infrared seeker head. The company won a contract from Lockheed Martin in 2020 to design and manufacture next-generation THAAD infrared seekers to improve the interceptor's ability to neutralize threats and improve its manufacturability.

BAE Systems officials also plan to work on the advanced infrared seeker at a new facility in Huntsville, Ala. Other key THAAD subcontractors are Boeing, Aerojet, Rocketdyne, Honeywell, and Milton CAT. Deployment of the THAAD system began in 2008.

THAAD is a key element of the U.S. ballistic missile-defense system to defend the continental United States, its deployed forces, and allies against ballistic missiles of all ranges and in all phases of flight.

THAAD consists of five major components: launchers, interceptors, a radar, THAAD fire control and communications (TFCC) units, and THAAD-specific support equipment.

Lockheed Martin started developing the THAAD system in 1992, and first tested the system three years later. The first THAAD tests that hit their targets were in 1999, after the first six ballistic missile-defense tests missed. THAAD missiles, which have a maximum range of about 125 miles, are expected to hit incoming ballistic missile warheads as high as 93 miles above the Earth's surface. ←

On this order Lockheed Martin will do the work in Dallas; Sunnyvale, Calif.; Huntsville and Troy, Ala.; and Camden, Ark., and should be finished by December 2027. For more information contact Lockheed Martin Missiles and Fire Control online at www.lockheedmartin.com, or the Missile Defense Agency at www.mda.mil.

Protectors to prevent lithium-ion batteries from overcharging introduced by Littelfuse

Littelfuse Inc. in Chicago is introducing the ITV4030 series of 22 amp, three-terminal, surface-mountable lithium-ion battery protectors for tablet computers, robotic appliances, and emergency radios. These 4-by-3-millimeter devices protect battery packs against overcurrent and overcharging. They use embedded fuse and heater elements that interrupt the charging or discharging circuit before the battery pack becomes overcharged or overheated. The power electronics devices offer a surface-mountable design; certifications from UL and TUV; and is halogen-free and RoHS compliant. An embedded three-terminal fuse cuts off the circuit when overcurrent issues occur. A heater element, directly embedded under the fuse element, generates enough heat to blow the fuse once overcharging is detected by IC or FET. For more information contact Littelfuse online at www.littelfuse.com. ←

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Raytheon to provide U.S. military with 154 terrain-matching Tomahawk missiles

BY John Keller

PATUXENT RIVER NAS, Md. – U.S. Navy land-attack experts are asking Raytheon Technologies Corp. to build 154 BGM-109 Tomahawk Block V missiles able to attack ground and sea targets under terms of a \$217.1 million contract.

Officials of the Naval Air Systems command at Patuxent River Naval Air Station, Md., are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., to build 154 Tactical

the missile to switch targets while in flight. It can loiter for hours and change course instantly on command.

The Tomahawk Block V is a recertified and modernized missile with upgraded navigation and communications. The Block Va can strike moving targets at sea, while the Block Vb has a multi-effects warhead that can hit diverse land targets. Tomahawk's most recent use was in 2018 when U.S. Navy sur-

face warships and submarines launched 66 Tomahawk missiles at Syrian chemical weapon facilities.

Tomahawk Block V was introduced in 2021 with improvements to navigation and in-flight targeting. Block Va, the Maritime Strike Tomahawk (MST), enables the missile to engage a moving target at sea, and Block Vb outfitted with the Joint Multiple Effects Warhead System (JMEWS) warhead for hard-target penetration.

Tomahawk Block V have longer range and dynamic targeting than its predecessors, and has unique flight, launch, and information-processing capabilities. Raytheon can integrate a new sensor suite into the Tactical Tomahawk quickly. The company provides seeker, processor, software, and a new inertial measuring unit for terminal maneuvers, as well as redesigned power budget and system cooling.

On this contract Raytheon will do the work in Tucson, Ariz.; Pontiac, Mich.; Camden, Berryville, Ark.; Huntsville and Anniston, Ala.; Clearwater, Fla.; El Segundo, Ontario, Moorpark, Anaheim, Irvine, Pomona, South El Monte, and Valencia, Calif.; Spanish Fork and Salt Lake City, Utah; Glenrothes, Scotland; Middletown, Conn.; Vergennes, Vt.; Midland, Ontario; Westminster, Colo., and other U.S. locations, and should be finished by January 2025. ◀

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



The tomahawk Block V uses an electro-optical sensor and radar altimeter to match nearby terrain to an internal database.

Tomahawk missiles — 70 of which are for the Navy, 54 for the U.S. Marine Corps, and 30 for the U.S. Army.

Tomahawk is a long-range, all-weather, jet-powered, surface-attack subsonic cruise missile used primarily by the U.S. Navy and the United Kingdom Royal Navy in ship- and submarine-based land-attack operations.

For navigation and guidance, the missile uses a combination of inertial, GPS, and terrain-matching that uses an electro-optical sensor and radar altimeter to match the terrain over which the missile is passing to an internal terrain database.

The Tomahawk Block V is the latest version, and is an upgraded Tomahawk Block IV, which has a data link that enables

ACT to provide electronics thermal management technology for SLAM-ER missile guidance

BY John Keller

ST. LOUIS – Smart munitions experts at the Boeing Co. needed electronics cooling technologies for the guidance systems on anti-ship and land-attack missiles. They found their solution from Advanced Cooling Technologies Inc. (ACT) in Lancaster, Pa.

Officials of the Boeing Defense, Space & Security segment in St. Louis have awarded a \$7 million contract to ACT to manufacture a thermal solution for onboard guidance technology used on the Harpoon and SLAM-ER cruise missile systems.

Thermal management is a critical enabling technology as these systems become more capable and precise, ACT officials explain. Boeing and ACT have worked closely during design to optimize the solution for performance, mass, and space.

ACT's thermal management hardware will help maintain safe operational temperatures of the missile guidance systems, company officials say. "We've spent the past year working closely with the team at Boeing, prototyping and getting this innovative and highly reliable thermal solution where it needs to be for mass production efforts," says Greg Hoeschele, ACT's lead engineer of product development.

The Boeing AGM-84H/K Standoff Land Attack Missile-Expanded Response (SLAM-ER) is 14.3 feet long, 13 inches in diameter, and weighs 1,487 pounds.

The SLAM-ER air-launched cruise missile is a derivative of the Boeing Harpoon anti-ship missile, which can attack land and sea targets as far out as 155 nautical miles. It relies on the Global Positioning System (GPS) and infrared imaging for its navigation and control, and can strike moving and stationary targets.

SLAM-ER missiles obtained initial operating capability in June 2000. They can launch from the F/A-18 Hornet, F/A-18

Super Hornet, and the U.S. Air Force's F-15E Strike Eagle. The missile carries an 800-pound explosive warhead, and uses an inertial navigation system supplemented by GPS, with infrared homing terminal guidance.

ACT focuses on custom-design two-phase heat transfer thermal management solutions. The company's products include heat pipes, custom liquid cold plates, heat exchangers, and thermally enhanced wedgelocks. On this contract, ACT's product development team has scheduled first deliveries for 2023. ←

For more information contact ACT online at www.1-act.com, or Boeing Defense, Space & Security at www.boeing.com/company/about-bds.



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ACT will design a thermal-management system for the U.S. Navy Boeing the Harpoon and SLAM-ER cruise missiles.

Wanted: ways to enable autonomous unmanned aircraft operations in controlled airspace

By John Keller

WRIGHT-PATTERSON AFB, Ohio – U.S. Air Force researchers are asking industry for technologies to enable unmanned aircraft to operate autonomously in congested airport terminal areas while following the same air traffic control (ATC) procedures as crewed aircraft.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have issued a request for information (RFI-RQKHC-2022-0001) for the Terminal Area Operations: Unmanned Aerial Systems project.

Researchers are trying to find companies able to provide enabling technologies for uncrewed aircraft to start, taxi, take off, depart, join aircraft formations, approach, land, taxi, and shut down within controlled airspace at cruise altitudes, in terminal airspace, and at large- and medium-sized airports.

This airspace is in the contiguous United States within the National Airspace System (NAS), as well in international airspace outside the U.S. Technologies developed are expected to be foundational for fully autonomous unmanned aircraft operations.

This request for information is to help government, academia, and industry understand the state of the possible that can deliver the autonomous technologies for unmanned aircraft operation in the terminal area, researchers say.

Unmanned aircraft today require much pilot-in-the-loop interaction in airport terminal areas — much the same as piloted aircraft in the terminal area must follow established U.S. Federal Aviation Administration (FAA) and International Civil Aviation Organization (ICAO) standards and procedures.



▲ The U.S. Air Force is looking for technologies to help unmanned aircraft operate safely and autonomously in congested controlled airspace.

The goal is for unmanned aircraft to comply with the same standards and procedures as well as with those unique to unmanned aircraft, autonomously with minimal pilot and ground controller interaction.

Automating some or all of these procedures could help reduce human operator workload and oversight necessary for operating unmanned aircraft in the terminal area.

The main goal, first, is to identify technologies suitable for integration and flight testing an autonomous terminal area operations functionality in an unmanned aircraft using existing airspace, airfield, and ATC infrastructure.

Solutions will be able to team humans and machines, and be able to scale-up to several different unmanned aircraft safely and in compliance with FAA and ICAO standards and procedures.

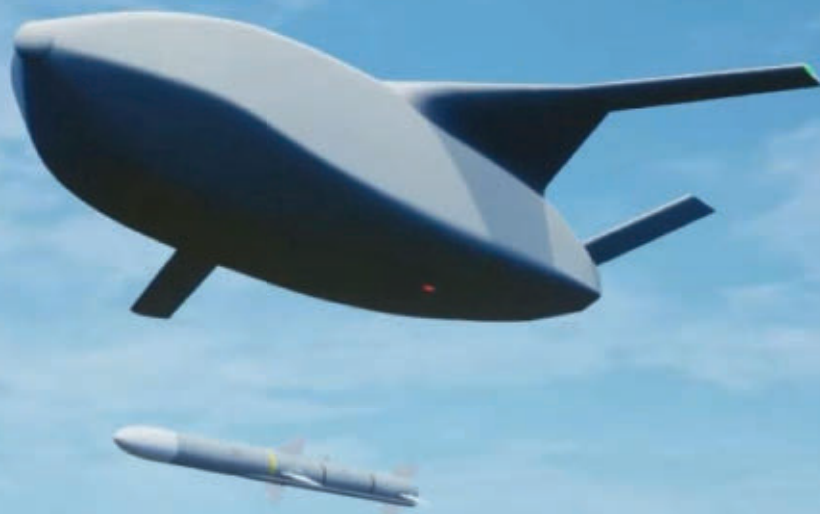
Air Force researchers say they plan to demonstrate autonomous capabilities that would enable unmanned aircraft to operate as though they were piloted aircraft. Once clearance is given, unmanned aircraft would start, taxi, take off, rejoin, switch to enroute flight, arrive at a destination, fly an approach to a runway, land, taxi, and shut down while autonomously avoiding conflicts on the ground and in the air.

Unmanned aircraft would maintain communication with ATC, airport ground control, and several unmanned aircraft with a backup capability in the event of loss or misunderstood communications. Navigation and runway approach with and without GPS also is required.

From industry, Air Force researchers want to know:

- what level of in-aircraft automation is available today, and what technology gaps exist;
- what technologies exist that would enable a unmanned aircraft to navigate autonomously on the ground and in the air while deconflicting from other obstacles and other aircraft;
- what technologies exist that would enable ATC control of unmanned aircraft in a similar fashion as manned aircraft with the same level of reliability;
- what technologies exist that would enable an unmanned aircraft to receive, process, and respond to ATC commands;
- could controller pilot data link communications (CPDLC) reliably receive ATC messaging for unmanned aircraft control;
- what other means can be used to receive ATC messaging reliably;
- what kinds of sensors are necessary to enable autonomous aircraft operation in the terminal area;
- can ADS-B provide deconfliction for ground and air traffic from startup through airborne operations to shutdown;
- what are the challenges and capabilities for extending such technologies to accommodate several unmanned aircraft being controlled and overseen by one operator, and how do these technologies scale as the number of unmanned aircraft increase;
- what safety concerns must be considered, and how would contingencies be handled;
- what technical or procedural limitations exist to extend these capabilities for military training and operations outside U.S. airspace; and
- what command, control, and navigation systems are certified for use in the NAS by a unmanned aircraft, and what is the path forward for certification. ◀

Companies interested were asked to email 20-page white papers by June 2022 to the Air Force's Capt. Christian Potts at christian.potts@us.af.mil. More information is online at <https://sam.gov/opp/a74f0b2cb8be40c8b82a2c9618c54c71/view>.



Air Force asks industry for autonomous fighter aircraft to shoot down enemy planes

BY John Keller

ROME, N.Y. – U.S. Air Force experts are reaching out to industry to find companies interested in developing an autonomous aircraft able to detect, track, and shoot down enemy piloted and uncrewed airplanes as large as single-aisle passenger jets.

Officials of the Air Force Research Laboratory Information Directorate in Rome, N.Y., issued a request for information (RFI-RIKD-22-03) in June for the Low Collateral Effects Interceptor (LCEI) unmanned aerial vehicle (UAV) project.

The LCEI should be autonomous aircraft, avionics, and sensors with hard-kill systems effective against groups 1, 2, and relatively small group 3 aircraft. These types of aircraft range from as small as a six-seat twin-engine general-aviation aircraft to as large as a Boeing 737 passenger jet.

Responses from this RFI are to help Air Force researchers plan for a possible future acquisition strategy and solicitation that could be issued as early as next year.

Testing of such an autonomous fighter aircraft will require the contractor to integrate the test aircraft with ground sensors and truth data systems. The government will provide red team targets, a test range, logistics support, and data collection at the initial flight assessment.

Initial flight tests will involve responding to scenarios designed to mimic operational incidents, as well as stress test the systems' engagement speeds, ranges, and endurance. The

▲ **The U.S. Air Force is gauging industry interest in developing a an autonomous aircraft able to detect, track, and shoot down enemy piloted and uncrewed airplanes.**

test aircraft must be based on U.S. components and electronics.

From industry, Air Force researchers want information about candidate test aircraft such as sprint speed; top engagement speed; maximum range; maximum loiter time; size,

weight, power consumption, and cost; required number of operators; required training of operators; resistance to shock, dirt, water, and temperature; operational weather limitations; ability to operate at night; multiple target engagements; engagement success rate by target type; engagement success rate by engagement speed; and engagement success rate by altitude.

Researchers also want an overview of candidate aircraft facilities, space, and power requirements; multi-mission capability; system architecture diagram; system maturity; manufacturing maturity; dependencies on external sensors; required external systems; system autonomy for administering kinetic effects; and ground station requirements.

Responding companies also should provide information about aircraft performance specifications; and the kinds of unmanned aircraft these systems have been able to defeat and under what conditions. ◀

Companies interested were asked to email 10-page white papers by 8 July 2022 to the Air Force's Matthew Zawisza at matthew.zawisza@us.af.mil, and Justin Furney at justin.furney@us.af.mil. More information is online at <https://sam.gov/opp/93083b68ca8e41fbbabb9101781c4695/view>.



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Lockheed Martin to upgrade electro-optical imaging system aboard attack submarines

BY John Keller

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

Officials of the Naval Sea Systems Command in Washington announced an \$23.4 million order to the Lockheed Martin Rotary and Mission Systems segment in Manassas, Va., for technical insertions and support for the AN/BVY-1 Integrated Submarine Imaging System (ISIS).

▲ **The ISIS submarine surveillance system rolls-up existing components and near-term capabilities into an architecture for inserting future capabilities as they become available.**

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

and future ballistic missile submarines.

The ISIS submarine electro-optical surveillance system rolls-up existing components and near-term capabilities into an architecture

for inserting future capabilities as they become available, including items taken from the Virginia-class submarine photonics program, Navy officials say.

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

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

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

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

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

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

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

On this order Lockheed Martin will do the work in Manassas and Gainesville Va.; Orlando, Fla.; and Newport, R.I., and should be finished by October 2025. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or Naval Sea Systems Command at www.navsea.navy.mil.

Rugged sunlight-readable LCDs for military applications introduced by TRU-Vu

TRU-Vu Monitors Inc. in Arlington Heights, Ill., is introducing the SRMW-24Z-SS sunlight-readable waterproof 24-inch liquid crystal displays (LCDs) for use in nearly all weather conditions or in demanding factory environments. This monitor is for military and marine applications, manufacturing plants, auto racing teams, quick-service restaurants, outdoor digital signage, and transportation. Originally built for use in professional soccer stadiums and football stadiums, the SRMW-24Z-SS rugged monitors offer the ability to see clear, sharp images even in direct sunlight, and waterproof enclosure resists rain, sleet, snow, and industrial water spray. The display is has no vents, fans, or filters to clean or repair; screen brightness that adjusts automatically to ambient light conditions; and has the ability to operate in hot and sub-zero conditions. The sunlight-readable SRMW-24Z-SS offers more than 1,000 nits of brightness, and its sealed stainless steel weatherproof enclosure has no entry points for water, dirt, dust, sand, or airborne particles. For more information contact TRU-Vu Monitors online at <https://tru-vumonitors.com>.

U.S. military chooses night vision image-intensifier tubes from Elbit and L3Harris

U.S. military logistics experts image-intensifier tubes for a variety of night-vision devices and weapons sights. They found their solutions from L3Harris Technologies and Elbit Systems of America. Officials of the U.S. Defense Logistics Agency Land and Maritime segment in Aberdeen, Md., announced contracts Friday to the L3Harris Integrated Vision Solutions segment in Tempe, Ariz., and to the Elbit Systems of America Night Vision segment in Roanoke, Va., for MX-11769 image-intensifier tubes. The contract to L3Harris is for \$11.1 million, and the contract to Elbit is for \$9.7 million. The electro-optical image-intensifier tube has a lifespan of 12,000 hours continuous use. The MX-11769 is a third-generation 18-millimeter image intensifier for the AN/PVS-14 night-vision monocular and several weapon sights. It also is part of the U.S. Army Enhanced Night Vision Goggle-Binocular (ENVG-B). For more information contact L3Harris Integrated Vision Solutions online at www.l3harris.com/all-capabilities/integrated-vision-solutions, or Systems of America Night Vision at www.elbit-america.com/night-vision. ←

Raytheon to build land-attack missile with imaging infrared seeker for new Navy frigate

BY John Keller

WASHINGTON – Surface warfare experts at Raytheon Technologies Corp. are continuing their work to develop the U.S. Navy's next-generation anti-ship and land-attack missile for the littoral combat ship and FFG(X) future multimission guided-missile frigate.

Officials of the Naval Sea Systems Command in Washington have announced a \$102.7 million order to the Raytheon Missiles & Defense segment in Tucson, Ariz., for the Over-the-Horizon Weapon System (OTH-WS).

defended land and sea targets. NSM is a modernized version of the Norwegian Penguin anti-ship missile.

The passive subsonic sea-skimming missile can penetrate advanced enemy defense systems, and has an upgraded seeker and target identification, Raytheon officials say. The NSM is aboard Norway's new frigate and coastal corvette, and gives surface warships sufficient firepower to defeat evolving threats.

The NSM uses composite materials for enhanced stealth, and a titanium-alloy blast-and-fragmentation warhead with void-sensing programmable intelligent multi-purpose fuze for use against hard targets like surface ships.

The missile has an imaging infrared seeker, an onboard target database, and navigates by Global Positioning System (GPS), inertial sensors, and terrain-reference systems. It can detect, recognize, and discriminate among targets independently, and is designed to strike enemy ships at or near the water line to inflict maximum structural damage.

Aboard ships, NSMs can be deck-mounted in packs of one, two, three, four, or six launchers. The NSM weighs about 880 pounds and has a range of about 100 nautical miles. It can be used in littoral waters near coasts, or in the open ocean. The missile can fly over and around land masses, travel in sea-skim mode, and then make random maneuvers in terminal phase to avoid enemy countermeasures.

Raytheon will build a NSM fire-control suite with operator interface, interfaces to the launchers, engagement planning system, and interface to host ship systems like GPS and inertial navigation systems. Its fire-control system will be able to launch from four to 16 missiles. ←

On this order Raytheon and Kongsberg will do the work in Kongsberg and Raufoss, Norway; Tucson, Ariz.; Schrobhausen, Germany; McKinney, Texas; and Louisville, Ky., and should be finished by May 2024. For more information contact Raytheon Missiles & Defense online at www.raytheonmissilesanddefense.com, or Naval Sea Systems Command at www.navsea.navy.mil.



The passive subsonic sea-skimming missile can penetrate advanced enemy defense systems, and has an upgraded seeker and target identification.

Raytheon engineers will build and deliver OTH-WS encanistered missiles loaded into launching mechanisms and a fire-control suite. Raytheon won a potential \$847.6 million contract in June 2018 for the OTH-WS project.

Raytheon is building the new missile in partnership with Kongsberg Gruppen in Kongsberg, Norway. The missile is to equip the littoral combat ship and FFG(X) future frigate with stand-off surface-to-surface weapons capability.

Raytheon and Kongsberg in their initial OTH-WS bid offered the Naval Strike Missile (NSM) — a fifth-generation long-range, precision-strike missile that offers strike capability against heavily

SATELLITE COMMUNICATIONS

▼ Navy chooses Comtech EF Data to provide satellite communications modems

U.S. shipboard communications experts needed satellite modems and upgrades for surface warships, submarines, and shore sites. They found their solution from Comtech EF Data Corp. in Tempe, Ariz.

Officials of the Naval Information Warfare Systems Command in San Diego announced a \$13.1 million order to Comtech EF Data for Comtech SLM-5650B modems, SLM-5650B modem upgrade kits, firmware upgrades, and technical support.

The commercially available modems support satellite communications (SATCOM) and interoperability across Navy platforms and shore sites. The order increases the current contract value from \$58.8 million to \$71.9 million.

The SLM-5650B satellite modem is for critical military, government, and commercial backhaul SATCOM applications. It complies with MIL-STD-188-165A/B, with STANAG 4486 Edition 3 Annex E, and supports FIPS 140-2 certified encryption.

The SLM-5650B supports backwards compatibility and interoperability for existing SLM-5650A networks while providing enhanced performance. Features include gigabit Ethernet bridge interface; LNB reference and voltage; and BUC reference.

The SLM-5650B is for applications with the Defense Satellite Communications System (DSCS), Wideband Global SATCOM (WGS), and commercial satellites.

Data rates from 8 kilobits per second to 155 megabits per second, and supports symbol rates from 32 kilosamples per second to 64 megasamples per second. The modem provides standard MIL-STD-188-114 (EIA-530 / RS-422), and EIA-613 (HSSI) serial interfaces, and can be configured to support G.703 and Low Voltage Differential Signaling (LVDS) serial interfaces.

It can support a 4-port 10/100/1000Base-T Ethernet network processor module that supports switching, routing, and advanced quality-of-service protocols. The military typically uses these SATCOM modems for secure communications on-the-move in rugged environments.

Direct sequence spread spectrum is available to support point-to-point and point-to-multipoint applications as an option with LDPC-based FEC and BPSK. Spreading factors to 512 are supported. The IF interface supports 52 to 88, 104 to 176, and 950 to 2000 MHz frequency ranges.



The modem supports EIA-530 (RS 422), EIA-612/613 (HSSI) and single Gigabit Ethernet port as standard features. An optional 4-port Gigabit Ethernet interface is also available.

For more information contact Comtech EF Data online at www.comtechefdata.com, or the Naval Information Warfare Systems Command at www.navwar.navy.mil.

OPEN-SYSTEMS DESIGN

▲ Black River to commercialize open-systems architecture for countering small unmanned aircraft

U.S. Air Force researchers needed an electronics open-systems architecture design for counter-small unmanned aircraft systems. They found their solution from Black River Systems Co. Inc. in Utica, N.Y.

Officials of the Air Force Research Laboratory Information Directorate in Rome, N.Y., announced a \$76.5 million order to Black River for Operational Counter-small Unmanned Aircraft System (C-sUAS) open systems architecture.

Black River engineers will find ways to enhance and commercialize C-sUAS technology quickly, based on an approach that Black River worked on previously for the Air Force to support rapid research, development, prototyping, demonstration, evaluation, and transition of C-sUAS capabilities.

The company is developing a flexible, rapid, agile contracting vehicle to support rapid prototyping and transition of counter small unmanned aircraft system enabling technologies to current and future programs.

These enabling technologies will be for combating commercial off-the-shelf (COTS) small unmanned aerial vehicles (UAVs) such as quadcopters that U.S. enemies use in non-traditional warfare and terrorist operations.

Black River is focusing on enabling technologies and prototypes for evaluation, and ways for the U.S. military to acquire these capabilities quickly in small quantities. The company will provide software, hardware, technical documentation and technical reports.

On this order Black River will do the work in Utica, N.Y., and should be finished by May 2023. For more information contact Black River Systems Co. online at www.blackriversystems.com, or the Air Force Research Laboratory Information Directorate at www.afrl.af.mil/RI.



TACTICAL NETWORKING

▲ Thales chooses tactical networking from Persistent Systems for military communications

Military radio designers at Thales Defense & Security Inc. in Clarksburg, Md., needed mobile ad-hoc networking (MANET) capability for the company's AN/PRC-148E Spear tactical radio. They found their solution from Persistent Systems LLC in New York City.

Thales and Persistent Systems have collaborated on a combined tactical communications solution, which the companies unveiled at the Special Operations Forces Industry Conference (SOFIC) in Tampa, Fla.

The U.S. Department of Defense (DOD) has wanted the ability to deliver a combination of MANET tactical networking and military radio to enhance communications and electronic control of unmanned vehicles in difficult terrain where hills and mountains can block radio signals.

MANET is a decentralized wireless network in which each communications node participates in routing by forwarding data for other nodes; even if one point-to-point radio link is blocked, the signal still gets through from other nodes that are repeating the message.

The combined Thales and Persistent Systems MANET and tactical radio capitalized on an advanced radio-over-IP capability to tether a Thales AN/PRC-148E Spear radio to a Persistent MPU5 wireless networking communications by bringing the Spear on to a digital network as an IP talk group.

"Imagine a helicopter transmitting on an AM frequency to a dismounted ground team," explains Shane Flint, vice president of business development at Persistent Systems. "With traditional tactical radios, some users might receive the helicopter's transmission and other users might not. But with a Spear/MPU5-equipped team, if any single Spear radio receives the helicopter's transmission, the entire team will receive it."

the Spear remotely to eliminate operator error and deliver plug-and-play capability.

"This capability was designed for combat operations, based on real-world feedback," Flint says. "The goal was to deliver a simple no-fail solution that empowers the warfighter." For more information contact Thales Defense & Security online at www.thalesdsi.com, or Persistent Systems at www.persistentsystems.com.

INFRARED COUNTERMEASURES

▼ Northrop Grumman to upgrade obsolescence in infrared countermeasures sensors

U.S. military aerial warfare experts needed advanced threat warning (ATW) sensors for the AN/AAQ-24 large aircraft infrared countermeasures system (LAIRCM). They found their solution from The Northrop Grumman Corp. Mission Systems segment in Rolling Meadows, Ill.

Officials of the U.S. Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, announced a \$31.2 million order to Northrop Grumman for the Large Aircraft Infrared Countermeasures Infrared Missile Warning Sensor effort.

The Northrop Grumman AN/AAQ-24(V) LAIRCM electro-optical missile warning sensor is designed to provide missile-warning capability to protect large military aircraft from infrared-guided, heat-seeking missiles — particularly those from shoulder-fired launchers like the U.S.-made Stinger Block 2 and Russian-made SA-14 missiles.

Northrop Grumman will deliver production sensors that update obsolete parts in the current sensor. The LAIRCM is a derivative of the AN/AAQ-24 Nemesis Directional IR Countermeasure (DIRCM) system. It jams the incoming missile's seeker with a IR laser energy beam, and operates autonomously without intervention from the aircraft crew.



LAIRCM automatically detects a missile launch, determines if it is a threat, and activates a high-intensity laser-based countermeasure system to track and defeat the missile, Northrop Grumman officials say.

The system is for large aircraft like the Air Force C-5, C-17, C-37, and C-40 cargo and utility jets; Air Force C-130H and MC-130W four-engine utility turboprop aircraft, the CV-22 tiltrotor aircraft, the KC-46 aerial refueling jet, as well as the U.S. Navy P-3 maritime patrol jet. LAIRCM also can fit on some large military helicopters.

LAIRCM focuses high-intensity laser energy at the infrared seeker head of incoming missiles to blind the missile and force it off its target. The system is designed to protect large aircraft from shoulder-fired, vehicle-launched, and other infrared-guided missiles when the planes are operating close to the ground, such as on takeoff and landing, as well as during low-level operations and aerial refueling.

Initial LAIRCM systems equipped C-17 and C-130 aircraft as a stop-gap measure, using an ultraviolet sensor, a countermeasure processor, and a small laser turret assembly.

Later-model LAIRCM systems use a smaller laser turret, and operate in the infrared region. Compared to first-phase LAIRCM systems, the newer models provide better resolution, better performance in optical clutter, and increased range of detection.

In the future military leaders are trying to develop aircraft-protection infrared countermeasures able to detect and classify incoming missiles, then emit a custom jamming energy to defeat them.

On this order Northrop Grumman will do the work in Rolling Meadows, Ill., and should be finished by May 2022. For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, or the Air Force Life Cycle Management Center at www.aflcmc.af.mil.

ELECTRIC AIRCRAFT

▲ Aernnova selected by Lilium to develop its eVTOL propulsion mounting system

Lilium N.V. a developer of all-electric vertical-takeoff and -landing (eVTOL) jet based in Wessling, Germany, has selected Aernnova, based in Miñano Mayor, Spain, to collaborate on the Lilium Jet's propulsion mounting system.

A propulsion mounting system - the structure that forms the rear part of the wings and front aerofoils - produces lift

by interacting with airflow from the engine. It also houses the propulsion and vectoring systems responsible for vertical and horizontal flight.

Electric jet engines integrated into the wing flaps provide advantages in payload, aerodynamic efficiency and a lower noise profile, while also providing thrust vector control to maneuver the Lilium Jet through every phase of flight.

Aernnova and Lilium will work together on the design, manufacture, and supply of the Lilium Jet's flap structure.

Aernnova is one of the largest Tier 1 aerospace suppliers, providing aerostructure for companies such as Airbus, Boeing and Embraer. The collaboration represents a significant step towards serial production of the Lilium Jet and Lilium's goal of making sustainable high-speed regional transportation a reality.

The Lilium Jet's propulsion mounting system will feature a complex and unique design. The integrated system will serve multiple functions and be modular and

scalable. It will utilize lightweight material such as carbon fiber-reinforced epoxy.

"Aernnova is an industry leader for customized design and manufacture of metallic and composite assemblies, which makes them an ideal partner," Yves Yemsi, Chief Operating Officer of Lilium, said. "It is important to us that we collaborate with the best aerospace suppliers and leverage their expertise."

"With 28 years of expertise in developing and creating aircraft structures, we are proud to be contributing to a project as exciting and unique as the Lilium Jet," Ricardo Chocarro, CEO of Aernnova, said. "This all-electric jet has the potential to change the aviation industry in a positive, sustainable way, and we are delighted to be a key partner."

AVIONICS

Bluetail selected by Alerion Aviation for digital aircraft maintenance and operations records

Alerion Aviation in Long Beach, Calif., needed enabling technology to keep its maintenance records. They found their solution from Bluetail Inc. in Scottsdale, Ariz.

Bluetail will provide the digitization and management of all maintenance records and logs for aircraft management and charter provider's fleet of business jet aircraft.

The Bluetail platform allows professionals to upload, search and manage records such as work orders or squawks





from any device, anywhere, anytime to enable collaboration across their team.

With Bluetail's SaaS platform, Alerion Aviation's DOM can search through volumes of information to find exactly what they need concerning any aircraft, no matter where it is.

"It's really easy to find an aircraft's current status, search previous maintenance records, and even locate 337 forms and other major documents," explained Bob Seidel, Alerion Aviation's CEO. "It saves us time and makes our operations much more efficient. It's consistent with our philosophy to be transparent with our customers and the FAA."

In addition to streamlining their overall aircraft operations, Seidel said that having faster access to various documentation will help the company maintain the highest safety ratings in the industry.

"With 19 jets and bases in New York, Southern California, and South Florida, it is critical to have a centralized and secure location for aircraft records and logs. This allows for timely sharing of information when an aircraft needs maintenance on the road," Seidel explains. "To eliminate that problem, we committed to being a paperless operation. We tried scanning our own documents early on, but we didn't have the right equipment or expertise."

For more information contact Bluetail online at <https://bluetail.aero>, or Alerion Aviation at www.flyalerion.com.

TARGETING OPTICS

► **Military orders commander's viewer for Army Bradley armored combat vehicles targeting**

U.S. Army armored combat vehicles experts needed electro-optical systems to enable commanders of the M2 Bradley Fighting Vehicle to search the surrounding area

while safely inside their vehicles. They found their solution from Raytheon Technologies Corp.

Officials of the U.S. Defense Logistics Agency Aviation segment at Redstone Arsenal, Ala., announced a \$52 million order to the Raytheon Intelligence & Space segment in McKinney, Texas, for The Improved Bradley Acquisition System (IBAS) commander's viewer unit. This is a one-year contract with no option periods.

The IBAS viewer for Bradley armored combat vehicles helps provides target acquisition, tracking, engagement, and fire control for the Bradley vehicle's tube-launched, optically tracked, wire-guided (TOW) missile system, as well as its 25- and 7.65-millimeter weapon systems.

Using forward looking infrared sensor technology and eye-safe laser rangefinder capabilities, the system enables the vehicle's commander and gunners to detect, identify, and acquire targets at long ranges to make the most of the vehicle's weapons. As a result, these systems give warfighters major battlefield advantages at night and in poor visibility.

The IBAS commander's viewer is an updated version of the Bradley Fighting Vehicle's commander's independent viewer — a 360-degree panoramic surveillance sight that gives the Bradley fighting vehicle improved hunter and killer capabilities, increases situational awareness, and boosts weapon effectiveness for the Bradley commander.

The second-generation infrared vision system for the Bradley Fighting Vehicle includes enhanced capabilities for early threat detection from long stand-off ranges.

Raytheon should be finished with the work on this contract by 31 March 2026. For more information contact Raytheon Intelligence & Space online at www.raytheonintelligenceandspace.com, or the Defense Logistics Agency Aviation division at www.dla.mil/Aviation. ◀



SECURE NETWORKING

▼ Secure server to synchronize network communications introduced by Microchip

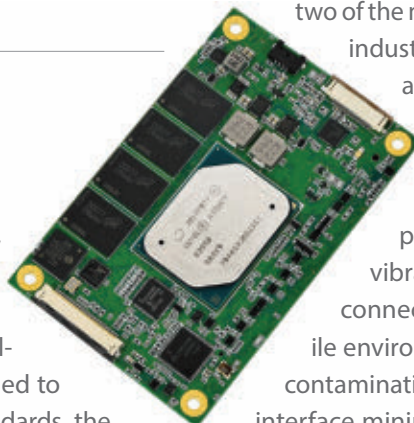
Microchip Technology Inc. in Chandler, Ariz., is introducing the software-configurable GridTime 3000 GNSS Time Server to provide power plants and substations with a new level of redundancy, network security, and resiliency. Power plants and substations rely on high-speed communications networks to transmit critical data such as operability metrics, network health, fault monitoring, power measurement, and usage trends. To synchronize communications and ensure continuity across these networks, substations require secure, precise timing and synchronization to avoid false tripping and to provide accurate time stamping of substation data. The GridTime 3000 system generates precise time and frequency signals to synchronize analog and digital communication systems. This resilient timing platform incorporates several timing inputs for protection in the event of a Global Navigation Satellite System (GNSS) signal disruption caused by severe weather, environmental disturbances, signal jamming, or spoofing. Three levels of internal holdover options are available including a base voltage controlled temperature compensated crystal oscillator (VCTCXO) and an optional high-performance oven controlled crystal oscillator (OCXO) or Rubidium oscillator option to extend holdover duration and enhance performance. The precision time server complies with IEC 61850-3, the environmental component of IEC 61850, an industry standard that defines communication protocols for power substations. It also complies with IEEE 1613-2009, the international environmental and testing requirements standard for power substations. For more information contact Microchip online at www.microchip.com.



EMBEDDED COMPUTING

▼ Open-standards embedded computing development chassis introduced by Abaco

AMETEK Abaco Systems in Huntsville, Ala., is introducing the DEVPX3 embedded computing development chassis for open-systems standards application development, integration, and testing. Aligned to OpenVPX and SOSA open-systems standards, the chassis can help embedded computing systems designers quickly demonstrate and prove the end capability of



3U VPX solutions at a system or board level. The lab-ready DEVPX3 development chassis enables sensors and systems designers to shorten lab and demonstration schedules by providing a fast and efficient way to stay up to date on VPX advancements from Abaco and its partners. Re-using existing boards or purchasing in-stock air-cooled variants also can help shorten software and firmware time to market, AMETEK Abaco officials say. The DEVPX3 embedded computing development chassis has eight individual slots, and supports conduction- and air-cooled Abaco 3U modules aligned to OpenVPX and SOSA standards. Users can configure the open frame and backplane quickly with off-the-shelf cabling or rear transition modules. For more information contact AMETEK Abaco Systems online at www.abaco.com.

RF AND MICROWAVE

▼ Quick-disconnect connectors for high-power applications introduced by Times Microwave

Times Microwave Systems in Wallingford, Conn., is introducing the HPQD and MPQD series RF and microwave connectors with quick-disconnect interfaces for high-power and high-voltage applications. HPQD and MPQD are for RF generators, matching networks, industrial lasers, EMI/EMC test chambers, and industrial heating and cooking. A key addition to Times Microwave's product portfolio, the HPQD and MPQD connectors are compatible with two of the most widely used interfaces in high-power industrial equipment. The HPQD and MPQD RF and microwave connectors feature a DC to 1.0 GHz operating frequency and offer tool-free installation and maintenance, and a positive locking mechanism that provides a secure, reliable connection that vibration will not loosen. These high-power connectors are for cleanrooms and other sterile environments as the designs reduce the risk of contamination from setup tools while the threadless interface minimizes potential debris from mating and unmating. For more information contact Times Microwave online at www.timesmicrowave.com.



CONNECTORS

► **Quick-disconnect RF connectors for high-power uses introduced by Times Microwave**

Times Microwave Systems in Wallingford, Conn., is introducing the HPQD and MPQD series RF and microwave connectors with quick-disconnect interfaces for high-power and high-voltage applications. HPQD and MPQD are for RF generators, matching networks, industrial lasers, EMI/EMC test chambers, and industrial heating and cooking. A key addition to Times Microwave's product portfolio, the HPQD and MPQD connectors are compatible with two of the most widely used interfaces in high-power industrial equipment. The HPQD and MPQD RF and microwave connectors feature a DC to 1.0 GHz operating frequency and offer tool-free installation and maintenance, and a positive locking mechanism that provides a secure, reliable connection that vibration will not loosen. These high-power connectors are for cleanrooms and other sterile environments as the designs reduce the risk of contamination from setup tools while the threadless interface minimizes potential debris from mating and unmating. HPQD and MPQD connectors can serve as drop-in replacements or as the interface of choice. They are compatible with the Times Microwave SFT specialty cable series -- a flexible solution for high-power handling, with low loss, and high shielding performance. The SFT's dielectric and jacket enables use in ambient temperatures as high as 200 degrees Celsius. For more information contact Times Microwave online at www.timesmicrowave.com.

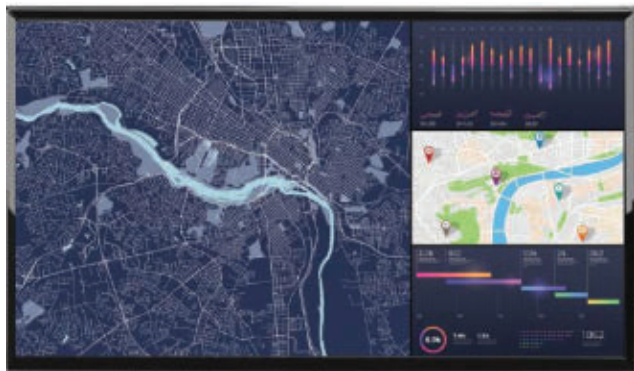


displaying several video sources simultaneously on one screen in customizable layouts. The video system is for advanced video teleconferencing technology (VTC) applications or as a desktop communications hub, supporting display and transmission of local and remote content bidirectionally. The QuadView IPXe model delivers image quality to 4K 60 Hz resolution with display windows of any size, anywhere on the screen. The QuadView IPXe offers the next generation in multiviewer performance with HDMI and IP inputs displayable. Users can decode and view IP streams to display signals from local and remote locations. The system supports mix-and-match input source types and resolutions, scaling video input up to 4K resolution, and analog and digital I/O audio, including audio embedded in HDMI and IP sources. The QuadView IPXe is a combination of a multi-channel encoder, decoder, and multiviewer in one desktop package. Users can display four video windows from 12 HDMI and IP sources. The system also encodes baseband video inputs and the multi-image output for remote viewing over a LAN or WAN. An embedded architecture offers security without PC vulnerabilities to external tampering and hacking. For more information contact RGB Spectrum online at www.rgb.com.

DATA PROCESSING

▼ **Multiviewer that shows several display windows simultaneously offered by RGB Spectrum**

RGB Spectrum Inc. in Alameda, Calif., is introducing the QuadView IPXe high-performance 4K multiviewer for



AVIONICS

▼ **Galvanically isolated discrete-to-digital sensor for avionics systems introduced by Holt**

Holt Integrated Circuits in Mission Viejo, Calif., is introducing the HI-8427 galvanically isolated discrete-to-digital sensor for a variety of aircraft and avionics systems. The HI-8427 provides 400 volts galvanic isolation between the sense inputs and the digital logic and two ground and open sensor modes, one for sensing analog inputs in the 0 to 5-volt range and the other for sensing inputs compliant to Airbus ABD0100 specification threshold levels found in 28-volt aircraft and avionics systems. The 400-volt galvanic isolation is provided by a capacitively coupled isolation barrier between the analog sense inputs and digital outputs, ensuring protection of sensitive digital circuitry. All sensor inputs are designed to comply with the power transient requirements outlined in MIL-STD-704. The 6.5-by-6.5-millimeter thermally enhanced TSSOP-20 package provides a compact



footprint for a six-channel device, which normally requires discrete components and significant board space. The two sense modes provide flexibility for use in 5- and 28-volt systems. Low-threshold mode may be used for detecting voltage levels in CMOS or TTL applications and 5-volt aircraft systems such as MIL-STD-1760 address line or similar discrete voltages. Ground levels are sensed at voltages less than 1.5 volts and result in a logic "0" on the digital output. Open or high levels are detected at voltages more than 4.0 volts, resulting in a logic "1" on the digital output. For more information contact Holt Integrated Circuits online at www.holtic.com.



ANTENNAS

▲ **Omnidirectional antennas for 5G wireless networks introduced by Fairview Microwave**

Fairview Microwave Inc., an Infinite Electronics company in Lewisville, Texas, is introducing 5G omnidirectional antennas to deploy and extend the range of WLAN and cellular communications networks and private wireless networks. The 5G outdoor-rated omnidirectional antennas cover 4G, 5G, LTE, and CBRS bands, and offer broad coverage. They support 6, 7, 8 and 10 dBi gain and offer an option for fiberglass radomes (PRO series). The antennas also include heavy-duty steel mast mounting brackets for rapid deployment and feature low-cost polycarbonate or ABS options. The antennas' rugged polycarbonate and fiberglass radomes withstand extreme weather and are rated to wind loading of more than 120 miles per hour. These collinear omnidirectional antennas feature Type-N connectors and are suitable for SISO or MIMO operation. Additionally, models that support 2x2 and 4x4 MIMO configurations ensure double and quadruple data speeds in comparison to single-input antennas. For more information contact Fairview Microwave online at <https://www.fairviewmicrowave.com>.

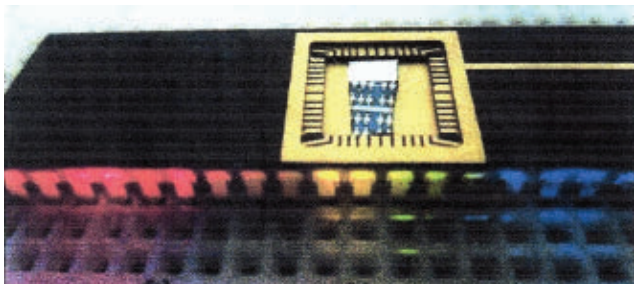
POWER ELECTRONICS

▼ **Rugged uninterruptible power supply (UPS) introduced by SynQor**

SynQor Inc. in Boxborough, Mass., is introducing the DC3 full power, high-voltage DC adjustable-output field-grade isolated uninterruptible power supply (UPS) for military and aerospace applications. The DC3 1250-Watt high-voltage DC adjustable output can deliver any output voltage between 25 volts DC and 325 volts DC; at full power it can deliver between 210 and 325 volts DC. The output voltage and current limit are user configurable. The rugged DC3 output of several units can be paralleled or configured in a N+M redundant configuration for increased output power. The UPS also can be configured to deliver simultaneously to the high-voltage DC output a 24-volt DC or 28-volt DC through its DC2 port and either 12, 15, 24, 28, 40, or 50 volts DC at 500 Watts through its DC1 port. The UPS can draw power from a wide range of AC

input voltages and frequencies, or from a 28-volt DC power source and deliver as many as three different isolated DC output voltages. Battery charging applications also are possible with the current limit feature. It is designed to withstand harsh and extreme electrical, shock/vibration and environmental conditions. Providing the power backup is a small sealed lithium polymer battery pack. This UPS also includes features that simplify its operation such as the SNMP Ethernet base module that allows real time remote system monitoring with trap/email features that warn users and monitors consoles for important system events. For more information contact SynQor online at www.synqor.com.





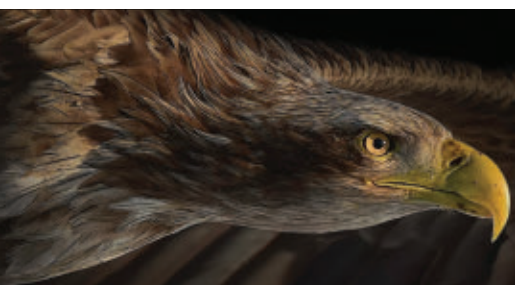
SPACE ELECTRONICS

▲ Zinc oxide thin-film transistor technology introduced for rad-hard space uses

Intellectual Property Developers LLC in Independence, Mo., is introducing zinc oxide thin-film transistors technology for radiation-hardened applications in space. Called the ZnO Radiation-Hardened Thin-Film Transistors, the patented rad-hard space electronics technology was developed together with Auburn University in Auburn, Ala. A thin-film transistor is made up of an annealed layer comprising crystalline zinc oxide, with a passivation layer adjacent to the thin-film

transistor. The passivation layer has a thickness and material composition such that when a dose of radiation from a radiation source irradiates the thin-film transistor, a portion of the dose that includes an approximate maximum concentration of the dose is located within the annealed layer. The annealed layer has a thickness and threshold displacement energies after it has been annealed such that a difference between a transfer characteristic value of the thin-film transistor before and after the dose is less than a first threshold; and a difference between a transistor output characteristic value of the thin-film before and after the dose is less than a second threshold. The thresholds are based on a desired performance of the thin-film transistor. The ZnO technology is radiation-hardened upon irradiation of gamma-ray radiation, and is intended for radiation hard electronics application in space, nuclear power facilities, high-altitude aviation, and other radiation environments. For more information contact Vincent Salva, president of Intellectual Property Developers LLC, by email at vpsuss@aol.com, or by phone at 816-254-6670. ◀

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Toray selected by Overair to provide materials for its Butterfly eVTOL

BY Jamie Whitney

TACOMA, Wash. - Overair Inc. in Santa Ana, Calif. needed a provider of advanced materials for its Butterfly electric vertical take-off and landing (eVTOL) vehicle.

They found their solution from Toray Composite Materials America Inc., in Morgan Hill, Calif.

Toray, a manufacturer of advanced carbon fiber and composite pre-impregnated materials, announced a strategic collaboration on using the company's pre-impregnated system in Overair's Butterfly prototype program.

The Butterfly is a low-noise eVTOL aircraft to provide sustainable aerial ridesharing in densely populated cities where heavy car traffic is a problem.

The Butterfly prototype aircraft uses Toray's T1100/3960 pre-impregnated system, a material that is formulated for high-performance aerospace applications where the ratio of strength to modulus properties is critical.

Toray's 3960 is a toughened 177 degrees Celsius-cure epoxy resin with a glass transition temperature (T_g) of 204 C. It is optimized for increased performance and enables autoclave and out-of-autoclave curing.

▲ **Butterfly electric vertical take-off and landing (eVTOL) vehicle will use tough, lightweight materials in its construction.**

The resin is synergistic with the TORAYCA T1100 next-generation intermediate modulus plus (IM+) carbon fiber, which is the highest-tensile-strength fiber

available today. The T1100/3960 unidirectional and plain weave pre-impregnated is used in the Butterfly's airframe structure and propulsion units.

Overair recently completed full-scale testing of Butterfly's propulsion system. The testing program validated Overair's design choices and Butterfly's expected performance capabilities. Butterfly's propeller was showcased at the Farnborough International Air Show from July 18 to July 22 in Farnborough, England.

"It is an honor for Toray to partner with Overair on this endeavor and provide the Butterfly a unique performance advantage with our 3960 pre-impregnated system," according to Jeff Cross, Director of Business Development for Aerospace at Toray.

"We're excited for the future as Overair proceeds with full-scale development and testing. The proven performance of our materials gives me confidence that we can help achieve Overair's objective of producing the safest, most efficient, and reliable eVTOL aircraft," Cross says. ◀



Airbus to study contrails produced by hydrogen combustion engines

BY Jamie Whitney

FARNBOROUGH, England - Airbus UpNext, a wholly-owned subsidiary of Airbus based in Madrid, Spain, has announced a flight test program to study the contrails produced by a hydrogen combustion engine as part the Company's ZEROe roadmap. The announcement was made in July at the Farnborough International Airshow.

The project, named "Blue Condor," will launch two modified Arcus gliders. One glider will be equipped with a hydrogen combustion engine and one will be equipped with a conventional kerosene-powered combustion engine in order to compare contrails emitted at high altitudes.

"Contrail characterization is of significant interest to Airbus. We know that hydrogen emits no carbon dioxide when burned, but we also know that with water vapor and heat being the most significant by-products, hydrogen combustion does produce contrails. Although these contrails differ significantly to those produced by conventional JetA/A1 combustion engines, understanding their composition will be key to support our

▲ **Blue Condor will launch two modified Arcus gliders — one with a hydrogen combustion engine, and one with a conventional kerosene-powered combustion engine — to compare contrails.**

decarburization journey," said Sandra Bour Schaeffer, CEO of Airbus UpNext.

The Blue Condor demonstrator will be supported by the Perlan Project team, which will be responsible for the modification of the Arcus gliders.

The German Research Center (DLR) will collect and analyze data captured using their measurement instrumentation sensors on a chase aircraft, while Airbus will ensure the provision of the hydrogen system and equipment, including the combustion engine as well as the details of the flight test mission.

The test flights will be carried out back-to-back under the same meteorological conditions. Test flights are scheduled for late 2022 in North Dakota in collaboration with the University of North Dakota. ◀

Airbus completes assembly of first future wing prototype

Airbus announced it has completed its first “Wing of Tomorrow” prototype at the Farnborough Airshow. Airbus says its first full-size wing prototype will help mature next-generation wing technologies. The completion of the first of three fully composite wing demonstrators marks the integration of more than 100 different component and manufacturing technologies that include an all-new industrial assembly system, and which have helped validate automation targets. The international team behind this UK-led program is developing high-performing wing technologies, including the incorporation of a folding wing tip. Alongside research into sustainable aviation fuels and hydrogen propulsion, Wing of Tomorrow marks how Airbus is contributing to aviation’s decarbonization ambitions and demonstrates the importance of large-scale industry collaboration in achieving our sector’s agenda for a more sustainable future. The new build philosophy on Wing of Tomorrow sheds in-tank working and enables manual and automated assembly to be smoothly integrated into an optimized industrial system. Through capturing the learning from building this first, and subsequent, wing demonstrators, Airbus will explore different scenarios to be able to make the right industrial choices to build our wings of the future. Wing of Tomorrow composite components are designed to make the best use of technologies and reduce the amount of work during the assembly phase by more than 50%. Automation of the remaining drilling, achieving good tolerance control and wing shape, as well as the introduction of new approaches to inspection and validation will support Airbus’ ambition to create the most highly efficient wings of the future.

ZeroAvia and Otto Aviation collaborate to make hybrid powertrain for Celera aircraft

ZeroAvia, a provider of hydrogen-electric solutions for aviation based in Hollister, Calif., announced it was collaborating with Otto Aviation LLC, in Yorba Linda, Calif., to develop a hydrogen-electric powertrain to power Otto’s Celera aircraft. Under the agreement, Otto and ZeroAvia will work to integrate ZeroAvia’s ZA600 zero-emission engines to Otto’s Celera aircraft. The collaboration has the potential to make the Celera the first new airframe design to leverage zero-emission propulsion in its launch models. The Celera is scalable as many as 19 passengers. Otto’s aircraft design offers low drag across the entire aircraft. The design of the

Celera fuselage, empennage and wings take advantage of laminar flow. Laminar flow is the minimum drag solution for aircraft surfaces and features smooth layers of airflow with little to no mixing of adjacent layers. When coupled with fuel-efficient propulsion systems, the Celera will reduce operating costs and increase range relative to comparable aircraft, while creating optimal passenger comfort and cargo capacity. When powered by ZeroAvia’s powertrain, the Celera will offer long range zero-emission flights, while further reducing operating costs, thanks to reduced maintenance costs and falling hydrogen-fuel prices. The Celera design is conducive to accommodate large volumes of hydrogen within the fuselage that will enable 1,000 nautical miles of range. The development of this 600-kilowatt powertrain is part of Project HyFlyer II aims to deliver a certified powertrain for aircraft of as many 19-seats by 2024.

Airbus and VRM to co-develop helicopter VR training for H145

Airbus Helicopters and VRM Switzerland have announced that the two companies are co-developing a virtual reality (VR) training device for the twin-engine H145 helicopter. This new training tool will offer H145 operators a compact training solution with realistic flight behavior with full-body immersion as well as the 3D vision and high resolution scenery of VR technology. VRM Switzerland and Airbus Helicopters established their collaboration in 2021 to bring the EASA-qualified H125 VR training device to the market, enabling pilots to train realistically and execute complete proficiency checks on the simulator. Scenarios that would be very risky to attempt in actual flight but which bring significant added value to training,” says Christoph Zammert, Executive Vice President of Customer Support & Services at Airbus Helicopters. “Having already successfully logged thousands of training hours with our simulators, we want to make this technology available to H145 operators by developing a VR flight training device for the five-bladed H145. This will allow H145 crews to prepare for their demanding missions with scenario-based training performed in a safe and realistic environment,” adds Fabi Riesen, CEO of VRM Switzerland. Containing the OEM data package, the H145 VR simulator - once qualified - will allow pilots to perform proficiency checks and receive training credits. It will be used to perform type ratings including normal flight, emergency situations, hoist operations and flight with night vision goggles, as well as instrument ratings. ←



Boeing is testing 30 sustainable technologies on its 777-200ER ecoDemonstrator

BY Jamie Whitney

SEATTLE - Boeing unveiled its 2022 ecoDemonstrator with a livery that honors a decade of testing to reduce fuel use, emissions and noise. The latest ecoDemonstrator, a Boeing-owned 777-200ER, will test about 30 new technologies aimed at improving sustainability and safety for the aerospace industry, including a water conservation system and technologies to improve operational efficiency.

“Boeing is committed to support our customers and enable the commercial aviation industry to meet our shared commitment to net zero carbon emissions by 2050,” said Stan Deal, Boeing Commercial Airplanes president and CEO. “The ecoDemonstrator program’s rigorous testing of new technologies further enhances the environmental performance of our products and services and is invaluable to continuously improving safety.”

During six months of flight and ground tests starting this summer, the 2022 ecoDemonstrator will evaluate:

- Additively manufactured airplane and engine parts including an auxiliary power unit (APU) exhaust duct support panel and an engine bracket. The goal is to reduce weight on the airplane, which saves fuel, and reduce waste in the manufacturing process. Both were developed by the Boeing Additive Manufacturing Innovation Center.
- Boeing and NASA are continuing their work on SMART vortex generators, small vertical vanes on the wing that improve aerodynamic efficiency during takeoff and landing. Shape memory alloys developed in collaboration with NASA will enable the vortex generators to retract into the wing during cruise, improving fuel efficiency and reducing carbon emissions.



◀ The Boeing ecoDemonstrator 777-200ER aircraft will test about 30 new technologies aimed at improving sustainability and safety for the aerospace industry.

- In partnership with Universal Avionics, the ecoDemonstrator pilots will help test next-generation head-worn head-up display (HUD) and enhanced vision system (EVS) camera. The SkyLens HUD is a transparent screen that places key information directly within a pilot's line of sight. This technology, coupled with EVS, provides an enhanced vision system that allows pilots to see in low-visibility conditions, enhancing safety by improving situational awareness and reduces weight on the airplane.
- In collaboration with Diehl Aviation, the ecoDemonstrator will test a water conservation system that uses wastewater from handwashing to flush the lavatories. By saving water — potentially more than 400 lbs. (181 kg.) of weight per flight — the system helps to reduce fuel use and carbon emissions.
- Partnering with Meggitt, Boeing is testing the discharge performance of a new fire suppression agent for the airplane's cargo compartment in flight. This effort is part of Boeing's commitment to eliminate the use of Halon 1301 across all commercial airplane models. International environmental and aviation regulations have imposed cutoff dates for using

Halon 1301 — the standard agent for extinguishing airplane fires — due to its ozone-depleting properties.

- Boeing is testing several technologies aimed at improving operational efficiency, including a capability that can improve situational awareness for pilots during airplane taxiing. This includes combining airport data sources with Jeppesen airport maps to enable single-engine taxi operations to reduce fuel consumption.
- In partnership with Collins Aerospace, Boeing is testing the performance of a new air chiller that uses an environmentally-preferred refrigerant. Airplane galleys contain refrigerators to keep food and beverages cold in flight. Just like in consumer refrigerators, refrigerants often contain industrial chemicals which are potent greenhouse gases if they leak. “The Boeing ecoDemonstrator program brings together the two most important ingredients to a more sustainable future — innovative technologies and partnerships with customers, suppliers, government agencies and academia,” said Chris Raymond, Boeing Chief Sustainability Officer. “We celebrate the past successes and look forward to continuing this iconic program to help decarbonize aviation, together.” ◀

Boeing taps Aireon to expand its space-based advanced data analytics capabilities

By Jamie Whitney

SEATTLE - Boeing sought a technology provider to provide space-based automatic dependent surveillance-broadcast (ADS-B) services. They found their solution from Aireon in McLean, Va. Boeing will use the stream to expand its advanced data analytics capabilities in its effort to further strengthen commercial air travel safety.

Aireon will provide historical aircraft data and near real-time aircraft event data via its AireonINSIGHTS product for select Boeing airplane programs.

As part of its implementation of an enterprise Safety Management System (SMS), Boeing will integrate the ADS-B data into its safety analytics tools. SMS is an integrating framework for managing safety risks. Through the use of data science and data analytics, the information will deliver insights to proactively identify hazards and monitor emerging safety trends.

The global space-based ADS-B data from AireonINSIGHTS can help customers gain insights to key performance indicators on flight safety.

Aireon has deployed a space-based air traffic surveillance system for ADS-B-equipped aircraft worldwide. Space-based ADS-B surveillance covers oceanic, polar, and remote regions, and augments existing ground-based systems that are limited to terrestrial airspace.

"The power of the Aireon data unlocks a cache of information for Boeing regarding the operations of its aircraft in the global airspace. With this integration, Boeing will have data to provide a full operational view of its fleet, and we are excited to partner with them," said Don Thoma, Aireon CEO. ◀

▼ **Boeing will use Aireon ADS-B data to expand its data analytics capabilities to strengthen commercial air travel safety.**