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UNMANNED GROUND VEHICLES

Enabling technologies for tracked, wheeled, and
legged unmanned vehicles in rugged terrain. PG. 16



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How might high-tech weaponry play out in Russia's invasion of Ukraine?



BY **John Keller**
EDITOR IN CHIEF

Will the invasion of Ukraine be a demonstration of the state-of-the-art in Russian military technology? Perhaps, but I'm still waiting for reports of decisive use of advanced-technology weapons such as electronic warfare (EW), cyber warfare, and navigation warfare that would offer crucial advantages to advancing Russian military forces.

It's clear that conventional Russian armored combat vehicles, maritime forces, and air forces have led the Russian advance into Ukraine, leaving widespread military and civilian damage in their wakes. Still, there have been few, if any, widespread reports of Russian high-tech weaponry that I've seen.

This is not to say that the best of Russian military technology won't be on display before fighting ends in Ukraine, but the longer this war drags on, the more likely we'll see deployment of some surprising Russian military weaponry.

It's anyone's guess what this relative quiet in the use of high-tech Russian military technology might mean. There's certainly a lot of speculation out there. It might political, in that Russian commanders may be reluctant to unveil their most promising technological developments in what until now remains a regional conflict.

It may be that Ukraine's military forces do not pose a serious enough technological challenge that would provoke the Russian military from bringing out its most impressive weaponry.

It also may be — but probably isn't likely — that Russian military leaders just don't have the sophisticated and high-tech weaponry that Western analysts had expected. I wouldn't take that one to the bank.

So what we know after nearly a week of the latest Russo-Ukrainian War? Russian conventional forces have attacked Ukraine on three sides and made some substantial advances from Crimea in the

south, Russia in the east, and Belarus in the north.

Russian land and air forces have destroyed civil power plants and oil facilities, as well as military airfields. There are Russian or Russian-backed forces that have crossed the vital Dnieper River in the north, and hold ground on both sides of the river near the capital Kyiv.

One thing's coming clear: invading and subduing Ukraine has not been so easy or so quick as the Russian high command might have believed. Every day that Kyiv holds out casts Russia more deeply into the role of global pariah. More of the world's governments are sending financial and material support to Ukraine. International financial sanctions on Russia haven't started to bite yet, but it's only a matter of time until they do. Switzerland and other countries are pledging to freeze Russian financial assets, sports teams refuse to take the field against Russian teams, and the list goes on. If Russia hasn't yet taken a status similar to North Korea and Iran, then it's not far off.

As long as the Ukrainian flag flies over Kyiv — or over even over isolated surviving outposts in that country — the tougher the situation becomes for Russia ... which brings us back to that Russian high-tech weaponry we haven't heard much about yet.

Russian can afford little tolerance for delay, and the longer this war goes on, the more likely we'll see use of advanced military technologies like electromagnetic warfare, large-scale cyber attacks, attempts to destroy or disable Ukraine's position, navigation, and timing (PNT) assets. I'd rather not even think about the potential use of nuclear, biological, or chemical weapons yet. God forbid.

We'll have to wait to see how events unfold in Ukraine. ◀

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NASA selects Lockheed Martin to lift samples off Mars surface

BY Jamie Whitney

WASHINGTON - The National Aeronautics and Space Administration (NASA) needed a specialized vehicle to collect surface and atmospheric samples off of Mars.

They found their solution from the Lockheed Martin Corp. Space segment in Littleton, Colo.

NASA officials say Lockheed Martin's Mars Ascent Vehicle (MAV) will be the first rocket fired off of another planet. The MAV will help retrieve samples collected by NASA's Perseverance rover and return them to Earth for study.

Once it reaches Mars orbit, a European Space Agency (ESA) Earth Return Orbiter spacecraft outfitted with NASA's Capture, Containment, and Return System payload will capture

the container. The spacecraft is to bring the samples to Earth in the early- to mid-2030s.

▲ Lockheed Martin will build spacecraft that will lift Mars samples to Earth by the 2030s.

Lockheed Martin Space will provide several MAV test units and a flight unit. Work under the contract includes designing, developing, testing, and evaluating the integrated MAV system, and designing and developing of the

rocket's ground support equipment. ←

The Mars Ascent Vehicle Integrated System (MAVIS) contract has a potential value of \$194 million. The performance period begins no later than Feb. 25 and will extend six years. To learn more about the Mars Sample Return program, visit NASA at <https://mars.nasa.gov/msr/>.



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Air Force asks industry to simulate electromagnetic warfare effects that destroy electronics

BY John Keller

KIRTLAND AIR FORCE BASE, N.M. – U.S. Air Force high-energy weapons experts are reaching out to industry to find companies able to model and simulate the effects of electromagnetic warfare weapons intended to destroy or disable enemy electronics, improvised explosive devices, unmanned aircraft, and similar systems.

Officials of the Air Force Research Laboratory Directed Energy Directorate at Kirtland Air Force Base, N.M., have issued a broad agency announcement (FA9451-22-S-0001) for the High Power Electromagnetics (HPEM) Modeling and Effects project.

This potential \$80 million project seeks to characterize the effectiveness of potential HPEM weapons by developing tools and generating vulnerability data to feed those tools.

The HPEM Modeling and Effects project consists of several future calls on specific areas of interest, which will be issued over the next five years.

The vulnerability data consists of the likelihood of destruction or disruption of enemy electronics when subjected to high-power electromagnetic energy. The project also investigates how to predict and model the fundamental mechanisms that cause these disruptions or failures.

Effects will involve empirical effects testing; HPEM weapons effectiveness modelling; fundamental HPEM effects research; battle damage assessment and recuperation time; emerging technologies like HPEM sources, diagnostics, and sensors; and evaluation tools for effects databases.

Numerical simulation involves developing simulation codes for HPEM systems and components modeling; using codes in developing HPEM systems and components; developing simplified high-performance computing and analysis tools; digital engineering of HPEM systems and components; multi-scale materials modelling; developing HPEM engagement-level codes; engagement

and mission level modeling of HPEM systems; and validating all software. ←



The Air Force wants industry to model and simulate electromagnetic warfare effects that could destroy or disable enemy electronics.

High-power microwaves offer technologies that enable low-collateral-damage military applications, counter electronic effects, counter improvised explosive devices, and counter weapons of mass destruction.

Focused beams of microwave energy can protect aircraft and ships against incoming missiles, and to help attack electronic targets. Researchers are developing sophisticated compact devices that convert stored electrical energy into high-power bursts able to penetrate structures and destroy electronics.

Air Force researchers say they expect to award one contract for each call. Email technical questions to afrl.rdh.acquisitions@mail-box@us.af.mil. Email business questions to Adan Dominguez at adan.dominguez.2@us.af.mil, or Julian Landavazo at julian.landavazo@us.af.mil. More information is online at <https://sam.gov/opp/48dcad42f0d443bf90992a062d435060/view>.

NASA offers as much as \$200 million to help push new space technologies to market

Companies with technologies that may advance exploration but need a little extra push to finalize development have two new opportunities to partner with NASA to make it over the finish line. Through Tipping Point, NASA seeks to support space technologies that can foster the growth of commercial space capabilities and benefit future agency missions. NASA is also offering businesses a chance to work with agency experts or use facilities to complete their work through a separate Announcement of Collaboration Opportunity. These opportunities focus on technology development for space infrastructure and capabilities for the Moon and near-Earth space. Selected proposals for working on and near the Moon could include infrastructure for power distribution on the lunar surface, solutions for using lunar resources, or autonomous construction – key components for long-term lunar exploration under Artemis. NASA will also consider proposals for infrastructure and capabilities in Earth orbit – which could range from climate research tools to in-space manufacturing and advanced propulsion.

Anritsu's test and measurement can help mitigate interference between 5G and avionics equipment

Anritsu Co. in Allen, Texas, has announced a testing solution to help mitigate possible interference between 5G wireless cellular networks using the C-band spectrum and avionics equipment, including radar altimeters. The MG3710E generates 3GPP-compliant interference waveform patterns for testing the receiver sensitivity and throughput of 5G and LTE UE and modules using the Vector Signal Generator MG3710E. The MG3710E, with the software installed and combined with the Radio Communication Test Station MT8000A and Radio Communication Analyzer MT8821C simplifies conducting interference evaluation tests required by

the 3GPP RF Compliance Test. The solution supports in-house pre-testing to confirm compliance of Sub-6 GHz 5G and LTE UE and modules before the official 3GPP Compliance Test. Additionally, the solution can be used during R&D to improve receiver sensitivity and throughput performance. 5G and LTE UE and module manufacturers must ensure that products pass the 3GPP RF Compliance Test administered by a certified test organization. The compliance test is the final *Continued on page 11*

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Navy asks industry for safety upgrades to F/A-18C/D flight-control computer

BY John Keller

PATUXENT RIVER NAS, Md. – U.S. naval aviation experts are asking industry to upgrade flight-control software in Navy combat aircraft to reduce the risk of pilots crashing into the ground on difficult missions.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., have issued a request for proposal (223201-21) for the Automatic Ground Collision Avoidance System (Auto-GCAS) Flight Control Computer (FCC) Upgrade.

Navy officials want industry to upgrade the avionics of the Navy Boeing F/A-18C/D light-attack bomber to enhance the aircraft's ability to prevent controlled flight into terrain when the pilot is fixated on a target during an attack dive; spatially disoriented; loses consciousness; or suffers degraded abilities due to oxygen deprivation.

The F/A-18C/D light-attack bomber has a quad-redundant digital fly-by-wire flight-control system that converts pilot and aircraft inputs to flight control actuator commands from surface actuators, air data sensors, pilot controls and displays, software, and the quad-channel flight control electronic set (FCES) subsystem.

The flight-control system provides overall control of the F/A-18C/D aircraft and controls flight, redundancy management, autopilot, input/output processing, system monitors, and built-in-test.

The planned upgrade will include the ability to translate the pull vector from the digital map computer into flight control movements, provide status to the mission computer, and perform system integrity checks.

◀ **Navy officials want industry to upgrade the avionics of the Navy Boeing F/A-18C/D light-attack bomber to enhance the aircraft's ability to prevent controlled flight into terrain.**

The automatic ground collision avoidance system project would be a change to the software in the aircraft's digital map computer, and combines with the existing terrain avoidance warning system to create the automatic terrain avoidance and warning system.

Software updates are necessary in the mission computer and digital map computer. The flight control computer program also will need updating. The company that might win a contract for this project will update and test the flight control computer program.

The automatic ground collision avoidance system is to provide a safety backup that automatically recovers the aircraft from an impending crash using digital terrain elevation data as a reference for ground elevation.

The system will compare digital terrain elevation to flight parameters to generate a warning and initiate automatic recovery if the pilot does not take action. The system will generate visual warnings/advisories and aural alerts to alert the aircrew when needed.

The system will enable the pilot manually to initiate a recovery that returns the aircraft to straight and level flight. Navy experts are looking for a company to modify the existing flight control computer program with new functionality to support automatic ground collision avoidance.

There are several key challenges that the contractor must face. While Navy experts will provide source code for the flight control computer program, they cannot provide the build tools that actually generate the executable program.

The F/A-18C/D aircraft uses the General Electric MCP 701E processor for flight control, which has no significant commercial use outside the F-18C/D application, and has proprietary build tools. ◀

Companies interested in this avionics software project were asked to upload proposals by 8 March 2022 to the PIEE Solicitation Module online at <https://piee.eb.mil/sol/xhtml/unauth/search/oppMgmtLink.xhtml?sol-No=N0001921R0045>. The original project has been delayed, and its original proposal deadline had been in November 2020. More information is online at <http://www.fbdaily.com/archive/2022/02-February/05-Feb-2022/FBO-06232217.htm>.

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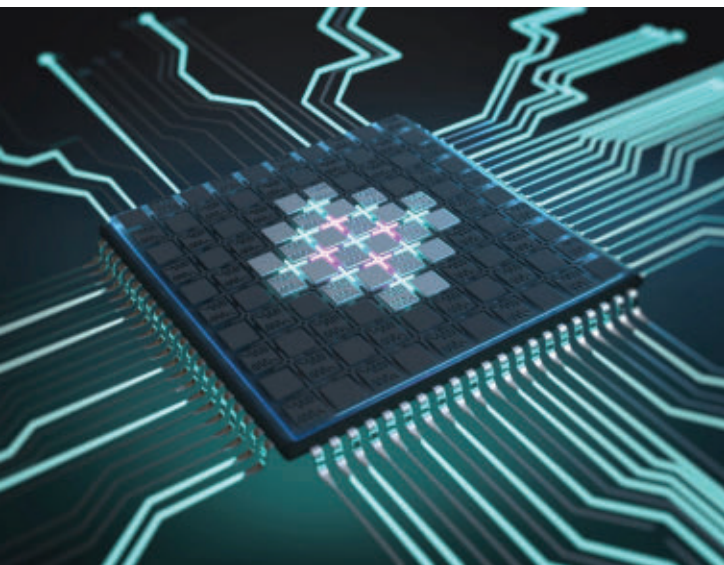
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Wanted: new ways to build quantum computers for solving difficult problems

BY John Keller

ARLINGTON, Va. — U.S. military researchers are asking industry to determine if it's possible to build a quantum computer that has a value that exceeds its costs — particularly for applications that require fault-tolerance.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a solicitation (DARPA-PS-22-04) for the Underexplored Systems for Utility-Scale Quantum Computing (US2QC) program.



The US2QC program seeks to determine if a relatively unexplored approach to quantum computing could yield valuable operation much faster than initially predicted.

The primary goal of the US2QC program is to determine if an relatively unexplored approach to quantum computing could achieve utility-scale operation much faster than conventional predictions. Utility-scale quantum computing is where the system's value is greater than its costs.

Quantum computing seeks to capitalize on quantum mechanics to deliver a huge leap forward in processor performance to solve particularly difficult problems.

Computer scientists have hypothesized — but not proven — that quantum computers will have a transformative influence on a variety of scientific and technical disciplines. Two factors make the precise influence of quantum computing unclear.

In most cases a solid comparison of the best classical alternatives for real-world usage has not been completed. Second, it is unclear when or if a utility-scale quantum computer can be built.

The complexity of a fault-tolerant utility-scale quantum computer could approach or exceed that of a classical supercomputer, DARPA researchers say. To prove this, however, could take years; scientists predict that a utility-scale quantum computer based on conventional designs is still decades away.

That process could speed-up, however, if an underexplored approach to quantum computing is discovered. That's where the US2QC program comes in.

The US2QC program seeks to find utility-scale quantum computer concepts with plausible paths to realization in the near term through verification and validation. Proposers should describe the scale, quality, and configuration of their utility-scale quantum computer concepts, and explain why the computational value of their systems are likely to exceed their costs.

Phase zero of the program requires each performer to describe a complete concept, including all components and subsystems, projected performance capabilities against a variety of metrics, and anticipated technical risks and mitigation strategies.

This concept is not expected to enable construction of a utility-scale quantum computer, but to create a component and subsystem research and development plan with technical detail sufficient to guide the design of a fault-tolerant prototype.

The first phase will design In this example, performers that continue into Phase 1 will design a fault-tolerant prototype that can be built as designed; identify all required components and subsystems; and establish minimum performance requirements.

The program's second phase will build utility-scale quantum computer with components and subsystems that meet anticipated performance specifications. ◀

Companies interested were asked to email eight-page abstracts by 23 March 2022 to DARPA at US2QC@darpa.mil. Those submitting promising abstracts may be invited to give oral presentations. Email questions or concerns to DARPA at US2QC@darpa.mil. More information is online at <https://sam.gov/opp/6c8cffdd547b4816bb8b09e4e4448892/view>.

Continued from page 7 product evaluation before commercial release. Failed tests may require redesign and retesting. Consequently, pre-testing during development is essential to avoid this risk.

U.S. Navy mulls unmanned surface vessel with modular payloads for specific missions

The utility ship of tomorrow is an unmanned surface vessel (USV) that will follow the laws of the sea, autonomously plot its own path, and take-on a range of modular payloads to serve the Navy over the course of its life. The U.S. Navy's new Medium Unmanned Surface Vessel (MUSV) will feature a broad payload area where the Navy can pick and choose the platform's capabilities. Navy experts want a new kind of unmanned surface vessel, know the rough size of the vessel they want, and do not yet know exactly how that USV will function in war. Designing an unmanned vessel that can take on a range of modular payloads and perform a wide range of missions enables Navy experts to figure out how to best incorporate robotic boats into normal operations first, and then fine-tune how they want to use those machines in the future.

Collins Aerospace announces MRO agreements at Singapore Airshow

Collins Aerospace in Cedar Rapids, Iowa, has announced it has inked a maintenance repair and overhaul (MRO) agreement at the Singapore Airshow last month. Collins Aerospace reported that China Airlines and its subsidiary Tigerair Taiwan signed a contract to use Collins' FlightSense aircraft prognostics and health management (PHM) software. FlightSense uses the Ascentia platform to analyze physics-based data, statistical analysis, and machine learning to reduce unscheduled maintenance and reduce service interruptions. Collins claims that the FlightSense suite has shown a 30% reduction in potential delays and a 20% decrease in unscheduled removals. Collins, a subsidiary of Raytheon Technologies Corp.,

cites data collected on a fleet of Boeing 787s and 777 respectively. Under the contracts, Collins will provide engine accessory repair services for China Airlines' fleet of 25 A321neo aircraft, and engine accessory repair and spares support for Tigerair Taiwan's fleet of 15 A320neo aircraft. The fleets are powered by Pratt & Whitney's GTF engines, which Collins supplies a number of engine accessories for including electronic controls, starters, pumps, valves, sensors and harnesses.

Continued on page 15



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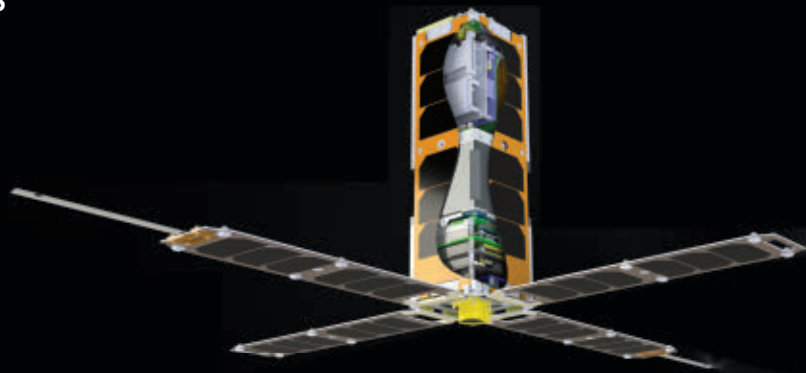
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The Dodona cubesat will demonstrate how Lockheed Martin's SmartSat software-defined satellite architecture can process collected image data of the Earth's surface.

D-Orbit deploys USC's La Jument cubesat to prove space artificial intelligence (AI)

BY Jamie Whitney

FINO MORNASCO, Italy - Space logistics and orbital transportation company D-Orbit in Fino Mornasco, Italy, announced the deployment of Dodona, a 3U CubeSat developed by the

University of Southern California (USC) in Los Angeles and Lockheed Martin Corp. The satellite launched in January as part of D-Orbit's DASHING THROUGH THE STARS mission.

Dodona carries Lockheed Martin's software-defined La Jument payload, which will help space-qualify artificial intelligence (AI) and machine learning (ML) technologies.

On orbit, the La Jument payload will demonstrate how Lockheed Martin's SmartSat software-defined satellite architecture can control a low-cost camera and perform onboard SuperRes upscale processing of collected image data of the Earth's surface. SmartSat enables users to expand satellite capabilities and change missions on orbit.

Powering the system is the NVIDIA Jetson general-purpose graphics processing unit (GPGPU), built on the CUDA-X software stack and supported by the NVIDIA JetPack software development kit (SDK). It delivers AI at the edge for advanced image and digital signal processing.

For the launch and deployment, D-Orbit relied on its ION Satellite Carrier, the Company's proprietary orbital transportation vehicle able to transport a batch of satellites into space and release them individually into precise orbital slots, customizing altitude, ascending node, and performing True Anomaly Phasing to reduce time from launch to full operation for satellite constellations to 85 percent. The DASHING THROUGH THE STARS mission is D-Orbit's fourth orbital transportation mission in less than 15 months. ◀

After deployment, ION will enter in-orbit validation to conduct in-orbit testing of the technology of the third-party payloads and run a second iteration of its own cloud platform. For more information contact D-Orbit online at www.dorbit.space.

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Honeywell demonstrates unmanned aircraft dodging collisions autonomously in test

BY Jamie Whitney

PHOENIX – An unmanned aerial vehicle (UAV) piloted by the Honeywell IntuVue RDR-84K radar system has triumphed in a high-stakes game of dodgeball, repeatedly swerving around intruder aircraft in tests that are key to the future of pilot-less aviation.

The tests, which took place near Phoenix, showed that the radar not only can detect airborne traffic but also can decide autonomously on a course of action. The radar can take over navigation and pilot an aircraft to safety using its onboard processor.

Avoiding unforeseen objects is a key requirement for autonomous drones and other aircraft that fly beyond visual line of sight (BVLOS) of an operator.

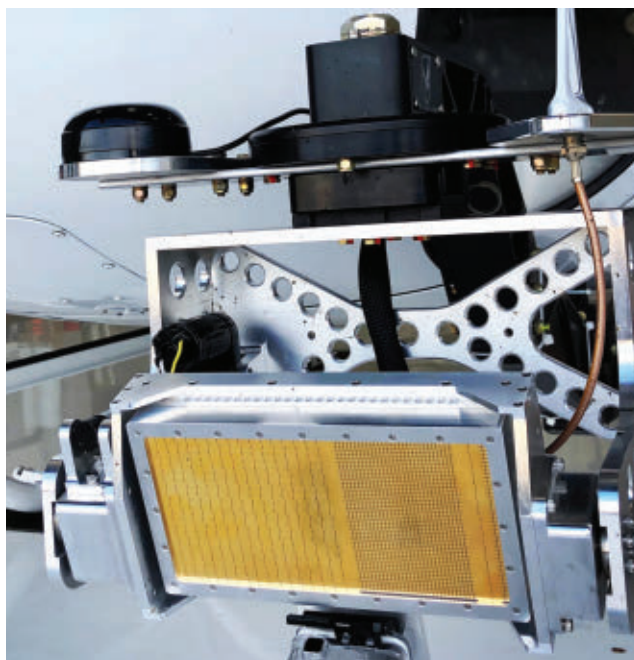
Radars must have long ranges because of the high speeds involved, and they must pick out airborne traffic from ground clutter, including moving cars. They also require precise location information to make sense of radar echoes.

This is difficult on the ground and even more complex in the sky. To compensate, pilots, and even huge air traffic control

radars, rely on cooperative aircraft to beam out their locations using onboard transponders. Objects without transponders — hobby drones, kites, birds and aircraft with broken transponders — are known as “noncooperating” traffic.

The RDR-84K, which is the size of a paperback book, has proven its ability to detect noncooperating traffic during extensive testing while mounted on helicopters and drones. But the new tests marked the first time it has performed the avoidance function without human intervention. ◀

With both drones on autopilot, Honeywell engineers flew two quadcopter drones directly at each other 300 feet above the ground at a test site in the desert. view the demonstration online at <https://watch.honeywell.com/watch/wivu1yJSAR9irbQ7K8RJSi>.



▲ The Honeywell IntuVue RDR-84K radar has demonstrated the ability to swerve around other manned and unmanned aircraft in congested urban airspace.

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Lockheed to build anti-submarine warfare (ASW) and anti-torpedo systems for warships

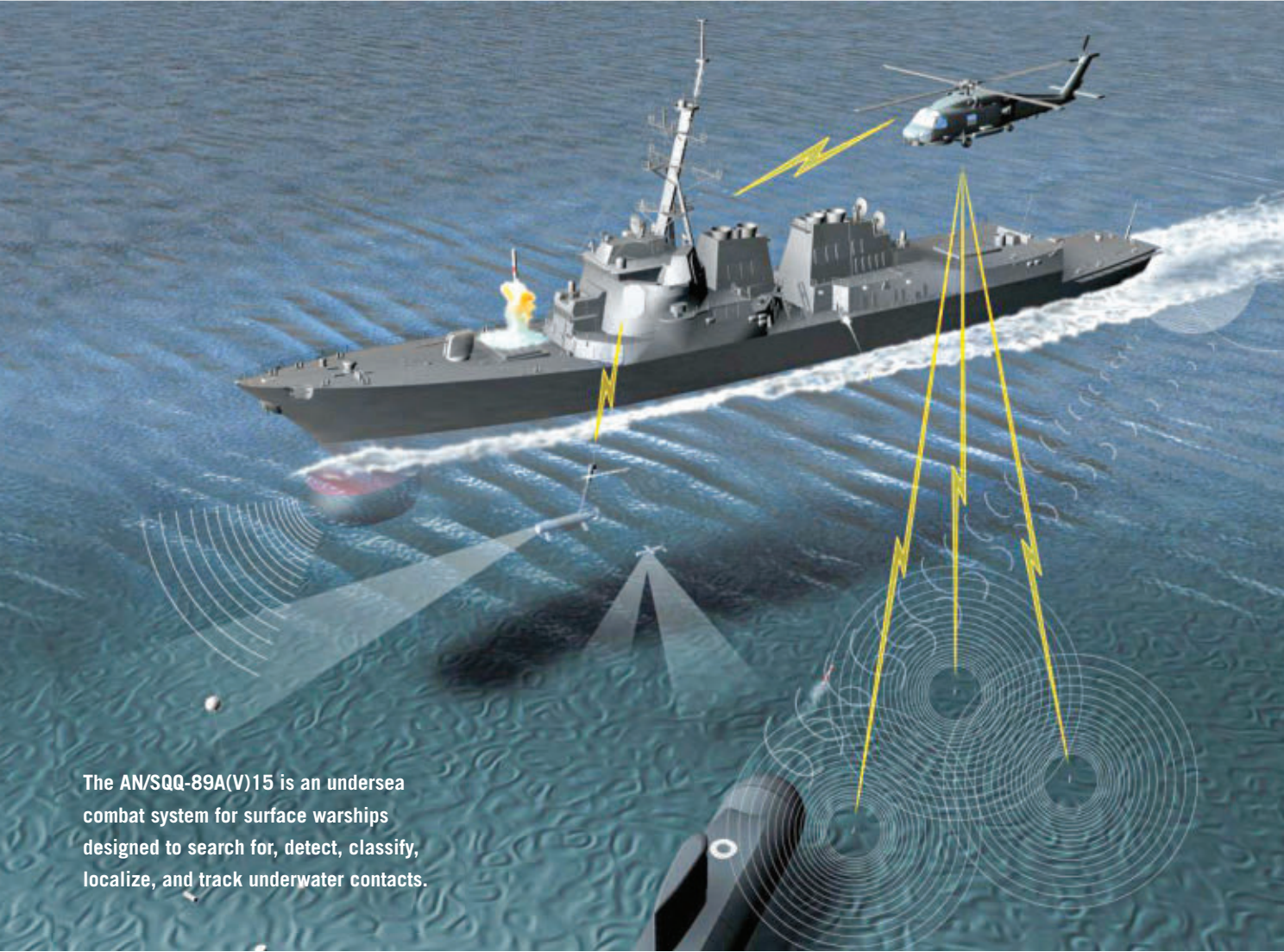
BY John Keller

WASHINGTON – Undersea warfare experts at the Lockheed Martin Corp. Rotary and Mission Systems segment in Manassas, Va., will provide the U.S. Navy with AN/SQQ-89A(V)15 anti-submarine warfare (ASW) systems for surface warships under terms of a \$59.5 million order.

Officials of the Naval Sea Systems Command in Washington are asking Lockheed Martin for technical insertion-22 (TI-22) shore sites systems, options, and engineering to support AN/SQQ-89A(V)15 development, integration, manufacture, production, and testing.

The AN/SQQ-89A(V)15 is an undersea combat system for surface warships that is designed to search for, detect, classify, localize, and track underwater contacts; and to attack or avoid enemy submarines, floating, tethered, or bottom-attached mines, and torpedoes.

The AN/SQQ-89A(V)15 uses active and passive sonar to enable Navy Arleigh Burke-class destroyers and Ticonderoga-class cruisers to detect, locate, track, and attack hostile submarines, mines, and torpedoes.



The AN/SQQ-89A(V)15 is an undersea combat system for surface warships designed to search for, detect, classify, localize, and track underwater contacts.

The counter-mine and anti-torpedo system provides multi-sensor track correlation and target track management control, and forwards data to the ship's weapons and decision-support systems. The AN/SQQ-89A(V)15 works together with the ship's active and passive hull sonar, multi-function towed array, sonobuoy processing, torpedo alerts, fire-control system, sensor performance predictions, embedded operator, and team training systems.

The AN/SQQ-89A(V)15 has an open electronics architecture to accommodate system upgrades, and makes the most of data accessibility and system modules, Lockheed Martin officials say. Its software application programs are isolated from hardware with open middleware to render applications processor-independent.

The system uses POSIX-compliant system calls and Motif and X-compliant display service calls. Symmetric multi-processors (SMPs) using Linux-based processing handle signal, data, display, and interface processing.

Virtual Network Computing (VNC) enables rapid re-allocation of operator console displays to suit the tactical situation, Lockheed Martin officials say.

Recent and planned upgrades to the AN/SQQ-89A(V)15 include improved automated torpedo detection, sonar performance prediction, advanced active sonar processing, re-designed active displays to reduce operator loading, and integrated training and logistics.

The AN/SQQ-89 is integrated with the Aegis combat system, vertical launch anti-submarine rocket (ASROC) system. A variant of the AN/SQQ-89A(V)15 is integrated with late-version Aegis combat systems being installed onboard new Arleigh Burke-class destroyers. A back-fit program is in place to retrofit existing DDG-51 class ships and Ticonderoga-class cruisers.

On this contract modification Lockheed Martin will do the work in Manassas, Va.; Lemont Furnace, Pa.; Clearwater, Fla.; Syracuse and Hauppauge, N.Y., and should be finished by August 2023. ←

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.

Continued from page 11

FAA says dangerous laser strikes reach highest numbers

The number of laser strikes against aircraft — a serious safety threat — topped all previous records in 2021. The Federal Aviation Administration received 9,723 reports from pilots last year, a 41 percent increase over 2020. Many types of high-powered lasers can incapacitate pilots. Pilots have reported 244 injuries since the FAA began recording data on laser strikes in 2010. The FAA says that shining a laser at an aircraft is a serious safety threat. Many types of high-powered lasers can incapacitate pilots, many of whom are flying airplanes with hundreds of passengers. Pilots have reported 244 injuries since the FAA began recording data on laser strikes in 2010. People who shine lasers at aircraft face FAA fines of up to \$11,000 per violation and up to \$30,800 for multiple laser incidents. The FAA issued \$120,000 in fines for laser strikes in 2021. Violators can also face criminal penalties from federal, state and local law enforcement agencies. ←

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Robots for the

ready battlefield

Enabling technologies
progress for tracked,
wheeled, and legged
unmanned vehicles

BY Megan Crouse

The *Empire Strikes Back* concreted *Star Wars* in the minds of the moviegoing public as a new phenomenon. One of the aspects that caught people's imaginations so much was the battle on the snow field and the walking tanks used by the evil Empire. Decades later, today's real-life walker robots have come full circle as the Boston Dynamics machine "Spot" features in the 2022 *Star Wars* television show *The Book of Boba Fett*.

In the real world, replicating the agility, balance, and adaptability of an animal's gait could re-define what terrain vehicles can travel over. They're also just one aspect of the growing field of unconventional autonomy, from autonomous tanks with treads to conventional wheeled vehicles turned into remote-controlled versions.

Walking robots since the 1960s

Robots with legs have existed in one form or another and fascinated people for decades. General Electric attempted to introduce a "Walking Truck" in the 1960s. The Army was encouraging the effort in this time, too, awarding a study contract for a human-operated machine with 12-foot legs and a 35-mile-per-hour walking speed. In fact, it only ever hit 5 miles per hour and proved onerous to drive. The future, it wasn't.

The major difference between this and other experiments with walking robots of the past and today's machines is the physical presence of a pilot. Without fly-by-wire or Wi-Fi capabilities, older models were intended to bring humans along for the ride to transport equipment or wounded people.



The General Dynamics Land Systems Tracked Robot 10-Ton (TRX) in action.

Today, robots with two legs or four that can operate on their own are a lucrative experiment for industrial work as well as the military.

Some companies and academic groups are combining walkers with wheels, or experimenting with two-legged robots, for industrial settings instead. The ETH Zurich Robotic Systems Lab has added wheels to a dog-like mobile platform, which they advertise as working in smart freight logistics systems. The

wheels enable it to traverse terrain including stairs, and the company claims it can carry more weight than a lightweight delivery drone suitable for the same purpose.

Rescue and cargo remain the primary use for military robots today. Robotic vehicles increase combat effectiveness in “dumb, dirty, or dangerous” situations in particular, says Tim Reese, director of U.S. business development at General Dynamics Land Systems in Sterling Heights, Mich. ‘Dumb’ missions may be

tedious, tiresome, or prohibitively boring for a human. ‘Dirty’ missions may involve chemical contaminants or the threat of disease, while ‘dangerous’ missions bring people onto contested ground where they or their vehicles are likely to come under fire.

When is a tank not a tank?

Tracked unmanned vehicles are undergoing their own technological changes at the same time as legged ones. General Dynamics Land Systems is competing for four U.S. Army initiatives today. Company officials say military customers are looking for the best way to navigate difficult terrain. Is the best way really adding legs to your vehicle? Integrating autonomy into treaded vehicles means a tank can be more than a tank — it becomes a robot.

“One of the largest challenges we’ve faced in our domain is terrain,” says Bill



The General Dynamics Tracked Robot 10-Ton (TRX) shows what it could do for warfighters on the battlefield

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Luke Travisano, engineer with Robotic Research LLC, conducts a test run of the autonomous system Pegasus, during the Project Convergence capstone event at Yuma Proving Ground, Ariz.

Tecos, technology fellow for advanced capabilities at General Dynamics Land Systems. “You have to be able to more accurately perceive what you’re able to maneuver through. That can depend on terrain segments or what we call terrain portions. That might [mean] the associated grade of the terrain that the associated vehicle can traverse. That may come down to: is that a flat surface or is it water?”

General Dynamics Land System’s most remarkable project in this area is the medium-class combat vehicle known as the Tracked Robot 10-Ton, or TRX, built on technologies proven with the Army’s Small Multipurpose Equipment Transport (SMET) robotic vehicle program. It’s part of the company’s competition entries for the Army’s Robotic Combat Vehicle Program of Learning program. They’re also contributing vehicles in three different size classes as well as the Katalyst open architecture, which includes added mobility, lethality, and survivability functions.

Not all uncrewed vehicles of this ilk are technically autonomous. For example, General Dynamics Land System’s small Multi-Utility Tactical Transport (MUTT) accepted for the Army’s Small Multipurpose Equipment Transport (S-MET) program, has a means of control called the dismount following tether. This is “a Kevlar line connected to sensors on the vehicle that a soldier connects to his or her equipment on their person,” says Ray Moldovan, manager of U.S. business development at General Dynamics. “Based on the soldier’s movement, the system shadows the soldier.”

Similar vehicles may have low-powered remote control and cameras that relay imagery to an operator at a remote location.

For now, TRX hosts U.S. government-owned autonomy software, Moldovan explains, which enables it to do basic tasks like waypoint navigation. The TRX Next Generation Electronic Architecture also will be used eventually for this, as for the other vehicles of this line.

Software development

The speed of software development has had a big impact on projects like these, says Tecos.

“Technology has been going at a very quick clip, and when you look at this evolution, it’s predicated on iterative-type development,” says Tecos. “Very quick software cycles, being able to demonstrate things in a digital environment. Although some of the different sensor types have been out for a while, newer sensors have emerged, and lidar is commonly used. You have to look at the combination. How they’re integrated, when they’re powered on and off has an impact on the mission.”

Military use opens the machinery up to situations industrial machines probably won’t face. “For example, anything that emits power is going to compromise your mission, which means you’re more susceptible to detection by an adversary — as opposed to cameras, that don’t do that,” says Tecos.

So, the algorithms General Dynamics vehicles need must be able to adapt to “degraded” states they might encounter in a dangerous situation, Tecos says.

The industrywide acceleration of changes and improvements in software affects development of this type of vehicle in a major way. Customers in the military electronics industry are asking for designs to be more modular more often than they did one or five years ago, Tecos says.

“That doesn’t mean a huge tech disparity between then and now. However, modular designs are essential now because the ability to adapt and augment quickly, both from software and hardware perspectives, are key,” Tecos says. “That’s because technology is moving so fast. If it’s taking a long time to implement these technologies, that’s going to have an impact on your customer.”

Artificial intelligence

Artificial intelligence (AI) and machine learning also are a big part of developments, and are having a profound impact on this area.

“Obviously, it’s new, but its applicability across all aspects of engineering are very large,” Tecos says. “In our domain its contributions to situation awareness and lethality are continuing to grow at quick paces.”

He also points out that advancements in sensor technologies — namely the ability to detect, monitor and better understand

an environment —is an area in which companies are competing to give military customers an advantage.

“Software’s going to be a key advantage here. Its evolution and new emerging potential are going to be critical. How those can be evaluated and eventually tested on or off platform will be huge contributors.”

Reese of General Dynamics points out that with increased emphasis on software, increased emphasis on cyber security has to go hand-in-hand.

“Cyber obviously is a very important aspect to this,” he says. “It’s not necessarily just running your virus protection, but things about authentication, root and trust, being able to protect your data on the move as well as at rest.”

Another emerging technology that he sees as a strong enabler that will have a larger footprint in the future is Time Sensitive Networking (TSN), a set of standards currently under development in the IEEE 802.1 working group. Customers also are advocating for modular design and open approaches, Reese adds.

All-terrain wheeled mules

With General Dynamics Land Systems autonomous tanks in the testing phase, Reese notes that not all situations call for a walker.

“You can imagine a scenario where only a quadruped could get up or through a piece of terrain, because it’s restricted by trees or steep rock or whatever and that dog-type system would be right to carry gear,” he says. However, “Most of the scenarios the Army is looking to use robots in don’t need that. They need vehicles to carry more gear ... sensors that can operate away from human beings, and operate away from humans but part of a team.”

What do autonomous trucks for the military look like today? While low levels of autonomy and lane keeping enter the consumer car market, it’s been a bit harder to adopt the same to off-road operation or contested territory.

Unmanned ground vehicles (UGVs) have been a staple in the industry for a decade. DARPA sponsored a competition for autonomous vehicles in 2004. In 2013, IEEE posted an article about Lockheed Martin looking for commercial applications for technology developed for MULE, a six-wheeled unmanned vehicle remotely operated using a modified video game controller. This MULE never went into service, and indeed was considered a death knell for the Army’s robot-heavy modernization program at the time. However, there’s still enough momentum around the concept of an autonomous truck for it to be in conversation today.

The new ideal version connects to the Army’s Multi-Domain Operations strategy and adds artificial intelligence to the mix.



The autonomous system Origin prepares for a practice run during the Project Convergence capstone event at Yuma Proving Ground, Ariz.

In turns of purpose, they’re still trying to do the same thing that original DARPA challenge was — to avoid exposing soldiers to improvised explosive devices (IEDs). Other vehicles might be part of manned-unmanned teaming, which is in the field today in the form of drones operating alongside conventional aircraft. This is the direction the Army is pursuing today in regards to putting autonomous vehicles in combat situations.

They’re also looking for trucks that can compensate when humans “may find it challenging to maintain a high level of alertness if they’re driving a combat vehicle across unfamiliar or dangerous terrain,” says an Army announcement regarding the 2020 Artificial Intelligence for Maneuver and Mobility, or AIMM, Essential Research Program. Will today’s software capabilities, from more informed navigational tools to Natural Language Processing controls, be key to the battlefields of tomorrow? Or is this kind of autonomy doomed to remain impractical for a matter of decades?

WHO'S WHO IN AUTONOMOUS LAND VEHICLES

Boston Dynamics

Waltham, Mass.

<https://www.bostondynamics.com>

General Dynamics Land Systems

Sterling Heights Mich.

<https://www.gdls.com>

General Electric Co.

Boston

<https://www.ge.com>

Ghost Robotics Corp.

Philadelphia

<https://www.ghostrobotics.io>

Nvidia Corp.

Santa Clara, Calif.

<https://www.nvidia.com/en-us/>

Robotic Research LLC

Clarksburg, Md.

<https://www.roboticresearch.com>

Dogs and other walkers

Likely the most popularly known company in the field of autonomous walking robots is Boston Dynamics of Waltham, Mass., which failed to secure a permanent military posting with their ‘mule’ vehicle. However, the company is still a good look at which enabling technologies in this area are truly practical and mass producible. Today, Boston Dynamics focuses on industrial and service uses for their four-legged robots. Their robots are still agile and smart, and show a possible parallel path for walking autonomous robots in the commercial space.

The problem with using them for the military? Too loud. That was the verdict of the 2015 experiments with the Legged Squad Support System or LS3, the Marine Corps Warfighting Lab successor to the Boston Dynamics Big Dog (developed with funding from DARPA and the Army Research Laboratory’s RCTA program).

Instead, the company shifted to its smaller Spot robots for industrial use. The newest model, Spot 3.0, boasts flexible autonomy, repeatable data capture, integration with computer vision models, and an expanded Autowalk, the feature that allows operators to program in autonomous missions using dynamic sensing wherever the robot may go.

As far as software, Spot 3.0 enables connection with AWS, Azure, IBM Maximo, and other systems.

A Boston Dynamics spokesperson told Military & Aerospace Electronics that they see legged robots as “coming of age” today. “Quadrupeds are leaving the lab and entering the workplace, and the ongoing labor shortages plaguing many industries has only intensified the need. This year, customers will begin deploying mobile robots like Spot at greater scale across their enterprises.”



Master Sgt. Krystoffer Miller, 325th Security Forces Squadron operations support superintendent, operates a Quad-legged Unmanned Ground Vehicle at Tyndall Air Force Base, Fla.



Sunny, a 325th Security Forces Squadron military working dog, poses next to a Quad-legged Unmanned Ground Vehicle at Tyndall Air Force Base, Fla.

They also question how many projects in this area are practical. “But for industrial mobile robots to expand rapidly at enterprise scale, we also need to see greater reliability from the industry as a whole. We’ve seen a lot of products announced that are conceptual-only or that have only been deployed in small proof-of-concept exercises. As more and more businesses look to invest in real-world technology, the most reliable, robust and accessible products will prevail.”

Weaponized robots

Meanwhile, Ghost Robotics in Philadelphia creates models of a similar size and appearance for military customers. While Boston Dynamics specifies it will not sell weaponized robots, Ghost Robotics has leaned in the opposite direction. Its flagship Quadrupedal Unmanned Ground Vehicle product is the Vision 60, implemented in 2021 as part of a Virtual Security Operations Center project at Tyndall Air Force Base in Florida. Ghost Robotics’ dogs were implemented into existing patrol routes, and were semi-autonomous. An operator looked through the dog’s ‘eyes’ using Immersive Wisdom’s 3D Virtual Ops Center, software designed to provide greater security through use of a virtual reality environment.

“The major selling point of this technology is that it’s meant to be expendable, whereas our Airmen are not,” said Master Sgt. Justin Hanlon, 375th Security Forces Squadron operations non-commissioned officer in charge at Tyndall, in a 2020 press release.

“Instead of using a human being as a sentry, imagine a mobile sensor with a high-definition, wide-angle camera and long-range capabilities being controlled by a trained Airman from the safety and security of a Base Defense Operations Center or a Theatre Operations Center in both a garrison or contested environment,” said Hanlon.

Tyndall Air Force Base was chosen as a testbed for technologies like this in part because of ongoing construction after a hurricane struck it in 2018. This means that the Airmen stationed there could use robotic help and that the reconstruction



As well as advertising the quadrupedal form factor's ability to get up after a fall and/or abrupt change in terrain, they're also banking on the blind-mode operations that give it the semi-autonomy Tyndall was interested in.

Ghost Robotics founder and CEO Jiren Parikh says the animal inspiration for their robots goes as far as feet that can "feel by minute forces that are generated through current changes in the motors." Redundant sensors and this "blind mode" — the ability for the robot to sense its surroundings without sensors in the feet — set it apart, Parikh says.

Vision 60 runs on an NVIDIA Xavier AI GPU with open architecture, and Ghost Robotics notes that along with the differences in leg sensor functionality, their focus on software also sets them apart. The legs operate on "software springs" for more accurate control.

Meanwhile, Boston Dynamics is expanding into more custom robots for industrial use, diversifying from the photogenic 'dogs.' Their representative says they expect to see more walking vehicles as part of 'robot-as-a-service' models in the future.

"We welcome competition, as it validates the market potential of mobile robotic technology. We are encouraged that so many others are now beginning to see the value of mobile robots." ←

can take future technology into account. However, that also means these units are still considered experimental, and may or may not make a mark on the military more widely. A Ghost Robotics canine with a weapons system attached was revealed as recently as the Association of the United States Army's 2021 annual conference, but hasn't been publicly tested in the field, and would likely start out as the kind of semi-autonomous functionality being tested at Tyndall.

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Enabling technologies for image and video processing

The latest high-performance embedded computing image and video processors rely heavily on general-purpose graphics processing units (GPGPUs) to capture as much detail as possible.

BY Jamie Whitney

The U.S. Department of Defense (DOD) has a bevy of technological hardware and software at its disposal to provide warfighters with the most up-to-date intelligence. At the heart of disseminating that information is the ability to process images captured by a range of devices.

Of course, it is necessary to separate actionable intelligence from the digital chaff. Uncrewed vehicles often are at the tip of the spear in aiding data gathering to shield warfighters from harm.

Image processing industry experts note that the DOD is continuing to make significant investments in this sector.

Dan Mor is director of the video and general-purpose computing on graphics processing units (GPGPU) division at Aitech Defense Systems Inc. in Chatsworth, Calif. He says that many market researchers believe that artificial intelligence (AI) and image processing in the military and aerospace industry is anticipated to “register significant market growth during through 2025.” This growth, Mor says, is driven by the usefulness shown by AI and image processing.

“Systems powered by AI can perform many tasks, such as object recognition, classification, making conclusions and predictions, that not long ago were assumed to require human cognition, Mor says. “And, as AI’s capabilities have

dramatically expanded, we have seen a growing number of use cases in different fields, including the defense and space market.

“Much of this stems from the increased interest seen in these market studies, driven by recent trends of using robotics in the defense and space industry as well as the integration of AI in avionics, ground mobile and ground fix platforms, Mor continues. “The implementation of AI and the changing conventional weapon to ‘smart’ battlefields that better utilize imaging and

graphic data will enhance the performance of existing platforms of armed forces around the world. We’re seeing a significant growth in GPGPU-based processing platforms that are enabling AI performance to the edge. This is a huge leap forward in the realm of image processing, as networks and capture points become more diverse both in location and type of inputs.”

Open architecture

The DOD has long been pushing for vendor-agnostic components

through open-systems standards programs and design approaches like Sensor Open Systems Architecture (SOSA) and Modular Open Systems Approach (MOSA).

Image processing hardware — like nearly everything under the purview of the DOD — has a focus on using commercial off-the-shelf (COTS) components to reduce cost and enable technicians to replace parts or upgrade equipment.



▲ **The Curtiss-Wright GDVU ground vehicle displays follow an open modular approach and are focused on the use of ruggedized consumer technologies to give the familiarity of the latest smart devices in today’s military systems.**



Low PIM Rated Sub 6 Ghz 5G Antennas

In-building distributed networks and outdoor wireless networks call for robust antennas that offer wide bandwidth coverage, low PIM ratings as well as MIMO and SISO technology support.

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“The defense and space markets are always looking for small form factor (SFF) and size, weight and power (SWaP) or size, weight, power and cost (SWaP-C) optimized systems, so we, as an industry, need to be developing critical rugged AI GPGPU systems for these market verticals,” Mor says.

Overlapping needs

For many people, the phrase “metaverse” may have been learned when Facebook founder Mark Zuckerberg announced that the social network would be jumping into that space with both feet. The metaverse is a 3D space that enables people from all over the world to socialize, collaborate, learn, and more. The military is also going “meta” as well, says Ike Song, president and general manager of strategy at the Mercury Systems mission systems segment in Andover, Mass.

“The military is trying to have its own version of the metaverse, whether it’s a distributed interactive simulation, (or) live virtual (reality),” Song says.

Song explains that the Army is undertaking a way for soldiers to use technology in a single platform in which they can not only train and rehearse but fight as well.

One system, called the Integrated Visual Augmentation System (IVAS), provides visual intelligence directly to soldier via augmented reality (AR) goggles. In addition, the IVAS system connects the ground-based soldiers with crews in vehicles like Strykers and Bradley Fighting Vehicles.

▲ **A U.S. Army soldier tests a Microsoft-designed prototype goggle, the Integrated Visual Augmentation System (IVAS).**

“Up until this point IVAS has really been focused on the dismounted Soldiers and getting that fighting goggle right,” Army Major Kevin Smith, C5ISR Night Vision and Electronic Sensors Direction (NVESD) Research and Development Coordinator and PM IVAS Platform Integration Directly Responsible Individual (DRI) said in 2021. “So, in parallel, we in the Night Vision Electronic Sensors Directorate have been working to build-in applications to leverage both new and existing sensors on the vehicles to give the Soldier not just enhanced visual situational awareness, but also C2 [Command and Control] situational awareness while they’re inside of a platform or vehicle.”

On the screen

Whether in a soldier’s goggles, on a ship, or in the sky, actionable intelligence must be disseminated to a commander or to the warfighter directly.

“Future technologies like AR [augmented reality] could facilitate the ability for remote users to have the views and situational awareness of a manned vehicle while operating from the safety of a hardened remote position,” says Richard Pollard, a senior product manager at Curtiss-Wright Corp. in Davidson, N.C. “The same technologies used in AR solutions will also facilitate sharing of unmanned system video more easily to multiple users locally and globally. Each system could become a mobile situational awareness node giving total coverage of a combat area.”

Digital displays across the board have increased fidelity while dropping in price over the past two decades. Mercury's Song notes that consumer products like televisions have gotten much larger than previous decades. That, and comfort and familiarity with personal devices that have screens — touch and otherwise — has been utilized by military technology as well.

"The emergence of ruggedized commercial HMI [human machine interface] technologies that today's operators are already familiar with from their smart phones and tablets being used in rugged display solutions gives any user the feeling of immediate familiarity with their vehicles systems," Curtiss-Wright's Pollard says. "This reduces training burden and lowers cognitive load allowing the operator to deploy more quickly and focus on the mission instead of operating their equipment."

Reducing risk

Image processing can result in a deluge of raw data — the majority of which may prove unactionable. Aitech's Mor notes that uncrewed systems like UAVs and remotely controlled robots can take humans out of the line of fire, but technology can also reduce the strain of image analyzing.

"Today's unmanned battlefields involve complex image processing, AI and video analytics. These processes include, but are not limited to image classification, image location and image segmentation," says Mor. "Let's examine a use case of bringing AI to the defense drone industry. Drones are used for intelligence, surveillance and reconnaissance. Usually drones record many hours of footage every mission—video footage that takes a long time for human analysts to analyze. While human analysts process footage, the ground situation may change, and a latency between analyzed footage and real-time battle conditions is presented.

Mor continues, "AI technology (deep learning process) enables the processing of much more data within the same timeframe, which will bring situational awareness to 'near real time' status. But it needs to be rugged and it needs to be reliable. Being able to use GPGPU-AI-based systems in the harshest environments gives system engineers the ability to forge new ground in rugged embedded computing. Aitech is focused on delivering this exceptional technology to our military, defense and space customers to use in their applications worldwide."

Mor says that image classification, location, and segmentation are "perfect candidates for deploying NVIDIA deep learning inference networks, which can benefit from hundreds of parallel CUDA cores calculations."

The DOD may be aiming to reduce the risk humans face on the battlefield with autonomous systems that can operate independently. Mercury's Song says fully-autonomous systems may be commonplace in the battlefield of the future, but humans will remain in the loop in the meantime. In addition, Song says that commercial applications like urban air mobility (UAM) in electric vertical takeoff and landing (eVTOL) may help shape military technology.

"It's kind of interesting that they want to go full autonomous, but I don't think they could get there very quickly," Song says of military technology aspirations. "I think all the projections that they're going to go to autonomous is going to take a while. Meanwhile, it's going to be semi-autonomous. So again, you need a very unique display requirement to ensure that the pilot can see. But even if it's fully autonomous, I do think that you need to have passengers seeing what's going on around the aircraft. So situational awareness is going to be very important to that. So there's a lot of things going on the commercial side, which I think is going to take over the investment of the military side, whether it's the display or the sensor fusion. So, things that the military have been trying to do for UAVs is 'sense and avoid.' But I think when it's the UAM that does this, they have to resolve 'sense and avoid,' even if it goes to a very simple semi-autonomous piloting. So, I think those are the two major commercial trends that's going to flow over to military."



The Aitech A179 ultra-small-form-factor GPGPU AI supercomputer enables flexible I/O and video capture to simultaneously manage multiple data and graphics streams.

In the field

Aitech's Mor says that his company's A179 ultra-small-form-factor GPGPU AI supercomputer enables flexible I/O and video capture to manage multiple data and graphics streams simultaneously. The A179 Lightning is a ruggedized, fanless computer that is roughly the size of a cell phone. The A179 is powered by NVIDIA Jetson Xavier NX based on the Volta GPU,

which has as many as 384 CUDA cores and 48 Tensor cores.

Video capture is enabled with several input types that can use multiple video streams simultaneously. These include SDI (SD/HD), four FPD-Link III (to MIPI CSI) camera inputs and eight composite (NTSC/PAL) channels.

Standard I/O ports, such as Gigabit Ethernet, USB 3.0 and 2.0, DVI/HDMI out, CANbus, UART Serial and a number for discretes, offer flexibility in data management. The system also accommodates as many as two optional expansion modules (via factory configuration), such as additional I/O expansion modules or an optional NVMe SSD. The system allows for a removable Micro SD card and features 8 GB of LPDDR4x.

Curtiss-Wright's Pollard says his company's ruggedized vehicle displays "follow an open modular approach and are focused on the use of ruggedized consumer technologies to give the familiarity of the latest smart devices in today's military systems."

The GVDU rugged touchscreen displays are "plug and play" with most PCs, and the smartphone-like USB HID projective capacitive (PCAP) touchscreen allows wet and gloved fingers to operate it. The display is ruggedized to military standards like MIL-STD-810G, MIL-STD-461F, and MIL-STD-1275E.

Unlike smart phones, however, the GVDU is designed to be washed down. GVDU displays show clear, high-resolution images,



The Mercury new 6U OpenVPX use the latest Intel Xeon D-1700 processors, which were formally code named Ice Lake D.

even outdoors in high brightness light conditions, without reflections. The multi-touch touchscreen can be used in the rain and while wearing thick gloves.

The Curtiss-Wright GVDU's internal embedded processor supports an enhanced set of data interfaces, including Ethernet, USB, RS-232/RS-422, and GPIO. The internal processor provides graphics input to the displays and receives all touchscreen

and bezel button operations. The processor may be used to implement a map display, and function as a mission computer.

The GVDU military rugged displays are available in several sizes, including 10.4-inch, 12.1-inch, and 15.6-inch. Contact the factory for larger sizes, such as 17.3-inch and 21.5-inch. These SWaP-optimized displays are qualified by independent, accredited test facilities for compliance with industry standards.

Late last month, Mercury Systems announced 6U OpenVPX avionics embedded computing modules. Mercury officials say their company's modules are the first safety-certifiable multi-core modules to use the latest Intel Xeon D-1700 processors, which were formerly code named Ice Lake D.

The modular, open system architecture design approach leverages BuiltSAFE elements with dual Xilinx Virtex UltraScale+ XCVU9P FPGAs, which have a reconfigurable framework to support real-time algorithms. There are PCI Express 3.0 interconnects and integrated 40 gigabit-per-second Ethernet.

The board supports packages such as VxWorks to achieve FAA CAST-32A objectives. The modules feature commercial-off-the-shelf (COTS) elements complete with hardware and software DO-254 and DO-178 artifacts to deliver performance and streamline subsystem development, integration and deployment. ←

WHO'S WHO IN DIGITAL IMAGE PROCESSING

Abaco Systems

Huntsville, Ala.
www.abaco.com

Aitech Defense Systems Inc.

Chatsworth, Calif.
www.rugged.com

Curtiss-Wright Defense Solutions

Ashburn, Va.
www.curtisswrightds.com

Combat Proven Technologies (CP Tech)

San Diego
<https://cp-techusa.com>

Core Systems

Poway, Calif.
<https://core-systems.com>

Crystal Group Inc.

Hiawatha, Iowa
www.crystalrugged.com

Extreme Engineering Solutions (X-ES)

Verona, Wis.
www.xes-inc.com

Mercury Systems

Andover, Mass.
www.mrcy.com

PacStar, a Curtiss-Wright company

Portland, Ore.
<https://pacstar.com>

Panasonic Corporation of North America

Newark N.J.
<https://na.panasonic.com/us>

Pixus Technologies Inc.

Waterloo, Ontario
www.pixustechnologies.com

Systel Inc.

Sugar Land, Texas
www.systelusa.com

Teledyne FLIR

Wilsonville, Ore.
www.flir.com



Industry asked for ways to enhance high-resolution synthetic aperture radar (SAR) images

BY John Keller

ARLINGTON, Va. — U.S. military researchers have briefed industry on the upcoming Fiddler program (DARPA-SN-22-23) to improve automatic object recognition in synthetic aperture radar (SAR) images.

Commercial and government investments are leading to rapid growth in Earth-observation satellites and remote-sensing data, DARPA researchers say. In particular SAR can produce high-resolution images of the Earth at night and in all-weather conditions.

This unique imaging capability makes SAR particularly useful for time-critical applications like change-detection after natural disasters and identifying illegal fishing operations.

The objective of the Fiddler program is to improve automatic object recognition in SAR images. Object recognition often requires significant examples to train machine learning classification algorithms. Obtaining training data can be time

▲ **The DARPA Fiddler program seeks to produce high-resolution images of the Earth at night and in all-weather conditions.**

consuming, expensive, and even impossible in dynamic conditions.

The use of machine learning and computer vision methods to generate training data in dynamic maritime environments is of particular interest to this program.

Performers first will develop ways to create object reference models directly from real SAR image examples. From these models, they will develop how to generate or render synthetic SAR images of the object at new imaging geometries and configurations.

Performers then will demonstrate generation of diverse training data to train robust SAR object detection methods rapidly from few real examples. ◀

Email questions or concerns to Kevin Rudd, the DARPA Fiddler program manager, at HR001122S0016@darpa.mil. More information is online at <https://sam.gov/opp/94f14230d6424489a5839383e6833d24/view>.

Military to build compound semiconductor fabrication for RF and microwave chips

BY John Keller

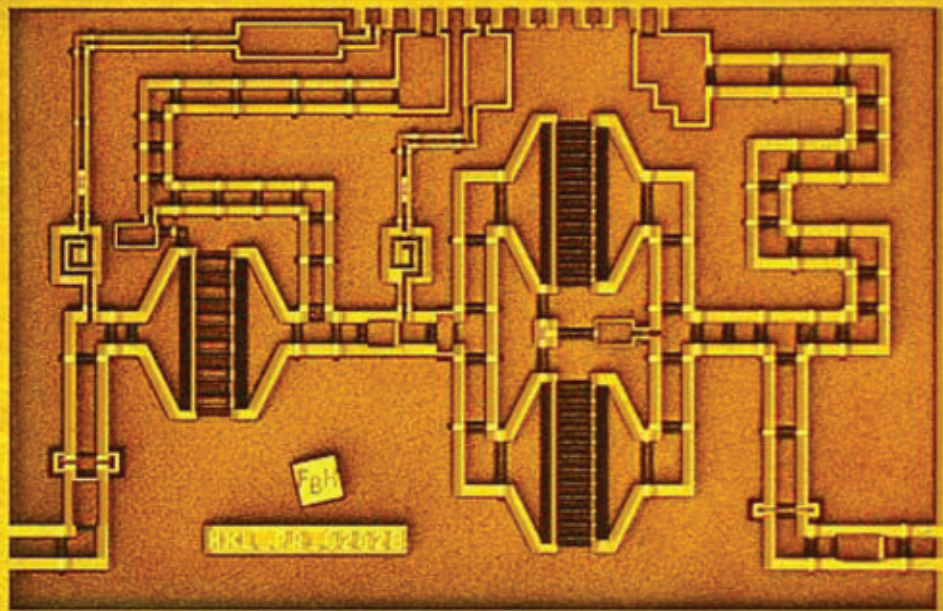
CONCORD, Mass. — U.S. military microelectronics experts plan to build a 161,000-square-foot advanced compound semiconductor laboratory and microelectronics integration facility for multi-wavelength sources, large-format multi-wavelength detector arrays, RF and microwave electronics, high-power electron-

The compound semiconductor facility at Hanscom Air Force Base will consist of new laboratory and office space with a cleanroom complex for use by the Lincoln Lab Advanced Technologies Division.

The facility will have about 90,000 square feet of cleanrooms; 52,638 square feet of microsystem integration cleanrooms; 12,000 square feet of building support; and 7,000 square feet of physical plant.

The intent is to consolidate Lincoln Lab's existing compound semiconductor materials growth, fabrication, and characterization facilities to enable multi-wavelength sources, large-format multi-wavelength detector arrays, radio frequency electronics, high-power electronics, and integrated photonics fabrication and packaging of specialized advanced electronic prototypes.

The new facility will be three stories high and will include large and sophisticated cleanrooms for microprocessor development and experimentation; complex heating, cooling, and electrical



Military experts will build a 161,000-square-foot advanced compound semiconductor laboratory and microelectronics integration facility for RF and microwave electronics at Hanscom Air Force Base, Mass.

ics, and integrated photonics.

The new microelectronics facility will be at Hanscom Air Force Base in Bedford, Mass., and is to enable the Massachusetts Institute of Technology Lincoln Laboratory to apply advanced technology to problems of national security.

Officials of the U.S. Army Corps of Engineers New England District in Concord, Mass., announced a \$278.6 million contract to the Gilbane-Exyte joint venture in Providence, R.I., to build an advanced compound semiconductor laboratory and microsystems integration facility at Hanscom Air Force Base.

systems; secure communications areas; places for hazardous, toxic, and corrosive process liquid and gas; transport, distribution and waste collection systems; and a foundation that minimizes vibration and noise. ←

In addition, the facility will have new will have new access roads, replacement parking, utilities, and landscaping. For more information contact Gilbane Building Co. online at www.gilbaneco.com, MIT Lincoln Laboratory at www.ll.mit.edu, or the Army Corps of Engineers New England District at www.nae.usace.army.mil.

Raytheon to build five Next Generation Jammer midband (NGJ-MB) EW avionics systems

BY John Keller

PATUXENT RIVER NAS, Md. – Airborne electronic warfare (EW) experts at Raytheon Technologies Corp. will build five advanced electronic jammers for U.S. Navy EA-18G Growler EW jets under terms of a \$226.7 million order.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Raytheon Intelligence and Space segment in El Segundo, Calif., to build five Next Generation Jammer-midband (NGJ-MB) low-rate initial production lot-II ship sets.

The NGJ midband is an advanced electronic attack system that denies, disrupts, and degrades enemy communications and air-defense radar systems. It is built with a combination of agile active electronically scanned arrays (AESA) and an all-digital back end.

The NGJ-MB helps the Growler aircraft operate at long ranges, attack several different targets simultaneously, use advanced electronic jamming techniques, and incorporate rapid upgrades through a modular, open-systems architecture.

Raytheon delivered the first NGJ-MB pod to the Navy for testing in July 2019. The technology also can be scaled to other missions and aircraft.

The NGJ is a tactical electronic jammer pod that replaces the 40-plus-year ALQ-99 jammer system on the EA-18G — a version of the Navy's carrier-based two-seat F/A-18F Super Hornet jet fighter-bomber that is modified specially for electronic warfare.

The EA-18G leads an airborne attack by disrupting enemy radar, communications, and computer networks with jamming signals and computer viruses. The aircraft also can destroy enemy radar installations with its AGM-88 High-speed Anti-Radiation Missiles (HARM).

Raytheon's NGJ will integrate the most advanced electronic attack technology into the EA-18G, such as high-powered,

agile beam-jamming techniques, and solid-state electronics to deny, degrade and disrupt enemy threats while protecting U.S. and coalition forces.

Raytheon's NGJ will provide airborne electronic attack and jamming capabilities, and will include cyber-attack capabilities that use the aircraft's active electronically scanned array (AESA) radar to insert tailored data streams into enemy radar and communications systems.



The NGJ midband is an advanced electronic attack system that denies, disrupts, and degrades enemy communications and air-defense radar systems.

The NGJ also will have an open-systems architecture for future upgrades. Raytheon will use its gallium nitride (GaN)-based AESA technologies for the NGJ design.

Eventually Raytheon engineers may modify the NGJ to install it aboard the F-35 joint strike fighter, unmanned aerial vehicles (UAVs), as well as to other manned aircraft in addition to the EA-18G.

The goal of the NGJ technology-development phase is to develop an electronic attack system that will improve airborne

electronic attack capabilities against advanced threats through enhanced agility and precision within jamming assignments, increased interoperability, and expanded broadband capability for greater threat coverage against a wide variety of radio frequency emitters, Navy officials say.

The Navy also is developing the Next Generation Jammer Low Band (NGJ-LB) in an urgent effort to develop low-band tactical radar jammers using existing technologies for low size, weight, and power consumption (SWaP) applications on the EA-18G Growler EW jet.

L3Harris Technologies in Melbourne, Fla., won a contract in late 2020 to design and build the NGJ-LB, which experts say will be useful in jamming low-band radar systems

design to detect stealth aircraft like the F-35 joint strike fighter. The NGJ-LB transmitter will fit in a pod on Station 6 of the EA-18G.

The system will enhance the performance of frequency coverage, effective isotropic radiated power, spatial coverage, spectral purity, and polarization; obtain existing contractor data related to transmitter group performance; and assess the potential to deploy an open-systems interim pod solution rapidly. ◀

On this contract Raytheon will do the work in Forest, Miss.; McKinney, Texas; and El Segundo, Calif., and should be finished by September 2024. For more information contact Raytheon Intelligence and Space online at www.rtx.com, or Naval Air Systems Command at www.navair.navy.mil.

U.S. Navy's new shipboard EW system is being shrunk down to fit inside smaller ships

Northrop Grumman is pushing ahead with plans to develop a lightweight version of the AN/SLQ-32(V)7 Surface Electronic Warfare Improvement Program (SEWIP) Block III for the U.S. Navy. This shrunk-down version of the system could give smaller vessels a cutting-edge suite of electronic warfare (EW) capabilities — one that not only can provide advanced passive detection of RF threats but also make precise and potent electronic attacks on several different targets simultaneously. The types of capabilities offered by SEWIP Block III Lite could be a game-changer for responding to threats from anti-ship missiles, unmanned aerial vehicles (UAVs), marauding aircraft, other ships, and more. It also could provide a secondary shipboard multi-mode radar and high-bandwidth communications capability. Advanced SEWIP systems also can be networked together with SEWIP systems on other ships, as well as space-based nodes and airborne sensors.

Vector network analyzers for mobile radio introduced by Rhode & Schwarz

Rohde & Schwarz in Munich is introducing four R&S ZNL and R&S ZNLE vector network analyzers for mobile radio and wireless local-area network (LAN) applications. The test instruments are intended for automated testing, production, service lab, and education uses. The R&S ZNL14, R&S ZNL20, R&S ZNLE14, and R&S ZNLE18 economy vector network analyzers have the frequency range necessary to investigate even third harmonics for 5 GHz and 6 GHz band technologies, and can support as many as 20 GHz of operation frequency. The time-domain and distance-to-fault analysis options available in the lower frequency models are

for signal and power integrity applications as well as cable and filter testing. These test and measurement devices have two-port network analysis for component S-parameters from 5 kHz to 14 GHz, and 5 kHz to 20 GHz, and have two-port network analysis for S-parameters from 100 kHz to 14 GHz, and 100 kHz to 18 GHz (20 GHz in overrange). The latest firmware release for these vector network analyzers also includes an option that provides lower frequency R&S ZNL models with an internal continuous-wave (CW) signal generator. The light weight and small form factor make it easy to move the devices between test stations or labs. The ZNL also comes with an optional battery pack for field use. Users just push a button to switch on the instrument and start measuring with their ZNL or ZNLE. No external monitors, notebooks or additional software installations are needed. For more information contact Rohde & Schwarz online at www.rohde-schwarz.com.

Feed-through terminations to match RF and microwave and power offered by BroadWave

BroadWave Technologies Inc. in Greenwood, Ind., is introducing the model 894-326-FTT feed-through terminations to match RF components with high-impedance test and measurement equipment such as an oscilloscope. The model 894-326-FTT is a 600 Ohm device operating from DC to 1000 MHz. This unit exhibits 1.20:1 maximum voltage standing wave ratio (VSWR), is rated 5-Watts average power, and has a BNC male / BNC female connector configuration. Type N, SMA, and TNC test and measurement connector configurations, as well as custom impedances, are available for these feed-through terminations. For more information contact BroadWave Technologies online at www.broadwavetechnologies.com. ◀



Army asks AeroVironment to provide small long-endurance surveillance unmanned aircraft

BY John Keller

REDSTONE ARSENAL, Ala. – U.S. Army unmanned aerial vehicle (UAV) experts needed long-range small unmanned aircraft for Kosovo that warfighters can launch by hand in the field. They found their solution from AeroVironment Inc. in Simi Valley, Calif.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced an \$11 million contract to AeroVironment for the RQ-20 Puma Long-Endurance (LE) unmanned aircraft system for surveillance missions.

Puma LE is a ultra-lightweight group 2 aircraft that is launchable by hand or by bungee, and provides flight endurance of as long as 6.5 hours.

This represent Group 2 capabilities in a Group 1 footprint while stowed in a two-case mission packout, company officials say. The Puma UAV weighs 23.5 pounds. The Puma's secondary

payload bay offers dedicated power and Ethernet wireless connectivity, providing 3.4 pounds of payload capacity.

The hand-launched Puma LE can operate in all environments and provides an operational range of 37.3 miles over land and water when used with the AeroVironment long-range

tracking antenna.

Operators can swap between Mantis i45 and the optional Mantis i45 N for day and nighttime operations. Its plug-and-play, interoperable line-replaceable unit (LRU) components can be shared across other Puma all-environment (AE) aircraft. ◀

▲ **Puma LE is an ultra-lightweight group 2 unmanned aircraft that is launchable by hand or by bungee.**

On this contract AeroVironment will do the work in Simi Valley, Calif., and should be finished by 25 Jan. 2022. For more information contact AeroVironment online at www.avinc.com, or the Army Contracting Command-Redstone at <https://acc.army.mil/contractingcenters/acc-rsa>.

Unmanned F-16D jet fighter to boost trust in AI as a partner for humans

BY John Keller

ARLINGTON, Va. – U.S. military researchers are moving forward on a project that relies heavily on artificial intelligence (AI) and machine autonomy in complex air combat maneuvering that involves manned aircraft and combat unmanned aerial vehicles (UAVs).

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a solicitation (HR001122S0015) for the Air Combat Evolution (ACE) Full-Scale Aircraft TA-4 project, which seeks to increase trust in combat autonomy using human-machine collaboration in aircraft dogfighting.

After a successful first phase, the ACE program has entered its second phase. This solicitation asks industry for propos-

ACE is applying existing AI technologies to aircraft dogfighting in experiments of increasing realism, and is developing ways to measure, calibrate, increase, and predict human trust in combat autonomy performance.

The program is scaling machine automation in aircraft dogfighting to more complex, heterogeneous, multi-aircraft, operational level simulated scenarios informed by live data. These scenarios are expected to lay the groundwork for future live, campaign-level experiments.

The idea is to enable one human pilot to become a more deadly warfighter by leading several semi-autonomous artificially intelligent unmanned aircraft, all from his own cockpit. This would shift the human role from sole operator to system mission commander.

In particular, ACE aims to enable a pilot to handle a broad, global air command mission while his aircraft and unmanned aircraft team members attack enemy aircraft and ground targets.

ACE would have the human pilot handle complicated jobs like developing an overall engagement strategy, selecting targets, and choosing weapons, and enable the combat UAVs to handle aircraft maneuver and engagement tactics.

To achieve this, however, the human pilot must be able to trust his unmanned wingmen to conduct complex tactics in scenarios like dogfights where adversaries are within visual range.

The primary objective of this solicitation is to develop full-scale experimental aircraft that can implement the ACE algorithms and technologies, including human machine interfaces (HMIs), generated by other ACE contractors.

The company chosen will modify and test two F-16D aircraft jet fighters to accept within-visual-range autonomy algorithms developed previously, and provide appropriate interfaces to integrate previously developed human-machine interfaces, safety pilot overrides, and a paddle off/on disconnect enable live within-visual-range engagements. ←

Companies interested should upload unclassified proposals no later than 18 March 2022 to the DARPA BAA website at <https://baa.darpa.mil>. Classified proposals require special handling. Email questions or concerns to DARPA at HR001122S0015@darpa.mil. More information is online at <https://sam.gov/opp/a663ea810a3e4386ac3f0c09a78ccbd5/view>.



The Air Combat Evolution (ACE) Full-Scale Aircraft TA-4 project seeks to increase trust in combat autonomy using human-machine collaboration in aircraft dogfighting.

als to convert existing F-16 aircraft into human-in-the-loop, safety-sandboxed testbed aircraft to support autonomy development and experimentation.

The solicitation involves technology areas that call for additional aircraft hardware and additional aircraft mission systems software integration to support autonomous within-visual-range maneuvering and trust research in the ACE program.

The additional aircraft options will support ACE as well as a wider range of autonomy development needs. The ACE project also will develop enabling technologies to enhance collaboration among humans and unmanned combat aircraft in a variety of combat scenarios.

DARPA tasks Northrop Grumman with developing prototype AI assistant for rotorcraft

BY Jamie Whitney

BALTIMORE - The Defense Advanced Research Projects Agency (DARPA) has awarded a contract to Northrop Grumman Corp. Mission Systems segment in Baltimore to develop a prototype artificial intelligence (AI) assistant for UH-60 Black Hawk helicopter pilots.

The prototype will be embedded in an augmented reality (AR) headset to help rotary pilots perform expected and unexpected tasks. Rotorcraft aircrews face numerous demands particularly when flying in close proximity to buildings, terrain, people and from the threat of adversary radar systems.

Today, simple warning systems are the most common means for aiding a rotorcraft aircrew, such as auditory alerts to increase altitude. These warning systems are limiting and can induce unanticipated cognitive burdens on pilots.

Studies have shown that inattentional blindness to such warnings can occur, often making them ineffective for the aircrew.

DARPA's Perceptually enabled Task Guidance (PTG) program aims to develop AI technologies to help users perform complex mental and physical tasks.

The goal is to provide users of PTG AI assistants with wearable sensors that allow the assistant to observe what the user perceives and know what the user knows.

Using advanced information processing and an AR interface, the goal of the program is to have the AI assistant provide feedback and guidance through speech and aligned graphics at the right place and time to augment the aircrew.

"The goal of this prototype is to broaden a pilot's skill-set," says Erin Cherry, senior autonomy program manager, Northrop Grumman. "It will help teach new tasks, aide in the recognition and reduction of errors, improve task completion time, and most importantly, help to prevent catastrophic events." ◀

In addition to a long service life in the U.S. and allied militaries, a civilian version of the venerable Black Hawk also is available. For more information contact Northrop Grumman Mission Systems online at <https://www.northrop-grumman.com/who-we-are/business-sectors/mission-systems/>, or DARPA at <https://www.darpa.mil/program/perceptually-enabled-task-guidance>.



DARPA's Perceptually enabled Task Guidance (PTG) program aims to develop AI technologies to help users perform complex mental and physical tasks.

Navy emphasizing unmanned surface vessels (USVs) and AI in Middle East

U.S. Navy leaders are emphasizing unmanned surface vessels (USVs) in their testbed effort for new platforms operating in U.S. Central Command, says Vice Adm. Brad Cooper, commander of the U.S. 5th Fleet in Manama, Bahrain. The International Maritime Exercise 22 builds on a special unmanned group that has been operating in the 5th Fleet since September. Ten of 60 nations are bringing autonomous surface vessels to the exercise in what will be the largest unmanned exercise in the world. Task Force 59, created last year to help the Navy expand its unmanned systems testing, quickly evolved into working with regional partners — first with Bahrain, and then Jordan. Ten of those nations are bringing unmanned platforms. It'll be the largest unmanned exercise in the world," Cooper, the commander of 5th Fleet, said at an event co-hosted by the Center for Strategic and International Studies and the U.S. Naval Institute. Task Force 59, created last year to help the Navy expand its unmanned systems testing across domains, quickly evolved into working with regional partners — first with Bahrain, and then Jordan. "We're taking off-the-shelf emerging technology in unmanned, coupling with artificial intelligence (AI) and machine learning, in really moving at pace to bring new capabilities to the region," Cooper says. ◀



Researchers ask industry to develop high-energy sources for laser weapons

BY John Keller

ARLINGTON, Va. — U.S. military researchers are asking industry to develop affordable high-energy laser sources for future laser weapons that can destroy or disable enemy unmanned aerial vehicles (UAVs).

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a broad agency announcement (HR001122S0017) for the Modular Efficient Laser Technology (MELT) program.

MELT seeks to develop a compact, scalable, actively coherently beam combined semiconductor laser source with excellent beam quality to create a mass-producible, low size, weight, and power (SWaP) scalable laser source.

MELT aims to capitalize on technologies such as semiconductor fabrication techniques, coherent beam combining, photonic integration, and 3D integration and packaging.

▲ **The MELT project seeks to develop a compact, scalable, actively coherently beam combined semiconductor laser source with excellent beam quality.**

Today's laser weapons that use multiple beam-combined high-power fiber amplifiers as the high-energy laser sources, as well as large complex optical subsystems that condition and project the laser beam

do not scale well, DARPA researchers say.

On the other hand, coherent beam combined tiled array high-energy laser sources are scalable because they eliminate these large subsystems.

Coherently beam combined tiled arrays offer a path to better high-energy laser sources because of the ability to generate and project the laser beam directly without bulk optics; the intrinsic scalability of a tiled array with no inherent limits; the ability to perform non-mechanical beam steering for beam jitter corrections; and the ability to apply complex phase corrections to compensate for atmospheric disturbances.

The proliferation of small, low-cost unmanned aerial vehicles (UAVs) on the battlefield requires a layered defense that includes low-cost laser weapons. The deep magazines of laser weapons are suited to counter swarms of hostile UAVs, and have the potential to achieve very low operating cost — assuming low production costs can be achieved. Counter-UAV and similar applications need a broad range of power levels from a few kilowatts to megawatts, which isn't possible today.

Instead, MELT seeks to develop a laser tile as the building block for compact, scalable, panelized laser weapons. The laser tiles will integrate into planar arrays for scalable laser weapons with comparable or better performance than current laser weapons.

MELT seeks to demonstrate a 3-by-3 panelized array of laser tiles with excellent beam quality as a scalable high-energy laser source.

The mass, volume, and size goals for the laser tiles and panelized array of laser tiles include the semiconductor amplifier emitters, optics, phase sensing and control, power delivery, power conversion, thermal dissipation, computing, external connections, inter-tile electrical, coolant, and data connections.

Each MELT tile will contain a 2D array of laser emitters whose phase can be sensed and controlled continuously to achieve coherent beam combination. For scalable output power, several to several hundred of these tiles may be arranged as a panelized, gimbal-mounted laser weapon source that produces a usable output beam.

The DARPA MELT project has three technical challenges: a dense planar tiled array of amplifiers with uniform spacing and emission normal to the 2D surface; realizing a scalable phase sensing architecture for a panelized high-energy laser source; and realizing a compact scalable cooling solution to remove the anticipated thermal load from a panelized high-energy laser source.

The MELT program will be a five-year \$60 million program. All proposals in response to this BAA must address all three phases.

The goal of this program is to develop a mass-producible, low SWaP, scalable laser source. This will require the development of a new type of high-energy laser source. The MELT program is interested only in semiconductor diode-based laser technologies that do not include optically pumped brightness converters.

Companies interested were asked to upload abstracts by 7 March 2022, and full proposals no later than 2 May 2022 to the DARPA BAA website at <https://baa.darpa.mil>. ←

Email questions or concerns to Thomas Ehrenreich, the DARPA MELT program manager, at HR001122S0017@darpa.mil. More information is online at <https://sam.gov/opp/11dc6b43a8ef4723ae5e004c29537c99/view>.

Future military satellites will offer arrays of sensors and weapons for hypersonic missile defense

China, Russia and the United States all are revisiting space-based missile defense and anti-satellite weapons to counter rapidly developing and proliferating hypersonic missiles, a great power contest that promises to accelerate the militarization of outer space. Space-based systems add another layer to existing missile defenses and most likely would focus on intercepting missiles during the early stages of their powered boost phase. Armed satellites can attack enemy satellites in several ways, including through physical attacks, directed energy or conventional weapons, electronic warfare, chemical sprays or even direct collision. In January, China's Shijian-21 satellite used a robotic arm to pull a dead Beidou satellite out of its normal geosynchronous orbit and place it into a distant graveyard orbit designated for satellites nearing the end of their operational lives.

Navy enhancing sensors, navigation, and autonomy for unmanned submarines

Huntington Ingalls Industries (HII) is widely known for its work on large warships and submarines. But the firm has also been designing and producing underwater drones to the Navy for many years now. It performed the first ever submarine-launched unmanned undersea vehicle in 2015. The REMUS drone was a milestone in undersea warfare history. The Navy is pursuing a wide range of unmanned systems including small, medium, large, and extra-large undersea UUVs, unmanned surface vessels, and unmanned aircraft. Most of all, the Navy is working to network all of them together.

Russian MiG-41 stealth jet fighter may be able to shoot down incoming hypersonic missiles

In the technology world, the term "vaporware" refers to a product that is not yet available and remains largely in the concept stage — it also often is something that fails to materialize and never makes it to market. Russia's MiG-41 stealth interceptor seems to fall into the category of military vaporware. Since being announced back in 2018, a few details have emerged about the MiG-41 jet fighter, including that it would be equipped with a ramjet or turboramjet engine and would use stealth technology and be capable of reaching a speed of Mach 4 to 4.3, while some reports suggest it could even reach Mach 5. ←

Northrop Grumman to build Marine Corps NGHTS handheld laser target designation system

BY John Keller

QUANTICO, Va. – Electro-optical targeting systems experts from the U.S. Marine Corps needed a portable system to help Marines acquire targets quickly on the battlefield. They found their solution from the Northrop Grumman Mission Systems segment in Apopka, Fla.

Officials of the Marine Corps Systems Command at Quantico Marine Base, Va., announced a \$252 million eight-year contract to Northrop Grumman for the Next Generation Targeting Handheld System (NGHTS).

NGHTS is a lightweight man-portable system that enables Marines to acquire targets quickly; perform guidance against targets; and generate target location data during combat operations. NGHTS will combine target location, laser spot imaging, and laser target designation.

The contract includes low-rate initial production, full-rate production, testing, spare parts, engineering services, logistics support, training, and documentation.

The Marines today use four legacy systems: the Portable Lightweight Designator Rangefinder, Joint Terminal Attack Controller, Laser Target Designator and Thermal Laser Spot Imager. The intent is for NGHTS to replace all four systems.

The NGHTS handheld targeting system will combine all of the legacy capabilities into one system that is compatible with current and future fire-support systems, and will support the Marine Corps for the next 15 to 20 years. NGHTS will reduce the weight of Marine Corps laser designation and laser spot imaging capability by 60 percent, experts say.

In December 2018 the Marine Corps awarded four other transaction authorities (OTAs) to BAE Systems, Elbit Systems of America, Fraser Optics, and Northrop Grumman for the first phase of the NGHTS program. The OTAs were to evaluate contractor ability to produce NGHTS, and gain insights into the best possible system.

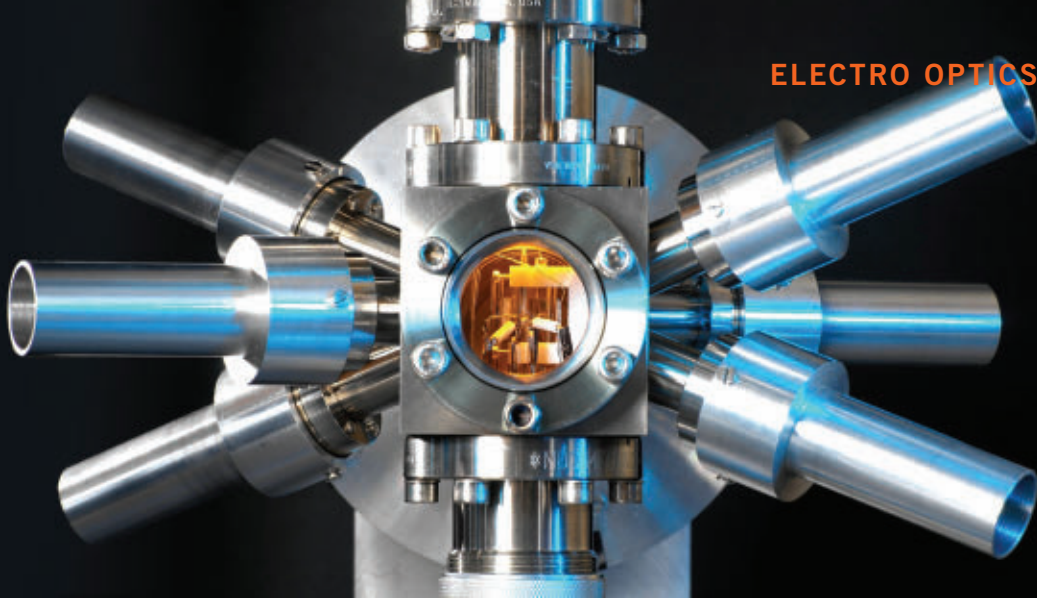
In early 2015 The Marine Corps awarded a \$73.4 million contract to Elbit Systems of America in Merrimack, N.H., to build as many as 1,500 Common Laser Range Finder-Integrated Capability (CLRF-IC) handheld tactical laser rangefinders, which are small enough for individual Marine infantrymen to carry.

The handheld CLRF-IC handheld laser rangefinder systems are to help deployed Marines detect, identify, and pinpoint targets during the day, at night, and in bad weather. ←



The Next Generation Targeting Handheld System (NGHTS) will enable Marines to acquire targets quickly; perform guidance against targets; and generate target location data during combat operations.

On the NGHTS contract Northrop Grumman will do the work in Apopka, Fla., and should be finished by February 2030. For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com.



Industry asked to develop optical clocks for precise PNT without use of GPS

BY John Keller

ARLINGTON, Va. – U.S. military researchers are asking industry to develop optical precision timing technologies to increase the precision of small, rugged, lightweight clocks in optical networks that will provide position, navigation, and timing (PNT) in the absence of Global Positioning System (GPS) signals.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have issued a broad agency announcement (HR001122S0023) for the Robust Optical Clock Network (ROCKN) program.

ROCKN seeks to develop enabling technologies in optical timing and networking technologies to increase precision and holdover of small, rugged, lightweight clocks.

ROCKN will develop two types of robust, low size, weight, and power consumption (SWaP) optical clocks: portable clocks with 100 times higher precision than today's state-of-the-art portable clocks; and transportable clocks with a month holdover of GPS-quality time.

Both clocks are to be engineered sufficiently to operate independent from human operators in outside-the-lab environments for extended periods of time.

Precision timing is ubiquitous and essential today for many civilian and military applications like communication systems, electrical power grids, air traffic control, and financial networks. Moreover, critical components in many military operations like precision navigation and sensor fusion rely on precision timing.

▲ **ROCKN seeks to develop enabling technologies in optical timing and networking technologies to increase precision and holdover of small, rugged, lightweight clocks.**

The primary sources of precise time today are GPS satellites, each of which has an atomic clock on board that disseminate precise time throughout the world and reference regularly to the U.S. Naval Observatory (USNO) master clock in Washington.

All state-of-the-art atomic clocks today operate using microwave atomic transitions, ranging from prototype atomic fountain clocks that serve as atomic frequency references for the time standard at USNO and the National Institute of Standards and Technology (NIST) to small commercial Rubidium Atomic Frequency Standard (RAFS) clocks that are deployed on GPS satellites.

Yet timing technologies based on microwave transitions are limited in precision. That's where the DARPA ROCKN project comes in. ROCKN focuses on developing precision timing technologies based on optical atomic transitions.

The ROCKN program builds on two decades of advancement of optical atomic clocks in the lab with the goal to develop technologies that can operate in the field. ROCKN has one 24-month first phase, and an optional 24-month second phase. ◀

Companies interested were asked to upload abstracts by 10 Feb. 2022, and full proposals by 4 April 2022 to the DARPA BAA website at <https://baa.darpa.mil>. Email questions or concerns to DARPA's Tatjana Curcic, the ROCKN program manager, at ROCKN@darpa.mil. More information is online at <https://sam.gov/opp/a6938fed0e184906871e938d84c85f8d/view>.



Meta optics, or metalenses, is a new flat lens technology for sensing and imaging in unmanned vehicles, augmented-reality displays, and consumer electronics.

Air Force researchers eye meta optics for small sensors for unmanned aircraft

BY John Keller

WRIGHT-PATTERSON AFB, Ohio – U.S. Air Force researchers are asking industry to develop advanced-technology inexpensive electro-optical sensors for small disposable unmanned aerial vehicles (UAVs).

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have released a pre-solicitation (FA8650-22-S-5009) for the Low-Cost Optical Systems Technology (LOW-COST) project.

The size and weight on onboard infrared and visible-light sensors make their integration on small UAVs difficult; conventional optics have several stages and occupy much more volume than the lenses themselves.

For these kinds of sensors, the optics are held in place by a supporting structure that maintains the alignment of the optical elements. Often there are tradeoffs between volume and weight, size and performance, and complexity/cost.

High-performance electro-optics typically are complex, costly, and can stretch size constraints in small UAVs. The use of meta optics, however, has the potential to yield relatively small and high-performance infrared sensors, thanks to flexible optical system design and component manufacturing.

Meta optics, or metalenses, is a new flat lens technology for sensing and imaging in unmanned vehicles, augmented-reality displays, and consumer electronics.

Air Force researchers are looking to apply new optical technologies to compact infrared and visible-light sensors for attritable and low-cost, small, unmanned aircraft.

The Low-COST program seeks to reduce the cost, size, and weight of optical systems in small UAVs operating in combat conditions by using meta optics to realize increased system performance through hybrid and planar optic systems.

Enabling configurable meta optic systems to work with computational imaging and image processing is expected to demonstrate increases in system performance outside of imaging applications is a primary goal of the program.

This will provide a new capability for active and passive infrared and visible-light sensors on small and attritable UAVs and provide autonomous sensing capabilities such as incoming missile warning, laser warning, and infrared search and track (IRST). These capabilities currently do not exist at costs, sizes, and weights small enough for small UAVs and attritable platforms.

This is a pre-solicitation notice only, and a broad agency announcement with more details for this program may be released in February or March 2022. Air Force researchers say two contractors ultimately may share as much as \$2.7 million on this project through 2025. ◀

Researchers are not asking for any proposals yet. Email technical questions or concerns to the Air Force's Joseph Burns, the LOW-COST program manager, at joseph.burns.9@us.af.mil, and contracting questions to Mark Merrifield at mark.merrifield@us.af.mil. More information is online at <https://sam.gov/opp/06deb11ae09c481486f5a8431424b5bd/view>.

TRANSDUCERS

► SyQwest to provide transducers for ASW sonar aboard Navy surface warships

U.S. Navy anti-submarine warfare (ASW) experts needed a company to build important components in support of the Navy PMS-401 Submarine Acoustic Systems Program Office. They found their solution from SyQwest Inc. in Cranston, R.I.

Officials of the Naval Surface Warfare Center in Crane, Ind., announced a \$10 million contract to SyQwest to build TR-343 sonar transducer ceramic stack assemblies for the Navy Submarine Acoustic Systems Program Office at the Pentagon.

The TR-343 transducer is part of the AN/SQS-53C hull mounted sonar array subsystem, AN/SQQ-89(V) anti-submarine warfare (ASW) system. The AN/SQS-53 is a component of AN/SQQ-89(V) acoustic sonar weapons system for surface warships.

SyQwest Inc. manufactures and tests transducer ceramic stack assemblies for the TR-343 transducer which is used on U.S. Navy surface ships. The TR-343 transducers are part of the AN/SQS-53 Hull Mounted Sonar Array Assembly which is a component of AN/SQQ-89(V) acoustic sonar weapons (ASW) system.

The AN/SQQ-89(V) is an integrated surface ship undersea warfare (USW) combat system with the capability to search, detect, classify, localize, and attack submarine targets. The ceramic stack assembly provides the required piezoelectric characteristics to produce mechanical motion in the water for generating sonar signals when a large voltage is applied.

The AN/SQS-53 hull mounted sonar array is a large bulb-like structure built into the bows below the water line of U.S. Navy Arleigh Burke-class destroyers, Ticonderoga-class cruisers, and Japanese navy Kongo-class destroyers. This contract includes foreign military sales.

The surface ship AN/SQS-53 is a computer-controlled surface-ship sonar that has active and passive operating capabilities providing precise information for ASW weapons control and guidance.

The AN/SQS-53C, the latest version of this hull-mounted sonar system, retains the transducer assembly from either the AN/SQS-53A and 53B, yet provides greater range and detection capability with only half of the electronics footprint and less weight than earlier versions.

Constructed in standard electronic modules, the AN/SQS-53C is an all-digital system that provides apparent range, bearing, and true bearing of submarine contacts with active sonar and true bearing of contacts with passive sonar.

Active sonar transmits a ping to bounce sound waves off the hulls of submarines. Passive sonar means simply



listening for the sounds of submarines and surface vessels. This system is the basic sonar watch-standers tool to keep an eye on all ship traffic; the system often detects other surface ships at greater ranges than can most radar systems.

The AN/SQS-53 simultaneously can detect, identify, and track several different targets, and interfaces with the host vessel's digital computers. It has three active modes of operation: surface duet, bottom bounce, and convergence zone. It also can ping off buoys to pinpoint its own location in foreign ports.

For more information contact SyQwest online at www.syqwestinc.com, or the Naval Surface Warfare Center-Crane at www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Crane.

NETWORKING SOFTWARE

BAE Systems to develop networking management software to link sensors and weapons

U.S. military researchers needed fast self-healing web-like networking that connect sensors and weapons on land, on and under the sea, in the air, in space, and in cyberspace. They found their solution from the BAE Systems Electronic Systems segment in Nashua, N.H.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a \$24.9 million contract to BAE Systems for the Mission-Integrated Network Control (MINC) project.

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

BAE Systems joins Peraton Labs Inc. in Basking Ridge, N.J., on the MINC program. Peraton won a \$19.3 million contract on 3 Jan. 2022 for the project.



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

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

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

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

On this contract, experts from BAE Systems and Peraton Labs will not develop any new communications and network resource hardware, but rather will develop the network and communications systems algorithms and software to configure and control available resources opportunistically.

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

BAE Systems and Peraton Labs will help develop on-demand connectivity between sensor-to-shooter networks by focusing on three key capabilities: developing an always-on network overlay to access available networking and communications resources and control parameters; using a cross-network approach for managing network

configuration; and creating ways to determine the best information flows for kill web services.

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

For more information contact BAE Systems Electronic Systems online at www.baesystems.com, Peraton Labs at www.peratonlabs.com, or DARPA at www.darpa.mil.

NIGHT VISION

▼ Physical Sciences joins firms developing small lightweight night-vision glasses

U.S. military researchers needed a company to develop night-vision devices far smaller and lighter in weight than today's night-vision goggles, which would be about the same size and weight as a typical pair of eyeglasses. They found their solution from Physical Sciences Inc. in Andover, Mass.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a \$6.4 million contract to Physical Sciences for the Enhanced Night Vision in eyeglass form factors (ENVision) project.

Physical Sciences joins SRI International in Menlo Park, Calif.; the University of California at San Diego (UCSD); and Raytheon BBN Technologies Corp. in Cambridge Mass. on the ENVision project.

Today's night-vision goggles typically are as bulky as four inches long and as heavy as 2.2 pounds. This causes a large torque on the wearer's neck, which limits the wearer's agility and often leads to chronic injury over prolonged use of these electro-optical devices.

Modern night-vision goggles also burden the wearer with a narrow field of view and generally have limited spectral access to the near-infrared spectral band, which limits situational awareness.



This drawbacks from refractive optics for imaging, and image-intensifier tubes — two technologies in modern night-vision systems that have remained largely the same since their inception.

Instead, the DARPA ENVision program is asking SRI International, UCSD, and Raytheon BBN to overcome these limitations by developing enhanced direct-view night-vision systems that are of a size and weight near those of typical eyeglasses.

SRI International won a \$5.2 million ENVision contract on 3 Nov. 2021, UCSD won a \$3 million ENVision contract on 24 Sept. 2021, and Raytheon BBN won a \$2.3 million ENVision contract on 23 Sept. 2021.

The small lightweight night-vision eyeglasses that these three organization will develop are to extend visual access beyond near infrared to include shortwave, midwave, and long-wave infrared spectral bands through a common aperture, giving users access to spectral ranges from 1.5 to 12 microns. These night-vision eyeglasses, furthermore, would widen the user's field of view to natural eyesight of about 100 degrees.

Optical specialists have attempted to widen the fields of view for today's night-vision goggles, but improvements come at the cost of increased systems size, weight, and wear-and-tear on the user. The ENVision project seeks to explore the next technical leap in night-vision technologies by achieving direct vision of the infrared through photon upconversion.

While current night-vision systems use a multi-step process, the physics to upconvert infrared photons directly to visible light in one step has been known since the invention of the laser in 1960. Direct photon upconversion involves the absorption of two or more photons and re-emission of a photon of higher energy.

Currently, these processes are inefficient and are limited in the bandwidth of light that can be upconverted simultaneously. Yet recent advances in material systems such as polaritonic structures and sensitized core-shell nanoparticles have opened up new avenues in exploring photon upconversion.

The process of photon upconversion-based night vision would eliminate the need for several components and could lead to even simpler, all-optical night-vision systems in the future, such as night vision contact lenses, DARPA researchers say.

Planar optics and planar image intensifiers could enable direct vision of several infrared bands through one common aperture. Structured materials such as diffractive optics and metamaterials enable one to embed optical functionalities far beyond those of traditional refractives into one optical element.

While wide field of view, broad bandwidth, and high imaging quality all are achievable individually, combining these traits in practice remains a challenge. In addition to planar optics, image intensification is necessary to convert the often

weak infrared light into visible photons detectable by the naked eye.

The ENVision program will last for four years in two two-year phases, and has two technical areas: prototypes and upconversion. Those participating in the first technical area will develop prototypes of enhanced night vision systems in eyeglass form-factors, while those in the second technical area will investigate

broadband direct photon upconversion.

For more information contact Physical Sciences online at www.psicorp.com; UCSD at <https://ucsd.edu/research-innovation/>; Raytheon BBN at www.raytheon-intelligenceandspace.com/capabilities/bbn; or DARPA at www.darpa.mil/program/envision.



RADIO COMMUNICATIONS

▲ L3Harris to provide more Falcon IV AN/PRC-167 manpack radios for special forces

Radio communications experts at L3Harris Technologies Inc. will continue building next-generation secure manpack radios for U.S. Special Operations Command to enable commando teams to communicate on frequencies from 30 to 2,600 MHz with embedded communications security.

Officials of Special Operations Command (SOCOM) at MacDill Air Force Base, Fla., announced a \$297.2 million order to the L3Harris Technologies Communications Systems segment in Rochester, N.Y., to provide Special Operations Forces with Falcon IV AN/PRC-167 Multi-channel Manpack radios — also known as the Tactical Communications Next Generation Manpack (STC NGMP) Radio system.

The new manpack radio has an open-systems architecture to enable periodic hardware, firmware, operating software, and radio waveform upgrades. L3Harris won the initial PRC-167 contract in June 2017.

The new radios are replacing SOCOM's current radio communications equipment like the AN/PRC-117F and PRC 117G multiband multimission radios, as well as the AN/PRC-150 multiband radio.

The new radios also enable Special Operations forces to receive and distribute intelligence, surveillance, and reconnaissance data in the form of full motion video, and support simultaneous dual-channel line-of-sight, and beyond-line-of-sight operation using legacy, and advanced digital radio waveforms.

SOCOM experts are asking L3Harris to provide a special forces radio with National Security Agency (NSA) and Joint Interoperability Test Command (JITC) certifications, and make the new communications system available for purchase no later than June 2018.

The new radio will be capable of simultaneous two-channel operation with each channel able to support narrowband and wideband waveforms simultaneously while receiving intelligence, surveillance, and reconnaissance (ISR) data in full-motion video as an embedded capability or via an attached mission module.

The STC NGMP will be able to crossband data from one of its two channels to the other and from the ISR receiver to either of the two radio channels, as well as include an embedded selective availability anti-spoofing module (SAASM) Global Positioning System (GPS) receiver.

SOCOM is asking for capabilities like the Demand Assigned Multiple Access (DAMA) integrated waveform (IW) for UHF satellite communications (SATCOM), Mobile User Objective System (MOUS), general purpose narrowband and wideband high frequency (HF) waveforms, advanced special communications modes (ASCM) and electronic counter-countermeasures (ECCM) waveforms.

L3Harris also will provide program and configuration management, systems engineering to include software, logistics support, operational and depot-level maintenance, data, and training.

On this contract L3Harris will do most of the work in Rochester, N.Y., and should be finished by June 2023. For more information contact L3Harris Technologies Communications Systems online at www.l3harris.com, or U.S. Special Operations Command at www.socom.mil.

SPACE ELECTRONICS

▼ NASA selects Lockheed Martin to lift samples off of Mars surface

The National Aeronautics and Space Administration (NASA) in Washington needed a specialized vehicle to collect surface and atmospheric samples off of Mars. They found their solution from Lockheed Martin Space of Littleton, Colo.

NASA says that Lockheed Martin's Mars Ascent Vehicle (MAV) will be the first rocket fired off of another planet. The MAV will help retrieve samples collected by NASA's

Perseverance rover and return them to Earth to study.

Once it reaches Mars orbit, the container would be captured by an ESA (European Space Agency) Earth Return Orbiter spacecraft outfitted with NASA's Capture, Containment, and Return System payload. The spacecraft would bring the samples to Earth safely and securely in the early- to mid-2030s.

Lockheed Martin Space will provide multiple MAV test units and a flight unit. Work under the contract includes

designing, developing, testing, and evaluating the integrated MAV system, and designing and developing of the rocket's ground support equipment.

The cost-plus-fixed-fee Mars Ascent Vehicle Integrated System (MAVIS) contract has a potential value of \$194 million. The performance period begins no later than Feb. 25 and will extend six years.

To learn more about the Mars Sample Return program, visit NASA at <https://mars.nasa.gov/msr/>.

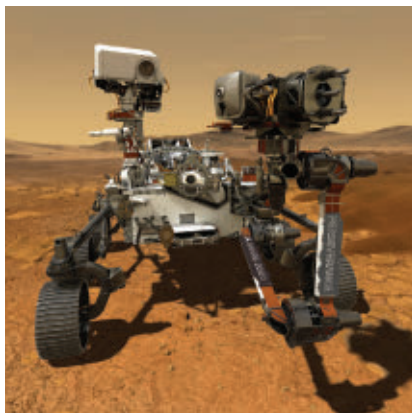
SENSORS

Northrop Grumman to provide conversion kits to transform artillery shells to smart munitions

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

Officials of the Army Corps of Engineers in Newark, N.J., announced a \$61.1 million order Tuesday to the Northrop Grumman Weapons Systems division in Plymouth, Minn., for M1156 precision guidance kits for the Army.

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





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

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

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

On this contract modification Northrop Grumman will do the work in Plymouth, Minn., and should be finished by July 2026. For more information contact Northrop Grumman online at www.northropgrumman.com, or the Army Corps of Engineers at www.usace.army.mil.

AVIONICS

► **Army buys Beechcraft King Air 360ER aircraft, avionics, and synthetic vision for Sri Lanka**

U.S. Army aviation experts needed a twin-engine turboprop aircraft for a variety of missions ranging from personnel and cargo movements to electronic intelligence for the Sri Lanka military. They found their solution from Textron Aviation Inc. in Wichita, Kan.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., announced an \$11.4 million contract to Textron Aviation for new commercial Beechcraft King Air 360ER aircraft and avionics for Sri Lanka.

The King Air 360ER turboprop is designed to reduce pilot workload with features like the Innovative Solutions & Support Inc. (IS&S) ThrustSense Autothrottle, which delivers precision control for optimized power output — including overtorque/overtorque protection for a more efficient takeoff.

Digital pressurization automatically schedules cabin pressure on climb and descent for passenger comfort and to reduce pilot workload. Features include digital pressurization indication; Collins Aerospace Pro Line Fusion avionics suite; three 14 inch touchscreen displays; synthetic vision; graphical flight planning; integrated charts and maps; engine indicating and crew alerting system; dual flight management system; multi-scan weather radar system; integrated terrain awareness and warning system; Traffic Alert and Collision Avoidance (TCAS II); automatic flight guidance system; and dual navigation and communication radios.

The King Air 360ER is 46.6 feet long, 14.3 feet high, and has a wingspan of nearly 58 feet. It can carry as many as 11 people with 550 pounds of baggage. It can fly as fast as 303 knots, has a maximum of 2,539 nautical miles, and can fly as high as 35,000 feet.

The plane has two Pratt & Whitney Canada Hartzell PT6A-60A turboprop engines and four-blade aluminum constant-speed propellers with auto-feathering.

The plane's Collins Aerospace Pro Line Fusion avionics offers touch-control primary flight displays; graphical touch-screen flight planning; presets to reconfigure all three displays; multi-sensor flight management system; integrated touch screen checklists; automatic wireless database and chart uploads; and an open and scalable electronics architecture for future upgrades and mandates.

The avionics also offers DO-260B compliant ADS-B, SBAS-capable GNSS; localizer performance with vertical guidance (LPV) approaches; radius-to-fix legs; and multiple input methods for heads-up flying.

On this contract Textron Aviation will do the work in Wichita, Kan., and should be finished by September 2025. For more information contact Textron Aviation online at <https://beechcraft.txtav.com>, or the Army Contracting Command-Redstone at <https://acc.army.mil/contracting-centers/acc-rsa/>. ◀



NEW PRODUCTS

MOTION CONTROL

► **Low-cost non-commutated linear actuator introduced by Moticont**

Moticont in Van Nuys, Calif., is introducing the DDLM-038-051-01 high-force-low cost non-commutated linear actuator for new and existing applications — especially for upgrading from a pneumatic system. This enclosed linear actuator, also called an electric cylinder, measures 1.5 inches in diameter with a housing length of two inches long. It develops 3.1 pounds of continuous force and 9.9 pounds of peak force at 10 percent duty cycle. It has a stroke of 0.375 inches. Zero cogging and direct coupling of the actuator to the load results in zero backlash and enables smooth high acceleration and deceleration, motion control, and high-speed positioning. The 0.25-inch diameter shaft has an internal thread on each end, for a total length of 3.875 inches, and extends 1.375 inches past the mounting ends of the actuator. The shaft extends through the 9/16-18 UNF by 0.25-inch long threaded stud at each end of the housing for mounting the DDLM-038-051-01 linear actuator. Long-life plain linear bearings support the internal shaft at both ends of the actuator and can tolerate a side load as strong as 5.4 pounds. Internal return springs are optional. Controllable force, stroke length, speed, low noise, and maintenance free, the DDLM-038-051-01 can be used with a position sensor and controller for repeatability, accuracy, and high throughput in a closed-loop servo system. For more information contact Moticont online at www.moticont.com.



manages the build process and connects build and version control systems with quality management and automated testing processes for large-scale system-level software projects. LDRA has long linked to Jenkins to enable developers to analyze, track test and verification fulfillment, and measure code quality.

Now, developers can view LDRA results directly in Jenkins. Jenkins is an open-source automation server that helps automate the parts of software development related to building, testing, deploying, and facilitating continuous integration and continuous delivery.

Related: LDRA integrates embedded computing software development tools for ARM processor applications. The LDRA plug-In for the Jenkins automation server makes system-level automated testing and verification easy for embedded software developers by presenting detailed results in Jenkins. Managing large-scale safety-critical systems, which often require a global array of components and technology providers, is a difficult and costly process — especially when development teams span continents, languages, and time zones. For more information contact LDRA online at www.ldra.com.

SOFTWARE

▼ **Plugin that integrates software design tools, automated testing, introduced by LDRA**

LDRA in Wirral, England, is introducing a software plug-in that brings the capabilities of the LDRA tool suite into the Jenkins automation server for continuous integration for agile software development. Jenkins automates and



POWER ELECTRONICS

► **Outdoor AC surge protectors for industrial automation introduced by Transtector**

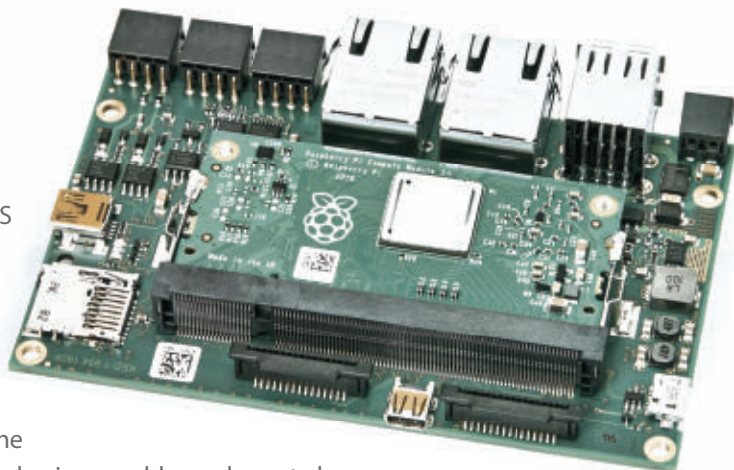
Transtector Systems, an Infinite Electronics brand in Irvine, Calif., is introducing the SP50RS series outdoor AC surge protectors for telecommunications base stations, industrial automation, emergency dispatch, and hospital applications. These AC surge protectors offer UL1449 Type 1 and Type 2 surge-protection devices and provide high surge protection capacity rated for main AC panel protection in a compact form factor with local and remote status indicators. These surge protectors feature high-capacity 50-kiloamp metal oxide varistor (MOV) power electronics technology protection; local suppression status LED; remote suppression status indicator; conduit hub mount or bracket mount; and NEMA 4X outdoor weather protection. For more information contact Transtector online at www.transtector.com.



SOFTWARE

► CODESYS software support for Raspberry Pi-based embedded computing introduced by Kontron

Kontron AG in Ismaning, Germany, is offering the CODESYS hardware-independent software for the company's Raspberry Pi based Pi-Tron CM3+ single-board computer for industrial programmable logic controller (PLC) applications. CODESYS has distinguished itself as an Industry 4.0 platform and facilitates data exchange between an industrial internet of things (IIoT) networks. Cooling uses the Pi-Tron CM3+ in industrial temperature ranges. Optimized passive cooling helps avoid performance fluctuations that can occur when the processor frequency is lowered. Pi-Tron CM3+ has communication interfaces and connections for sensors and actuators and a 24-volt connection for cabinet applications. Only components supported by the community software are used, so that the hassle-free creation of current Raspbian OS versions is guaranteed. Pi-Tron focuses on communications gateway or data logger functions in embedded computing systems, and can help systems designers implement complex automation solutions in combination with the multifunction I/O modules. For more information contact Kontron online at www.kontron.com.



in wearables and smart phones for indoor navigation, and for acquiring altitude data in activity meters. In recent years, as applications have expanded, demand increased for small waterproof barometric pressure sensors that resist external disturbances. The device has a built-in temperature compensation function, and ceramic packaging minimizes fluctuations of device-specific characteristics caused by mechanical stress during board mounting. These features enable accuracy barometric pressure measurement in applications requiring waterproof performance in environ-

ments exposed to large temperature changes. For more information con-

tact ROHM Semiconductor online at www.rohm.com.

SENSORS

▼ Waterproof barometric sensor IC for industrial equipment introduced by ROHM

ROHM Semiconductor in Kyoto, Japan, is introducing the waterproof BM1390GLV(-Z) compact barometric pressure sensor integrated circuit (IC) for industrial equipment and compact IoT devices. The barometric pressure sensor resists the effects of temperature fluctuations and mechanical stress, and combines MEMS and control circuitry to deliver IPX8 waterproof performance in a 2-by-2-by-1-millimeter package. Barometric pressure sensors have become popular



COMMUNICATIONS

▲ Fiber optic transceivers for rugged communications introduced by ShowMeCables

ShowMeCables, an Infinite Electronics-brand electronics distributor in Irvine, Calif., is introducing fiber optic transceivers for data communications, information technology, and telecommunications. These fiber optic transceivers are MSA-compliant and compatible with most switches and routers, and come in form factors such as GBIC, SFP, SFP+, and XFP. Distance options range from 220 meters to 120 kilometers and three transmitter wavelengths are available: 850, 1310, and 1550 nanometers. Operating data rates cover 100 megabits per second to 10 gigabits per second. Other options include single-mode or multimode optics and latching LC or nonlatching SC connectors. Most of these transceivers were designed to withstand extreme industrial temperatures. For more information contact ShowMeCables online at www.showmecables.com.



NEW PRODUCTS

POWER ELECTRONICS

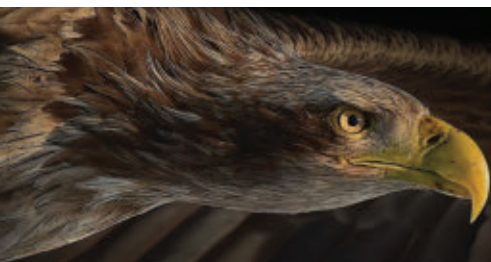
► AC-DC power supplies for test and measurement introduced by TDK

TDK-Lambda Americas Inc. in San Diego is introducing the CUS500M1 AC-DC power supplies for test and measurement, industrial, broadcast, and medical equipment. The TDK-Lambda brand CUS500M1 AC-DC power supply series is rated at 500 Watts and comes in a 3-by-5-inch package. It provides an alternative for the 600-Watt CUS600M models and is an alternative for low-power cost-sensitive applications. The CUS500M1 AC-DC power supply series accepts an 85 to 264 volts AC input and has a choice of seven output voltages: 12, 19, 24, 28, 32, 36 and 48 volts. A fan option with cover also is available. The open-frame models measure 76.2 by 127 by 37 millimeters, or 85 by 157 by 42.5 millimeters with the fan cover fitted. The convection-cooled CUS500M1 can deliver 300 Watts (500 Watts peak) in -20 to 40-degree Celsius ambient temperatures, derating linearly to 150 Watts load at 70 C. With forced-air cooling or



the integral fan fitted, the power supply series provides as much as 500 Watts in a 60 C ambient, derating to 400 Watts at 70 C. The efficiency of the series is as much as 96 percent. For more information contact TDK Lambda online at www.tdk.com. ◀

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Phone: 1-877-382-9187 / International Callers: +1-847-559-7598
E-mail: MAE@omeda.com
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VICE PRESIDENT/GROUP PUBLISHER **Paul Andrews**
203 423-3963 / pandrews@endeavorb2b.com

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

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

CHIEF CONTRIBUTOR **Megan Crouse**

ART DIRECTOR **Kermit Mulkins**

PRODUCTION MANAGER **Sheila Ward**

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

MARKETING DIRECTOR **Adrienne Adler**
603 891-9420 / aadler@endeavorb2b.com



www.endeavorbusinessmedia.com

EDITORIAL OFFICES

Endeavor Business Media, LLC
Military & Aerospace Electronics
61 Spit Brook Road, Suite 501, Nashua, NH 03060
603 891-0123 / www.milaero.com

SALES OFFICES

EASTERN US & EASTERN CANADA & UK
Keith Gregory, Sales Manager
508 1/2 Ocean Park Ave., Bradley Beach, NJ 07720
732 897-9550 / Cell 917 993-3741
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WESTERN CANADA & WEST OF MISSISSIPPI
Maureen Elmaleh, Sales Manager
7475 Miller Street, Arvada, CO 80005
303 975-6381 / Cell 212 920-5051
melmaleh@endeavorb2b.com

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

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