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COVER STORY

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ENDEAVOR BUSINESS MEDIA

BY **JOHN KELLER**, EDITOR IN CHIEF

Military researchers making progress toward high-power microwave weapons

You don't always have to shoot something to kill it; sometimes a heavy jolt of electronic energy like high-power microwaves will do the trick — especially if what you're trying to put out of commission depends on electronic components.

High-power microwaves — just like the related byproduct of a nuclear explosion called electromagnetic pulse (EMP) — essentially can fry modern electronic components virtually in the blink of an eye — just like a bolt of lightning.

Think of an incoming missile bombarded with high-power electromagnetic (HPEM) energy. Instead of a precision-guided munition, it's now a blind inanimate object hurtling through the air with little chance of hitting its intended target.

Sounds like HPEM technology might be useful on the battlefield. Well, it could be. High-power electromagnetics typically don't kill nearby humans and animals by accident like an exploding warhead can. In theory, users can direct this energy only where it's needed, leaving buildings, people, critical infrastructure, and anything else that doesn't rely on electronics unharmed.

There is progress toward enhancing enabling technologies for future HPEM weapons, yet it hasn't come easily. Yet without new enabling technologies in place to control powerful high-power electromagnetics, then designing HPEM weapons likely would be as difficult as ... well, controlling a bolt of lightning.

Experts at the U.S. Air Force Research Laboratory at Kirtland Air Force Base, N.M., launched a project in July called Advanced Electromagnetic Technology (AET) that seeks to develop new HPEM weapons concepts, materials, components, and compact power topologies for future military programs.

The project boils down to six core technologies, which are considered essential for future electromagnetic weapons, and also are difficult to achieve. These technologies are repetitive pulsed power; charged particle beam interactions; compact low-duty-factor prime power HPEM material and plasma technology; HPEM fundamental research; and solid-state-HPEM.

The Air Force isn't alone in pursuing these complex technologies. Also involved is the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va. Last March DARPA launched a project called Waveform-Agile RF Directed Energy (WARDEN), which seeks to develop high-power RF and microwave amplifiers able to generate sufficient electromagnetic radiation to damage or kill enemy electronics.

DARPA researchers have boiled the WARDEN project down to three core technologies: high-power microwave traveling-wave amplifiers; rapid assessment and numerical generation of electromagnetic response (RANGER); and agile waveform development.

WARDEN goes into specifics about how U.S. military forces might be able to exploit weaknesses in enemy electronics to damage, disable, or destroy these systems. Electromagnetic radiation can couple into targets in band via intentional ports such as antennas, for example This is called a front-door electromagnetic attack. These systems also can couple into targets in band via unintentional coupling paths such as seams, apertures, and cable-entry points. This is called a back-door attack.

Front-door systems have the longest range, but their effectiveness is limited to specific classes of targets. Back-door systems are effective against a wider variety of targets, but their range is limited by electromagnetic coupling inefficiencies due to their lack of frequency tunability.

WARDEN seeks to develop flexible technology that can be useful against a wide variety of target types by developing high-peak-power amplifiers for back-door attacks.

Once researchers can master some of these HPEM techniques, it won't be much longer before weapons designers truly can capture lightning in a bottle.

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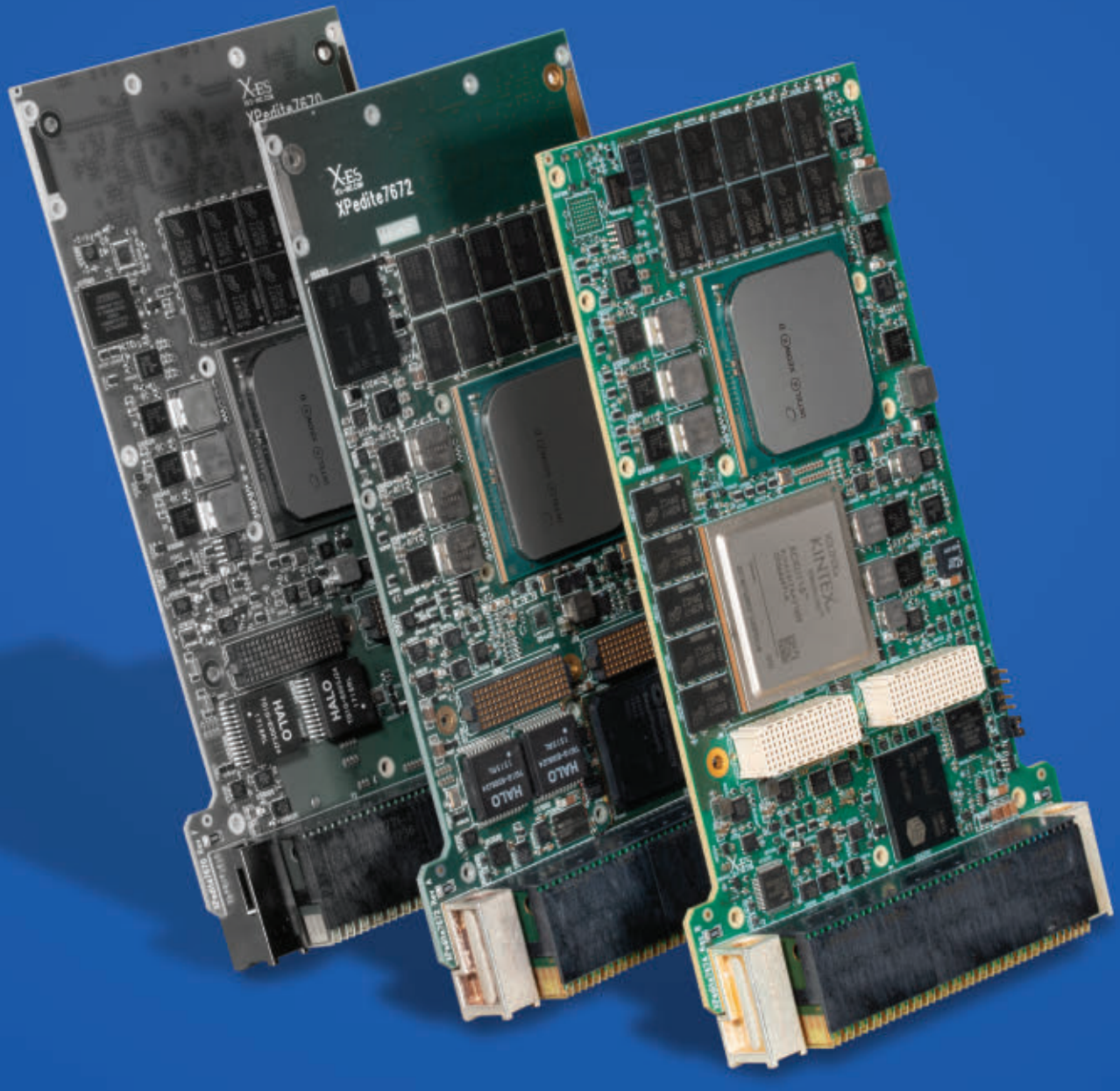

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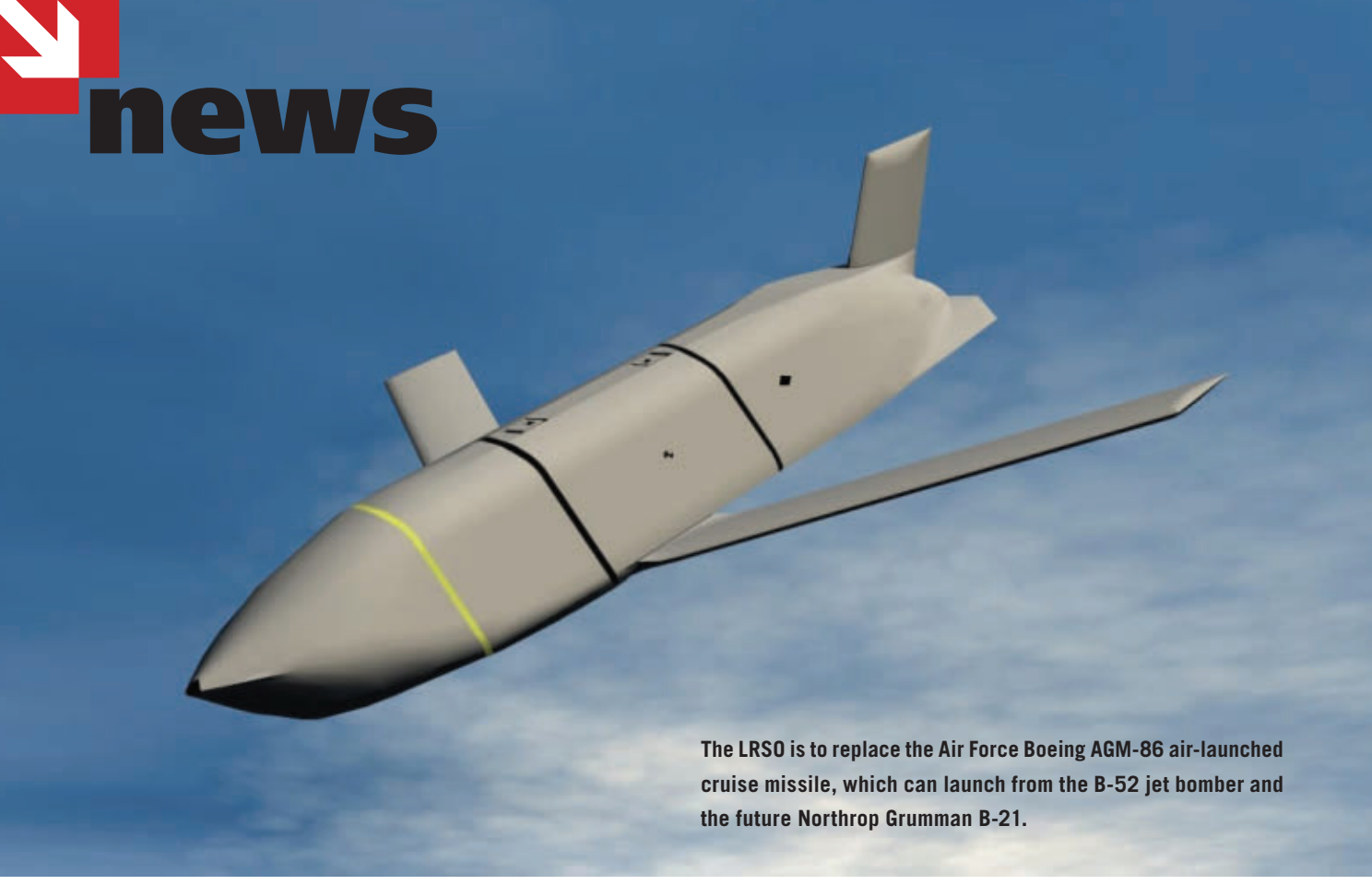

The LRSO is to replace the Air Force Boeing AGM-86 air-launched cruise missile, which can launch from the B-52 jet bomber and the future Northrop Grumman B-21.

Raytheon moves to full-scale development on LRSO air-launched nuclear weapon

BY **John Keller**

EGLIN AIR FORCE BASE, Fla. — Air-to-ground missile experts at Raytheon Technologies Corp. will start full-scale development of the next-generation U.S. Air Force air-launched nuclear missile under terms of a $2 million contract announced in July.

Officials of the Air Force Nuclear Weapons Center at Eglin Air Force Base, Fla., are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., for the engineering and manufacturing development (EMD) phase of the Long Range Standoff (LRSO) weapon system.

The deal eliminates Lockheed Martin Corp. in Bethesda, Md., from further development of the LRSO. The LRSO program is to develop a nuclear weapon that can penetrate and survive integrated air defense systems and attack strategic targets.

The LRSO is to replace the Air Force Boeing AGM-86 air-launched cruise missile, which was designed to launch from the B-52 jet bomber. The LRSO will launch from several different aircraft, including the B-52, and the future Northrop Grumman B-21. The LRSO is to have a range of about 1,500 miles.

Air Force officials chose Raytheon in April LRSO sole-source contractor on the LRSO technology, maturation, and risk reduction phase, which removed competitor Lockheed Martin. The Air Force could buy as many as 1,000 LRSO weapons.

The LRSO is to replace the nuclear AGM-86B in about 2030, equipping the B-52 and B-21 bombers as one-third of the nuclear triad. The missile's first flight could come in 2022.

On this contract Raytheon will demonstrate full production readiness for the LRSO missile. Raytheon will do the work in Tucson, Ariz., and should be finished by February 2027. For more information contact Raytheon Missiles & Defense online at www.rtx.com/our-company/our-businesses/rmd, or the Air Force Nuclear Weapons Center at www.afnwc.af.mil.

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BAE Systems to provide artillery with digital vetronics in $72.5 million order

BY **John Keller**

WARREN, Mich. — The U.S. Army is buying additional upgraded and fast-moving 155-millimeter self-propelled howitzer artillery vehicles with digital vetronics and modern power systems, as well as companion ammunition carrier tracked armored combat vehicles.

Officials of the Army Contracting Command in Warren, Mich., announced a $72.5 million order last month to the BAE Systems Platforms & Services segment in York, Pa., to build the M109A7 self-propelled howitzer and M992A3 ammunition carrier.

Photo: The M109A7 self-propelled artillery system uses new chassis components common to the M2A3 Bradley Fighting Vehicle to keep up with modern combat vehicles.

The M109A7 is the Army's newest M109 version. Formerly known as the M109A6 Paladin Integrated Management (PIM), the M109A7 uses the existing main armament and cab structure of a Paladin M109A6 self-propelled cannon, and replaces the vehicle's chassis components with modem components common to the M2A3 Bradley Fighting Vehicle.

The goal of these upgrades is to enable the M109A7 armored combat vehicle to keep up with the Army's fast-moving armored brigade combat team (ABCT) alongside the M1 Abrams main battle tank and the M2 Bradley armored personnel carrier.

The M109A7 program enhances the reliability, maintainability, performance, responsiveness, and lethality of the M109A6 Paladin self-propelled howitzer and M992A2 Field Artillery Ammunition Support Vehicle's (FAASV).

The M109A7 is the primary indirect fire support system for the armored brigade combat teams. Its improved chassis provides survivability and commonality with existing ABCT armored combat vehicles. The program seeks to reduce maintenance costs by replacing obsolete components.

The M109A7 capitalizes on today's most advanced technology, including a state-of-the-art digital backbone and power generation capability, BAE Systems officials say.

Legacy M109 howitzers first are shipped to the Anniston Army Depot, Ala., where they are disassembled to provide cab structures, overhauled gun and cannon assemblies, and other vehicle components, and re-shipped to BAE Systems combat vehicle factory in York, Pa., for final assembly.

The M109A7's on-board power systems harness technologies originally developed for the cancelled Non-Line-of-Sight Cannon. It has an electric drive that is faster than the previous hydraulic system, and has an automatic rammer for consistent velocities and accuracy.

The newest version of the M109 self-propelled cannon has a 600-volt power system to accommodate additional armor and future networking technologies. The gun can sustain a one round per-minute rate of fire and a maximum rate of fire of four rounds per-minute.

The first M109A7 low-rate production deliveries began in 2015. Ultimately Army leaders want to buy 133 of the self-propelled cannons.

On this contract modification BAE Systems will do the work in York, Pa., and should be finished by December 2023. For more information contact BAE Systems Platforms & Services online at www.baesystems.com/en-us/product/m109a7, or the Army Contracting Command-Warren at https://acc.army.mil/contractingcenters/acc-wrn.

Passenger aircraft and avionics adapting to environmentally friendly fuels

BY **Jamie Whitney**

WASHINGTON — The future of air travel looks to be faster and more environmentally friendly as the industry looks to balance consumer demand alongside "green" goals. Avionics to support environmentally friendly aircraft is in development.

Airlines for America (A4A) in Washington, the industry trade organization representing the leading U.S. airlines, announced the commitment of its member carriers to work across the aviation industry and with government leaders in a partnership to achieve net-zero carbon emissions by 2050. Likewise, Europe's aviation sector has announced the same goal, which they call "Destination 2050."

A4A members include Alaska Airlines, American Airlines, Atlas Air, Delta Air Lines, FedEx, Hawaiian Airlines, JetBlue Airways, Southwest Airlines, United Airlines, and UPS. Air Canada is an associate member.

A4A carriers pledged to work toward an expansion of the production and deployment of commercially viable sustainable aviation fuel (SAF) to make 2 billion gallons of SAF available to U.S. aircraft operators in 2030.

This spring, the French foursome of Air France-KLM, Total, Groupe ADP, and Airbus joined forces on the first long-haul flight powered by SAF.

The SAF biofuel on this flight came from waste and residue from used cooking oil, which was processed at the La Mède biorefinery in southern France and at the Oudalle factory near Le Havre, France, without using any virgin plant-based oil.

The future Boom supersonic aircraft is being designed to operate with environmentally friendly fuels.

French legislation calls for aircraft to use at least 1 percent SAF by 2022 for all flights originating in France, ahead of a plan to ramp up gradually to 2 percent by 2025 and 5 percent by 2030.

Cleaner-burning jet fuels made from sustainable sources can produce 50 to 70 percent fewer ice crystal contrails at cruising altitude to reduce aviation's impact on the environment, according to research by NASA and the German Aerospace Center (DLR).

"We know that contrail formation from jet exhaust has a larger, more immediate impact on climate than carbon dioxide emissions," says Richard Moore, a scientist at the Langley Research Center in Langley, Va. "This research shows we have an opportunity using alternative fuels to make immediate changes that could help the planet."

This spring, officials from Alaska Airlines and SkyNRG Americas pledged to increase investment in SAF.

SkyNRG Americas initially will focus on developing dedicated SAF production facilities to supply Western U.S. airports. These facilities will use commercially available technologies that enable the use of municipal solid waste and other waste-based inputs as feedstocks, as well as incorporating green hydrogen and renewable energy for minimizing carbon intensity.

Hydrogen heights

In June, GKN Aerospace in Redditch, England, announced a Swedish national collaboration program called H2JET, with the goal of fueling three engine subsystems for H2 medium-range civil aircraft. The two-year project sees GKN Aerospace collaborate with the Swedish Energy Agency, Chalmers University of Technology, Lund University, KTH Royal Institute of Technology, University West, Research institutes of Sweden (RISE), and Oxeon.

Hydrogen is expected to play a role in the decarbonization strategy of aviation as it can power aircraft efficiently, leaving water as the only by-product. It generates power

either by direct combustion — the focus of H2JET — or by generating onboard electrical power with a fuel cell.

Experts from Bye Aerospace in Englewood, Colo., found launch customers for their all-electric, seven-seat aircraft. Jet It and JetClub announced their agreement with Bye Aerospace this summer.

Jet It and JetClub, sister companies operating in North America and Europe respectively, have signed a purchase agreement for a fleet of eFlyer 800 and four eFlyer 4 aircraft. Jet It will operate the first fleet of electric aircraft in North America.

Set for operation by 2025, the eFlyer seats as many as seven passengers and one or two pilots. The eFlyer has cruise speeds of 320 knots and a ceiling of 35,000 feet.

Biggest MAX

On 18 June, Chicago-based Boeing announced its 737-10, the largest airplane in the 737 MAX family, completed a successful first flight. The 737-10 can carry as many as 230 passengers. It also incorporates environmental improvements, cutting carbon emissions by 14 percent and reducing noise by 50 percent compared to today's next-generation 737s.

Leiden, Netherlands-based Airbus in July delivered the first A350 from the company's widebody completion and delivery center in Tianjin, China. The center was inaugurated in September 2017 to produce A330s.

For nearly 20 years, the speed of commercial air travel has remained below the speed of sound, which is 761.2 miles per hour. Boeing claimed to be the fastest commercial jet in its 747-8I, which has a top speed of Mach 0.86 — or nearly 660 miles per hour — when the vaunted Concorde was retired in 2003. The Aérospatiale/BAC Concorde flew over twice the speed of sound.

In June, United Airlines, based in Chicago, announced plans to go supersonic later this decade with a purchased 15 Boom Overture aircraft.

The Overture, expected to roll out in 2025 with first flight planned for 2026 and delivery planned for 2029, will seat 65 to 88 passengers. At 205 feet in length, the Overture will cruise at 60,000 feet at Mach 1.7 and has a range of 4,250 nautical miles.

United also holds an option to purchase an additional 35 aircraft. The companies will work together on meeting operation requirements before delivery. Once operational, Overture is expected to be the first large commercial aircraft to be optimized to run on 100 percent SAF on day-one.

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Lockheed Martin to build ASW systems, hull-mounted sonar, for counter-mine warfare

BY **John Keller**

WASHINGTON — Undersea warfare experts at Lockheed Martin Corp. will provide the U.S. Navy with AN/SQQ-89A(V)15 anti-submarine warfare (ASW) systems and hull-mounted sonar transmitters for surface warships under terms of a $80.2 million order announced Tuesday.

Officials of the Naval Sea Systems Command in Washington are asking the Lockheed Martin Corp. Rotary and Mission Systems segment in Manassas, Va., to provide technical insertion-20 (TI-20) AN/SQQ-89A(V)15 surface ship undersea warfare combat systems and AN/SQS-53C hull-mounted sonar transmitter infrastructure shipset hardware.

The AN/SQQ-89A(V)15 is an undersea combat system that uses active and passive sonar to enable Navy Arleigh Burke-class destroyers and Ticonderoga-class cruisers to search for, detect, classify, localize, and track underwater contacts; and to attack or avoid enemy submarines, floating, tethered, or bottom-attacked mines, and torpedoes. This contract combines purchases for the U.S. Navy and Australia.

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

The hull-mounted sonar transmitters are shown on the guided missile cruiser USS Cowpens (CG 63) while the ship was in drydock.

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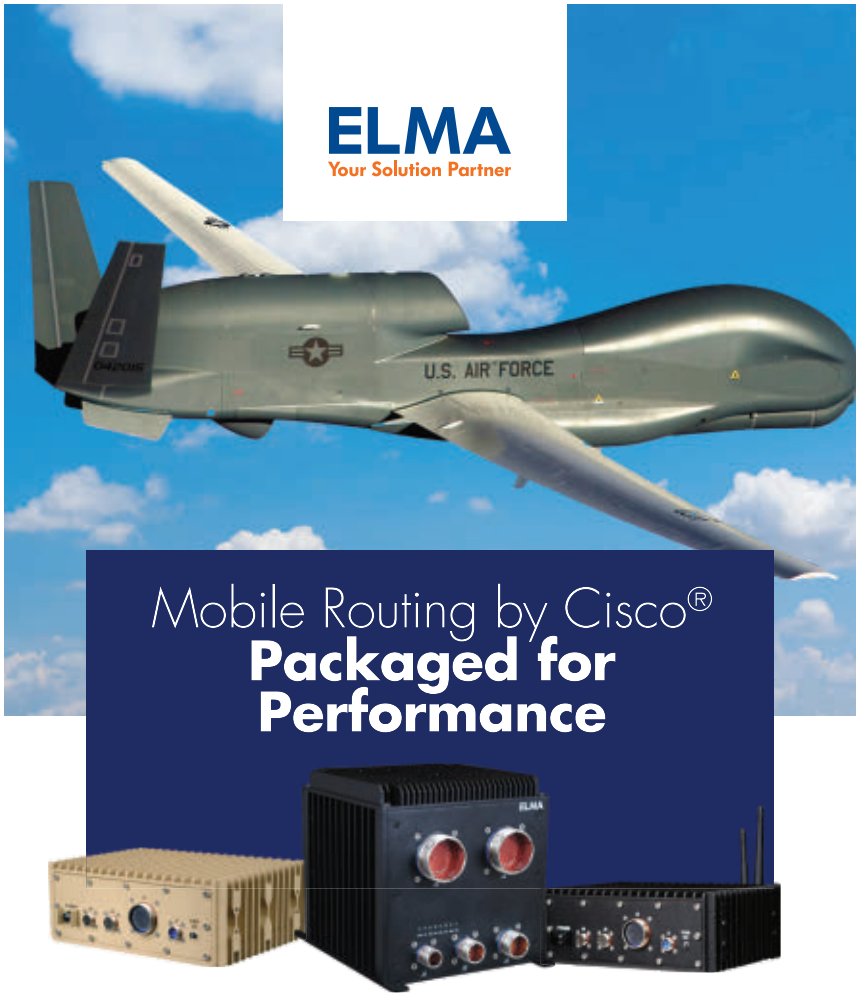
predictions, embedded operator, and team training systems.

The AN/SQQ-89A(V)15 has an open-systems 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



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U.S. Cyber Command leads military exercise to strengthen nation's cyber security

Cyber professionals from the U.S. and several other countries competed last month in an annual competition led by U.S. Cyber Command meant to enhance the nation's cyber security in wake of months of devastating attacks. The annual Cyber Flag competition this year brought together 430 cyber professionals on 17 teams representing U.S. Cyber Command at Fort Meade, Md., and U.S. defense agencies, the House of Representatives, the National Guard, and the U.S. Postal Service. It also incorporates teams from the United Kingdom and Canada. Each year, the teams are presented with a scenario involving a major cyber incident, with this year's scenario involving an attack by two adversaries on a logistics support depot. The competition wrapped up on 23 June and operated across eight time zones, with teams competing to win. The event is the Department of Defense's largest annual cyber military exercise, and this year used a virtual training platform to enable teams to compete from their home bases. As a result, the exercise was five times larger than in previous years.

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/SQS-53 hull mounted sonar array, meanwhile, 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. The AN/SQS-53 is a component of AN/SQQ-89(V) acoustic sonar weapons system for surface warships.

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.

On this order Lockheed Martin will do the work in Lemont Furnace, Pa.; Clearwater, Fla.; Syracuse and Owego, N.Y.; and Manassas, Va., and should be finished by June 2026. 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.

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ENABLING TECHNOLOGIES FOR THE U.S. Space Force

Space Force zeroing-in on satellites, launch vehicles, radar, electro-optical sensors, communications, and cyber security.

BY **Megan Crouse**

The newest branch of the U.S. military in residence at the Pentagon, the U.S. Space Force. operates at the upper limits of human territory. Its jurisdiction starts 60 miles above the surface of the Earth, extending outward from there.

Pundits have debated whether the Space Force is a necessary change. Could the Air Force not cover more space-based assets like satellites and vehicles? The answer is complicated, especially in the context of the Space Force's history of growing out of Air Force ventures.

For industry, the debate also goes on: will this benefit only the few large government space vendors in place now, or benefit industry as a whole? Many are taking a look at the enabling technologies behind the Space Force and how they might effect aerospace engineering, budgets and projects.

Past conflicts and responsibilities

In the Space Force's own words: "Space affects almost every part of our daily lives and is fundamental to our economic system. For example, satellites not only power the GPS technology that we use daily, but allow us to surf the web and call our friends, enable first responders to communicate with each other in times of crisis, time-stamp transactions in the world financial market, and even allow us to use credit cards at gas pumps."

The Space Force's jurisdiction covers the military use of satellites, which includes Global Positioning System (GPS), intelligence satellites, hypersonic missile detection, communications, remote sensing, radar, and space vehicles. As well as handling physical threats, a component of the Space Force also is responsible for the digital security of military space systems.

Photo: The Tactically Responsive Launch-2 (TacRL-2) mission launched on a Northrop Grumman Pegasus XL rocket from Vandenberg Space Force Base in June, delivering a technology demonstration satellite to low-Earth orbit. U.S. Space Force photo

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The Space Force operates as part of the Department of the Air Force, which in 2021 called for a budget supporting about 6,400 military and 3,600 civilian personnel. The transition is ongoing as bases and personnel fall on either side of the Air Force/Space Force line or somewhere in between. Specifically, the Space Force grew out of the Air Force Space Command, which has a storied history since its inception in 1982. The Space Command also operated in the realms of satellites, launch vehicles, and early warning ballistic missile systems — particularly radar.

Three distinct military space efforts come under the umbrella of the U.S. government as of 2021. The Space Force is a distinct group from the U.S. Space Command, a division of the Air Force to which the Space Force could provide troops if needed. A third, smaller group, the Space Development Agency, oversees the creation of the network of tracking satellites known as the National Defense Space Architecture. It is further distinct from the National Reconnaissance Office (NRO), which is still the agency with the most jurisdiction over U.S. intelligence satellites. Naturally, all of these groups will cooperate and communicate to a degree. The Space Force is still responsible for only about half of all U.S. military launches and satellites.

Naturally, even the Space Force's leaders have an Air Force connection. Chief of Space Operations and General Jay Raymond currently oversees the Space Force. He was appointed by former President Donald Trump and changed titles from his previous role as commander of the Air Force Space Command. Chief Master Sgt. Roger Towberman serves as the senior enlisted advisor.

So, where do these personnel (officially called Guardians) actually work? As in other elements of its creation, the Space Force will use Air Force bases to set up its operations. First, the government re-named Cape Canaveral Air Force Station and Patrick Air Force Base as Space Force bases in December 2020. More bases followed suit — in particular those with relevant capabilities and specialities, such as the former Ka'ena Point Satellite Tracking Station, Hawaii.

Budgets and contracting

More important to industry is how the Space Force's creation will change existing defense projects or affect contract proposals. In the 2020 Defense Space Strategy, U.S. Department of Defense (DOD) officials vowed that the Space Force would have cooperation with industry as a guiding principle. Industry also can expect to keep eyes out to see to what degree a the administration under President Joe Biden will embrace the Space Force established by the previous president.

For a small service, the Space Force has a very large research and development appropriation for its size: $10.3 billion in 2021. According to a Center for Strategic & International Studies report, the majority (35 percent, or $3.6 billion) of that money is assigned to classified matters. However, knowing the scope of the branch means we can make some educated guesses that it also will concern missile-warning systems, satellite constellations, communications, military space planes, and digital and physical security for same.

2021 was the first year the Space Force had complete independent control of its own budget process, which

The Upgraded Early Warning Radar system at Beale Air Force Base, Calif., moved over to the Space Force. U.S. Space Force photo

An Atlas V CST-100 Starliner rocket launches over a Redstone rocket at Cape Canaveral Air Force Station, Fla. in December 2019 — the same day the U.S. Space Force was founded. U.S. Air Force photo

led to some disagreements among lawmakers. The Biden administration is seeking a budget of $17.4 billion in 2022, about $2 billion more than the previous year. That additional money will go to keep the U.S. on an even playing field with Chinese and Russian anti-satellite weapons. Some members of the House Armed Services Committee said this budget did not focus enough on new defenses that can keep expensive satellites safe.

"We can leverage a burgeoning commercial industry," said Space Force Chief of Space Operations Gen. John Raymond. "The other thing that we need to do is to leverage our international partners to a greater extent."

In 2021 Raymond linked public excitement for commercial space flight to increased interest in Space Force recruitment. What about within industry?

In the beginning, the narrative went that Space Force might provide an in for smaller companies. "Because [the Space Force] will be a smaller service with fewer resources, it may be more dependent on industry for technical advice and policy input," Loren Thompson of Lexington Institute, which receives funding from defense contractors, told the Washington Post in 2018. "[It] would likely be more of a creature of industry than if the Air Force were kept intact."

Other opinions differ. "It's too soon to tell if there's any change yet," says Todd Harrison, director of Defense Budget Analysis and the Aerospace Security Project at the Center for Strategic and International Studies (also funded in part through the industry). "The Space Force acquisition enterprise was just inherited from the Air Force."

Therefore, the force is still moving over personnel who may have rotated in and out of space jobs throughout their careers. So, the field of space acquisitions is still being created.

The Space Defense Agency (SDA) mentioned above also could be of interest for industry. Although the agency is small, its roadmap includes launching an increasing number of defense-supporting satellites. Therefore, as a DOD feature writer says, "the SDA is relying heavily on industry and is encouraging new ways of thinking within the industry about how to provide capabilities to the

government. Instead of the kinds of big contracts that end up producing things like new airplanes or carriers, SDA wants the industry to understand that there will be an ongoing market for satellites — lots of them."

On the macro level, that means launches. The Space Force awarded a contract in 2020 to United Launch Alliance (ULA), a joint Boeing/Lockheed Martin effort, to launch 60 percent of the missions on its newest launch procurement contract. The remaining 40 percent went to SpaceX.

But these are companies that had existing relationships with the Air Force. What about new opportunities?

New opportunities ... eventually

"We're seeing billions of dollars of new money in commercial space, driving innovations in small satellites and launch vehicles," said Carissa Bryce Christensen, CEO of Bryce Space and Technology, at the Future of War conference in 2019. "That community is not well connected to the military and the intelligence community." She suggested the Space Force was an opportunity to change that.

Over the last two years, has that actually happened? Not yet, but changes in the Commercial Satellite Communications Office and elsewhere point in that direction, said Harrison of the Center for Strategic and International Studies. "The signs are there that they want to try to do that ... they're trying to forge a different, closer relationship." In June, Defense News reported the Commercial Satellite Communications Office will be transitioned into a "commercial services office" including not just satellites but also most space-related services.

The way the Space Force contracts for services also illustrates the way it sits between government and industry. In April, Bloomberg Government reported the force was considering using a commercial solutions opening (CSO) contract, which usually is applied to cutting-edge commercial technologies, for management consulting services. Could this effect the branch's effort to cut down on bureaucracy? Or does it muddy the waters on how to provide services and what role the force plays? Bloomberg Government says this is well within government-authorized use of CSOs for "innovative commercial technologies or services" and may affect how the Space Force sources personnel for administrative services in future.

This artist's concept illustrates Raytheon's increased use of artificial intelligence for military use. Raytheon photo

Industry will be looking for "clear organizational charters, exemplar mission scenarios, and access to special clearances so we can provide the most knowledgeable offering," says Tim Lynch, vice president of multi-domain strategy & business development at L3Harris Technologies Space & Airborne Systems in Palm Bay, Fla.

In statements reported by Space News in May, the Government Accountability Office (GAO) warned against the Space Force trying to reinvent the wheel when it came to budget and acquisitions. The House Armed Services Committee has criticized DOD space programs before for costing more than anticipated and not living up to goals of effectively using cutting-edge industry technology. Part of the problem is that the recent re-arranging of space agencies may not cut entirely through the red tape of overlapping departments and concerns in the space sector.

For example, the DOD has had satellites capable of broadcasting a jam-resistant GPS signal since 2005. However, the user equipment necessary to use this widely is still not in place.

"L3Harris Technologies is specifically evaluating and implementing lateral movement of technology, and missions from non-DOD portions of our portfolio," says L3Harris's Lynch. "Intelligence community missions are different, but very similar as they relate to technology. Over the last few years, we have been looking at all cross-cutting, multi-domain technologies that can enable the warfighter in space. All in all, our efforts to support the Space Force are truly focused on driving mission utility to the warfighter at a pace that our adversaries can't support."

Enabling technologies

The Space Force's enabling technologies in general are satellites, launch vehicles, sensors like radar, communications, and cyber security.

"The most important enabling technology is communications and processing that can provide low-latency,

direct-to-warfighter, mission-relevant information," says L3Harris's Lynch. "This critical information can be used to avoid conflict, and can be used to win conflict."

Harrison of the Center for Strategic and International Studies also emphasizes communications, specifically more resilient communications. If one communication link goes down or gets jammed, or a satellite gets destroyed by an anti-satellite weapon, an alternate communications pathway is crucial, he says. Projects to watch include SpaceX's low-Earth-orbit Starlink satellites, OneWeb Satellites (a joint venture between OneWeb and Airbus), and Amazon's upcoming Kuiper constellation. The Starlink's thousands of satellites would be a good example of a resilient network in space.

"There are a lot of really interesting things going on in commercial space in remote sensing," Harrison says. "I'm talking about imagery satellites and radar satellites, and for imagery satellites what we're seeing is commercial companies building out very large constellations of imaging satellites that have much higher revisit rates, so they can take multiple pictures of the same place on the ground every day. It may not be as high resolution as what the intelligence community can get with their satellites like from the NRO, but you can get pictures more frequently." That comes with obvious military applications.

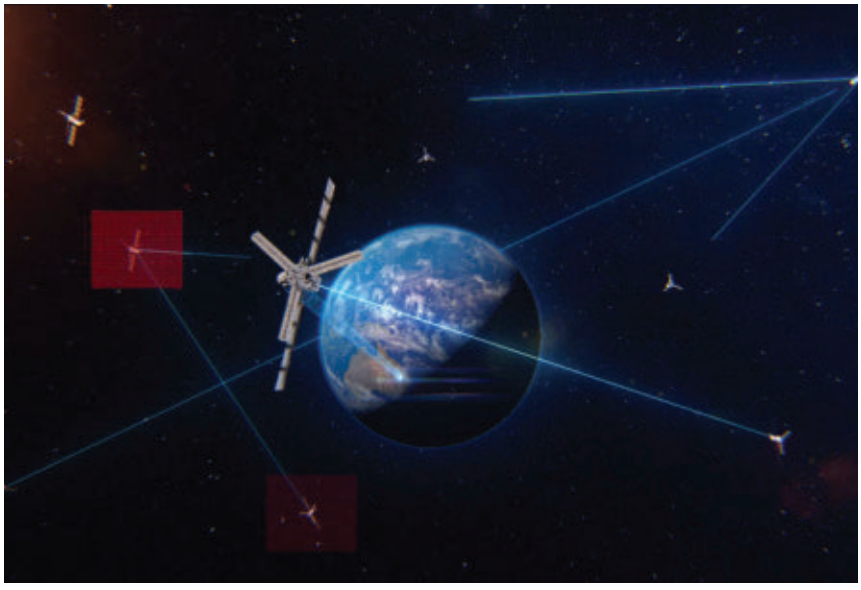
Synthetic aperture radar satellites represent another promising area in which the military could capitalize on existing commercial technologies, Harrison says. The commercial world is just starting to build this out, but "we're seeing a lot of companies building and launching synthetic aperture radar satellites that could have all sorts of military applications, from being able to image the ground day or night through bad weather. Radar can see through clouds, through smoke, can see at night. But also these satellites are really good at picking up moving objects."

When it comes to electronics specifically, "For space systems the thing I'd keep watching is antennas," Harrison says. "When you can make antennas smaller, both on the satellites and on the user equipment, it opens up all sorts of new user applications."

Hypersonic missile tracking satellites

Millennium Space Systems in El Segundo, Calif., and the Raytheon Technologies Corp. Intelligence & Space segment in Arlington, Va., will be sending up medium-orbit sensors that can track hypersonic missiles. But this is as much a job for software as it is for hardware. As part of

An Atlas V carrying the USSF-7 mission aboard rolls to the launch pad at Cape Canaveral Air Force Station's Space Launch Complex. United Launch Alliance photo



This artist's concept of satellites for the space-based Medium Earth orbit Track Custody Demonstration results from the Space Force May 2021 contract award to Raytheon Intelligence & Space. Raytheon photo.

the initiatives to embrace digital technology, the Space Force's Space and Missile Systems Center at Los Angeles Air Force Base, Calif., first asked for proposals for digital designs.

Boeing brings experience with digital twin technology to iterate on prototype sensors before Space Force finalizes anything, wrote Space News. That digital twin architecture will allow the Space Force to see how warning satellites will interact with tracking sensors in advance. That becomes even more important as satellite clutter increases, and as the best ways to exchange information between the ground, low- and medium orbits change.

One crop of warning satellites, the Next-Generation Overhead Persistent Infrared, will replace the Space Based Infrared System (SBIRS). The force awarded Lockheed Martin as much as $4.9 billion for three Next-Generation Overhead Persistent Infrared satellites and ground mission software in January.

WHO'S WHO IN U.S. SPACE FORCE BUSINESS

Boeing
Chicago
https://www.boeing.com

Bryce Space and Technology
Alexandria, Va.
https://brycetech.com

L3Harris Technologies
Melbourne, Fla.
https://www.l3harris.com

Lockheed Martin Corp.,
Bethesda, Md.
https://www.lockheedmartin.com

Millennium Space Systems
El Segundo, Calif.
https://millennium-space.com

Northrop Grumman Corp.
Falls Church, Va.
https://www.northropgrumman.com

OneWeb Satellites
London
https://onewebsatellites.com

Raytheon Intelligence & Space
Waltham, Mass.
https://www.raytheonintelligenceandspace.com

SpaceX
Hawthorne Calif.
https://www.spacex.com

United Launch Alliance
Centennial, Colo.
https://www.ulalaunch.com

GPS and intelligence satellites

Of the different types of satellites, many of the enabling technologies face the same challenges as many DOD projects: namely timely and cost-effective delivery of truly innovative products.

As well as missile warning projects, the Space Force also is working on Future Operationally Resilient Ground Evolution (FORGE) ground control to support the Next Generation Overhead Persistent Infrared satellites; Evolved Strategic SATCOM for protected satellite communications; secure communications; and Protected Tactical SATCOM secure communications satellites.

Getting more of these into space faster also connects to another effort the Space Force is trying out: more emphasis on flight without a launch pad.

Space planes

For example, on June 13 the Space Force oversaw a satellite placement sent up on board the Northrop Grumman Pegasus XL, first flown in 1990. The winged rocket is itself launched from a Lockheed Martin L-1011 Tristar commercial airliner. This type of launch gives the force far more launch point options than just the United States' California and Florida rocket yards. In a darker timeline, commercial airports might become the only option if the space launch centers become military targets. This particular launch also demonstrated a new speed goal: 11 months to build a satellite as opposed to the more common 24 to 60 months.

One of the more storied craft in the stable is the Boeing Phantom Works X-37B spaceplane, often breathlessly called "mysterious." This uncrewed vehicle launches vertically like the Space Shuttle and uses a runway to land. "The primary objectives of the X-37B are twofold: reusable spacecraft technologies for America's future in space and operating experiments which can be returned to, and examined, on Earth," according to a fact sheet produced by the Air Force.

The Space Force also uses Boeing's USA-299 uncrewed vertical takeoff spaceplane, which lands on its own horizontally. The purpose for which this vehicle is classified, but we do know it falls under Space Force jurisdiction.

Cyber security

With all of these connected systems, as well as the duel goals of engaging cutting-edge industry and providing cutting-edge defense, the Space Force's purview also involves cyber security in some ways unique to this branch. It wants to be "digitally dominant," according to a forward-looking document from Chief of Space Operations Gen. John Raymond as quoted by Fed Tech Magazine.

"Given the relatively small size of the USSF, accomplishing this goal will require us to amass a technologically adept, 'digitally fluent' space cadre more proficient, efficient, and agile than any other force in history," Raymond wrote. That means high-bandwidth networks and "site-agnostic solutions "enabling service-based, distributed functionality."

While the document calls for giving individual guardians the tools to empower digital safety and superiority in any situation, the true test of what this means may come in the future. What is definitely true is that the Space Force is coming of age alongside the 'digital natives' in the ranks. Plans are in place in that document for a 'Digital Headquarters' (which would be a function, not an alternative to a physical location) and digital-first communication.

In the past years, the Space Force has also sent out calls for proposals via Commercial Solutions Opening for technologies including artificial intelligence, weather, business systems, and information technology (IT). While still under active ethical debate, the U.S. military is exploring the use of AI in both offensive and defensive roles.

"AI-enabled ground and on-board (edge) sensor/data processing has the potential to provide significant near-term impacts to the mission capabilities that Northrop Grumman can offer to Space Force," says Matt Vandyke, consulting guidance navigation and control engineer at Northrop Grumman. "These advanced algorithms enable the development of sense-making pipelines to convert raw data to useful and actionable knowledge, increasing decisions superiority and information dominance.

"Future space missions will require high levels of autonomy. AI is a key and critical enabling technology for highly autonomous systems," Vandyke continues. "Next-generation guidance, navigation, and control algorithms and advanced fault management will use AI techniques to ensure safe and robust operations at the speed of relevance."

The Space Force still is in transition internally, ramping up to its intended personnel numbers. As such, industry has the chance to explore a digital-first customer and change to fit the mission with it, as well as the uncertainty of a potential new customer and new types of operation. As L3Harris's Lynch mentioned, knowledge is still one of the most-wanted elements in regards to the new branch.

Embedded computing sensor and signal processing meets the SWaP test

New enabling technologies in FPGAs, GPGPUs, and central processing units can fit on single chips, and are ready to meet emerging demands for artificial intelligence (AI) and machine learning.

BY **John Keller**

Electronic sensors are ubiquitous in defense, aerospace, and commercial systems, ranging from weapons seekers to smart phones, and the use of sensors is expected to grow as electronics size, weight, power consumption, and cost (SWaP-C) continue to drop.

On the face of it, that sounds sound great. The U.S. military is developing networks of sensors to give commanders eyes and ears everywhere from the seabed to space in efforts maintain a high state of global vigilance.

Practically, however, that means intelligence analysts are drowning in data, which makes distilling actionable intelligence out of oceans of data a difficult, costly, and time-consuming task. The answer to this dilemma lies in new generations of sensor and signal processing computers that bring capabilities like artificial intelligence (AI), parallel processing to the fore to tame the data monster and render mountains of data into assets rather than adversaries.

Mountains of sensor data

"We are experiencing a huge increase in the amount of data throughput our customers are requiring," says Jim Tierney, vice president of defense and aerospace at embedded computing chassis and networking specialist Atrenne, a Celestica company in Brockton, Mass. "The chassis systems that we manufacture need to keep all of their components secure while addressing the demand for more connections within the same amount of space on a front panel that has not changed in decades."

This creates challenges in packaging and interconnects. "As more data over an increasing number of connections grow within such a tight space, the density of wire harnesses increases, which runs the risk of insulation compression failures, especially in extreme environments when the system is enduring rugged conditions. This can cause signal integrity issues and potential failures, which is not an option," Tierney continues.

The Mercury model 6350 sensor and signal-processing system is designed to sit directly behind the antennae.

One challenge that Atrenne engineers have faced involves unmanned aerial vehicles (UAVs). "We work with a drone manufacturer that is acquiring data from cameras, both visual optics and IR, and displaying to a ground-based computer a topographical video of a landscape from over 60,000 feet in the air," Tierney says.

"Pointing out threats and opportunities in real-time, troops are more

The Mercury model 6350 is an eight-channel A/D and D/A Xilinx Zynq UltraScale+ RFSoC Processor in a small-form-factor rugged enclosure.

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.

To address these requirements, Fairview Microwave launched a new series of low PIM rated indoor wall mount and ceiling antennas as well as a series of outdoor rated omni-directional antennas. Fairview Microwave is ready to support 5G innovation, testing, and deployments, through an expansive product offering, product support, and a commitment to same-day shipping.

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aware of the situation when occupying unknown territories," Tierney continues. "The data load and processing requirements are massive. Between the shock and vibration caused by take-offs, landings, and turbulence, plus temperature and pressure variants, the embedded bus architecture and associated I/O medium needs to match the impedance characteristics to ensure flawless performance in moving the increased data required by today's leading-edge ISR platforms."

Challenges of ever-increasing amounts of sensor data are not expected to go away anytime soon. "Platforms are giant vacuum cleaners of the RF spectrum," says Shaun McQuaid, director of product management at sensor-processing specialist Mercury Systems in Andover, Mass. "That means we're seeing the amount of data expand so significantly, that commercial technology is being leveraged to handle those data streams."

Essentially that involves repackaging commercial data centers and high-performance networks as rugged embedded computing systems for aircraft, surface ships, submarines, land vehicles, and spacecraft — even for platforms as small as UAVs. This imposes difficult challenges on systems designers to deal not only with SWaP-C, but also with electronics cooling and thermal management; A/D and D/A converters; and finding the right mix of heterogeneous computer architectures that consist of central processing units (CPUs), field-programmable gate arrays (FPGAs), and general-purpose graphics processing units (GPGPUs) to handle the growing demands of sensor and signal processing.

"Where we have been is like setting up a home network on the platform," Mercury's McQuaid explains. "Today it is like setting up a small business on the platform, and doing a bit more. Where we are going is a true data center on the platform, with all the cloud computing infrastructure developed in the commercial world up at the front end doing AI and pre-pruning of all that sensor data."

Moving processors to the antenna

One of the primary ways that computers can deal with data overload is by preprocessing as it comes into RF and optical antennas. This involves digitizing the incoming analog signal as soon as possible, and performing some digital processing on the data before sending it on to heavy-duty processors elsewhere on the platform or on the network.

"They are digitizing right at the aperture now," says Marc Couture, director of C5ISR product management at the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va. "We have massive digital data being piped directly to our processors, and an increase in channels as well," This can help alleviate the load on a platform's main processors."

The job often is more difficult than it sounds. "We are seeing this distributed architecture more and more where sensors are on a mast, and we see local RF and signal processing happening right there at the antenna," says Rodger Hosking, vice president of Mercury Microelectronics, a wholly owned subsidiary of Mercury Systems (formerly Pentek) in Upper Saddle River, N.J. "We are eliminating a lot of noise and other things that can be picked up by RF cables."

Think of a data stream with noise, irrelevant information, and other extraneous material already eliminated before the data moves on to main processors. "Sometimes the DSP [digital signal processing] functions can do some local DSP functions that will reduce the amount of data that has to be sent down to the host," Hosking says.

Although the notion of moving pre-processors closely to antennas isn't exactly new, what is changing is the size of the pre-processors. "We were talking about a processing system next to the antenna, and now we are talking about that processing system resolved to a chip, where it used to be a couple of cards in a box," says Mercury's McQuaid. "It can be done on a chip, and that is a SWaP win. It also eliminates the problem of RF cabling from antenna to box, and gets it closer to the commercial model: routing and switching."

The Mercury SCFE6931 heterogenous processing module is powered by the Xilinx Versal field-programmable gate array system on chip, which combines provides digital processing and conversion all on the same chip.

Shrinking the size of preprocessors next to antennas has other design implications, as well. "As we get it closer and closer to the antenna, it frees-up size, weight, and power elsewhere in the system," McQuaid says. "Now those spaces are being filled with other digital processing equipment."

Influential applications

So what does all this capability bring to the table? "Application-wise, things like radar, EW [electronic warfare] image processing, and EO/IR [electro-optical and infrared sensing] are important," says Mercury's McQuaid. "Maybe I could do a signal capture and see a signal I haven't seen before, and develop a countermeasure for it because it is similar to a signal I have in my digital database."

Another potential application is intelligence, surveillance, and reconnaissance (ISR) with unmanned aerial vehicles with onboard sensors and sensor processors. "If you have a drone exploring a warfighting region, with these types of processors, this drone will be able to pick up signals to see what's down there at the RF spectrum, and redirect its mission and concentrate over regions with interesting features," says Mercury Processing's Hosking.

In addition, this kind of processing could enable several users on a network to use the same deployed sensor for different kinds of intelligence gathering. "One sensor could be distributed across a network to multiple users," Hosking says. "SIGINT [signals intelligence], radar, and image processing applications all could operate over network links using that broadband infrastructure. That will get it done."

Among the opportunities that advanced and networked sensor and signal processing capability provides is a growing use of artificial intelligence, otherwise known as AI, as well as machine learning for military applications. Data center-like embedded computing for digital signal processing can enable onboard processors to make decisions based on what their sensors perceive, learn from their experiences, and then share that information with other platforms in the area.

The Curtiss-Wright VPX3-1260 family of high-performance single-board computers is for mission computing; image and display processing; and intelligence, surveillance, and reconnaissance (ISR) systems.

"I feel strongly that artificial intelligence will play a big role in the future," says Mercury's McQuaid. "A lot of this DSP horsepower will be tied to AI applications," echoes Mercury Processing's Hosking. "AI can be used to make these unmanned vehicles and similar platforms smarter and more efficient." Adds Curtiss-Wright's Couture, "The sensors are all about extracting data. The sooner and faster you can do that, the faster you can make decisions."

Enabling technologies

Among the technology building blocks that are helping enable SWaP-optimized high-performance sensor and signal processing are fast A/D and D/A converters; network switching; diverse microprocessors; next-generation FPGAs that can contain RF circuitry; and high-performance thermal management and electronics cooling.

"The big technical trends that have had a macro effect certainly are A/D and D/A converters," says Curtiss-Wright's Couture. "As the sampling frequencies have increased and the bit resolutions have increased, the analog/digital divide narrows, and the digital circuitry is creeping up toward the apertures."

Echoes Jeff Bateman, product line manager for FPGAs and networking products for Curtiss-Wright Defense Solutions, "The digitization aspect and direct RF conversion can help capture and analyze more of the electromagnetic spectrum."

New generations of data converters are making the RF spectrum more accessible today than ever before. "You can't live without some type of RF processing," says Mercury Processing's Hosking. "The trend is to make it relatively simple. Now the A/D converters are so wide-bandwidth that you can do more processing after the digitization, which previously might have required sophisticated amplifiers or tuners."

In addition, the digital processors today offer capabilities that a decade ago couldn't even be imagined. "With the Intel Xeon processors you have processing engines that can ingest all of this data and do something with it in real time," says Curtiss-Wright's Couture. "One of the bigger game-changers is the introduction of GPGPUs. They once were in the sandbox for massive floating-point processing, but now they are bringing in all of the AI that designers need. An EW operator interpreting the data is getting a lot of help now.

"GPGPUs are doing a lot of the heavy lifting, and we are getting into the AI that can identify RF emitters of interest or do imaging processing, so analysts can concentrate on targets

WHO'S WHO IN SENSOR AND SIGNAL PROCESSING

Abaco Systems Inc.
Huntsville, Ala.
https://www.abaco.com

Acromag Inc.
Wixom, Mich.
https://www.acromag.com

Aitech Defense Solutions, Inc.
Chatsworth, Calif.
https://www.rugged.com

Atrenne
Brockton, Mass.
https://www.atrenne.com

Crystal Group
Hiawatha, Iowa
https://www.crystalrugged.com

Curtiss-Wright Defense Solutions
Ashburn, Va.
https://www.curtisswrightds.com

Elma Electronic
Fremont, Calif.
https://www.elma.com/en

Extreme Engineering Solutions Inc. (X-ES)
Middleton, Wis.
https://www.xes-inc.com

General Micro Systems
Rancho Cucamonga, Calif.
https://www.gms4sbc.com

Kontron America Inc.
San Diego, Calif.
https://www.kontron.com

Mercury Systems
Andover, Mass.
https://www.mrcy.com

Mercury Processing (formerly Pentek)
Upper Saddle River, N.J.
https://www.pentek.com

Systel Inc.
Sugar Land, Texas
http://www.systelusa.com

Xilinx Inc.
San Jose, Calif.
https://www.xilinx.com

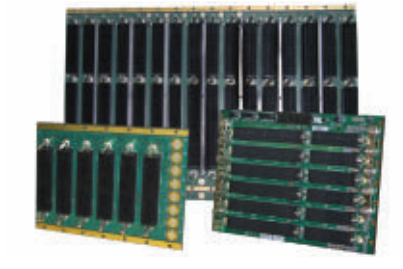
of interest that need their attention," Couture continues.

Now combine general-purpose processors, FPGAs, and GPGPUs in the same system and the capabilities expand exponentially. "We are seeing this kind of heterogeneous architectures, with general-purpose processors, FPGAs, and GPGPUs," Couture explains. "Different customers and different applications will change the ratios of those components."

Perhaps the biggest enabling technology in today's sensor and signal processing, however, involves the latest generation of FPGA systems-on-chip like the Versal device from Xilinx Inc. in San Jose, Calif. "The Versal extends what we are doing with RF system-on-chip," says Mercury Processing's Hosking. "In the future these Versal chips will have built-in data converters, but with wider bandwidth. This will transform signal-processing applications."

The RF system-on-chip, otherwise known as the RFSOC, "is a huge success for us, and has really changed the game, because it includes the digitizers, the FPGA resources, the ARM processors, and dual-100-Gigabit Ethernet engines," Hosking says. "That combination of resources has been very effective for distributed architectures."

Consolidating all those processing resources onto one chip offers huge benefits for system miniaturization, capability, and even for thermal management. "There used to be a lot of discrete parts with a distributed sample clock and trigger," says Curtiss-Wright's Couture. Now with it all in the FPGA there are massive benefits. You are not doing that on a printed wiring board and fighting the signal-integrity challenges. The common pool of FPGA logic is all co-located. This type of time difference of signal arrival, all on the same chip, is a big game changer."



The Atrenne Gen-3 OpenVPX backplanes are for 40 Gigabit systems, and are designed to the demanding signal integrity requirements in air-cooled or conduction-cooled development chassis.

Open-systems standards

Another technology driver with a big influence on today's sensor and signal processing systems is open-systems standards. Of these, perhaps the most notable is the Sensor Open Systems Architecture (SOSA) standard supervised by The Open Group in San Francisco. SOSA seeks to streamline existing industry standards, such as OpenVPX, to make them accessible for a wide variety of aerospace and defense systems, and help implement a true vendor-neutral design approach.

"SOSA is dominating all the VPX story. I've seen only a handful of RFPs and RFIs that were not SOSA related," says Mark Littlefield, senior manager embedded computing products and system solutions at chassis and networking specialist Elma Electronic in Fremont, Calif.

SOSA "is really all about ease of integration, knowing you can buy these components and it is plug-and-play; it will just works," Littlefield says.

Other industry standards coming to bear on sensor and signal processing include the small-form-factor VNX standard, which smaller than 3U VPX — circuit board dimensions about the size of a credit card. "With VNX modules you will see new life over the next 18 months, in problems that VPX won't fit," Littlefield says.

As an example, he cites the Common Launch Tube for small missiles or UAVs that is about 5.5 inches in diameter. "3U VPX won't fit; VNX does, but you might need seven or eight VNX problems in that space."

Honeywell to design quantum RF receiver technology for wideband precise sensors

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers needed a company to develop a small lightweight wideband radio frequency (RF) receiver with far higher sensitivity than technologies available today using quantum sensor as the receiving element. They found their solution from Honeywell Aerospace in Phoenix.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced a $5.5 million contract to Honeywell for the Quantum Apertures project.

Quantum sensing uses properties of quantum mechanics, such as quantum entanglement, quantum interference, and quantum state squeezing that have optimized for precision and beat current limits in sensor technology and evade the Heisenberg uncertainty principle.

Honeywell will help develop an RF and microwave receiver that is portable, programmable over a very large frequency range, and more sensitive than what classical systems can achieve at similar sizes and temperatures.

The quantum-based receiving elements will use excited Rydberg atomic states which have programmable sensitivity over a large range of frequencies and amplitudes.

Ultimately, the receiver system will be composed of a phase-sensitive array, lasers to program the sensor and read out radio signals, and processing electronics.

Honeywell researchers will develop enabling technologies to enable future researchers to capitalize on the receiver's enhanced capabilities to develop waveforms while also being compatible with constraints imposed by real-world defense applications.

The Quantum Apertures program has two technical areas: one that focuses on the receiver system and its application for military needs; and a focus on the sensor element itself.

The project will develop Rydberg sensor sensitivity in the 10 MHz to 40 GHz range with sensitivity below 10 to 16 Watts per square meter per Hertz (W·m-2·Hz-1) using a cubic centimeter sensor element. The project also will develop systems and waveforms that use these Rydberg sensors in other military research applications.

The goals are to improve sensor sensitivity in a small sensor; develop a continuous, fast, and broad frequency tuning capability; and develop individually addressable element arrays for detecting signal angle of arrival and channel parallelization for enhanced sensitivity or instantaneous bandwidth.

Photo (above): Honeywell is developing RF and microwave technologies that could lead to more precise sensors than have been designed before.

The project also seeks to expand compatibility to multi-frequency, spread spectrum, and other complex waveforms, including new waveforms that use the capabilities of Rydberg receivers; and to build quantum aperture receivers for future defense applications. For more information contact Honeywell Aerospace online at https://aerospace.honeywell.com, or DARPA at www.darpa.mil.

Air Force wants enabling technologies in high-power electromagnetic weapons

BY **John Keller**

KIRTLAND AIR FORCE BASE, N.M. — U.S. Air Force high-power electromagnetic (HPEM) weapons researchers are asking industry to develop new HPEM weapons concepts, materials, components, and compact power topologies for future military programs.

Officials of the Air Force Research Laboratory Directed Energy Directorate at Kirtland Air Force Base, N.M., have issued a broad agency announcement for the Advanced Electromagnetic Technology (AET) project.

This project also seeks to evaluate and capitalize on advances in prime power technologies to optimize size, weight, and power (SWaP) requirements for future HPEM weapon systems.

Photo (above): Advanced Electromagnetic Technology (AET) project may help lead to new generations of high-power electromagnetic (HPEM) weapons.

The five-year AET project revolves around six enabling technologies: repetitive pulsed power; charged particle beam interactions; compact low-duty-factor prime power HPEM material and plasma technology; HPEM fundamental research; and solid-state-HPEM.

Repetitive pulsed power seeks to advance compact pulsed-power technologies that enable compact, pulsed power systems suitable to drive high-power electromagnetic sources.

These enabling technologies include Marx banks, pulsed forming networks, pulse forming lines, linear transformer drivers, hybrid pulsed power topologies, nonlinear transmission lines, solid state switches, gas switches, capacitors, transformers, insulating dielectrics, varactors, resistors, magnetic and dielectric conducting and structural materials.

This research for high-power microwave weapons and similar systems also will develop prime power sources and strategies for compact energy storage, charging, discharging, and power conditioning of pulsed power systems for manned and unmanned aircraft. The research will include computer analysis and modeling of pulsed and prime power systems and components to predict and evaluate performance, operational suitability, and lifetime.

Charged particle beam interactions involves enabling technologies for high-energy particle beam weapons that can disable or destroy enemy electronic components and systems. This research effort can be divided into two components: the first component focuses on understanding and characterizing the effects that high energy particle beams can have on electronic systems, and the second component entails designing and building an accelerator with which to perform effects tests.

Compact low-duty-factor prime power seeks to develop compact prime power technologies for intermittent, high-power, pulsed operation, and high efficiency to function as compact energy storage and power conditioning sources for directed-energy systems like high-power microwave weapons and laser weapons.

HPEM material and plasma science and technology seeks to understand how millimeter wave radiation interacts with high-temperature materials to develop materials for power beaming applications.

HPEM fundamental research will work on the interactions of materials for next-generation high-power microwave weapons, including modeling, and testing of materials heated using high-power microwave or millimeter-wave radiation.

Solid-state HPEM seeks to develop nonlinear-transmission-line or other solid-state high power electromagnetic weapon concepts for future aircraft weapons. The effort will look into ruggedization, lifetime tests on system components, pulsed power, prime power sources, and antennas.

Companies interested were asked to submit proposals by 17 Aug. 2021 via the U.S. Department of Defense Secure Access File Exchange (SAFE) website at https://safe.apps.mil. Email questions or concerns to the Air Force's Susan Heidger at susan.heidger@us.af.mil. More information is online at https://sam.gov/opp/187749dbaa4848868dd9409305c4231d/view.

Jamming and spoofing of GPS satellite navigation signals keeps getting worse

The Cessna Citation Excel business jet was approaching the Sun Valley, Idaho, airport when something seemed off about its flight path. Like a lot of planes, it was tuned to GPS for guidance. Usually, that's a good thing. On this day in August 2018, however, a problem arose. The GPS signals near the airport were unreliable, and smoke in the area made for poor visibility. The midsize business jet was off-course and flying too low in the mountainous terrain. The likely cause for the wonky GPS readings? Military activity that caused jamming of the signals, according to an account from NASA's Aviation Safety Reporting System, which collates information provided by pilots, air traffic controllers and other aviation professionals. Fortunately, radar on the ground provided a more accurate reading, and controllers got the plane to its destination safely. It wasn't an isolated event. GPS is all too susceptible to jamming and its trickster cousin, spoofing. The signals used by aircraft, ships, farm tractors, and your smart phone originate from satellites 12,000 miles out in space. By the time they reach Earth, they're vanishingly weak and easily overwhelmed. A satellite launched in June to the GPS constellation represents a tiny step in making the service more secure. But satellites themselves face dangers. The precise signals from the Global Positioning System have worked their way into nearly every fabric of modern life, from recording bank transactions to synchronizing electrical grids to helping you find the nearest Starbucks. Businesses and individuals can use the system's PNT — positioning, navigation and timing — capabilities for next to nothing. In the U.S., GPS has about $1 billion a day in economic impact, according to the National Institute of Standards and Technology. It's also vital to the operations of the U.S. military.

Integration of shipboard sensors, communications, and weapon interfaces will be part of Constellation-class frigate's combat system integration by Lockheed Martin.

Lockheed Martin moves ahead with integrating frigate combat system and sensor

BY **John Keller**

WASHINGTON — Shipboard sensors experts at Lockheed Martin Corp. are moving ahead with initial design of the combat system aboard the future U.S. Navy Constellation-class frigate (FFG 62) under terms of a $7.9 million order announced in late June.

Officials of the Naval Sea Systems Command in Washington are asking the Lockheed Martin Rotary and Mission Systems segment in Moorestown, N.J., for contract options for combat system ship integration and testing on the future Constellation-class frigate.

USS Constellation will be the lead ship of the Constellation class of guided-missile frigates. Construction of the Constellation is to begin this year following the final design review, and should enter service in 2026. Navy leaders plan to buy 20 ships.

Lockheed Martin is designing the combat management system for the new frigates, based on the company's COMBATSS-21 ship combat management system, which is aboard the Freedom-class littoral combat ships.

COMBATSS-21 is built on an open-architecture scalable framework using non-developmental software, Lockheed Martin officials say. Custom software adapters called boundary components support sensors, communications, and weapon interfaces, and are designed to accommodate future technology insertion and system upgrades with minimal effect on the system[s core software.

Frigates are relatively small, light, and fast surface warships that protect the powerful capital ships, and provide escort protection and help with command and control for lightly armed naval surface warships, as well as to commercial or military merchant ships.

Frigates play a crucial role of keeping naval battle groups together, intact, and functioning in the face of the enemy. They screen ships from aircraft and submarine attack, and can act as advance scouts to determine what's beyond the battle group's horizon.

In addition to developing the combat management system for the Navy's future Constellation-class frigates, Lockheed Martin also builds the Navy's Aegis combat system for Navy Arleigh Burke-class destroyers and Ticonderoga-class cruisers at its Moorestown, N.J. facility.

Lockheed Martin now builds the combat management system for the Navy's Freedom-class littoral combat

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L3Harris developing unmanned surface vessel for electronic warfare (EW) and intelligence

BY **John Keller**

WASHINGTON — Unmanned vehicles experts at L3Harris Technologies Inc. are moving forward in a project to design and build a prototype Medium Unmanned Surface Vehicle (MUSV) for intelligence gathering and electronic warfare (EW) missions.

Officials of the Naval Sea Systems Command in Washington are asking the L3Harris Technologies Unmanned Maritime Systems division in Broussard, La., for engineering and technical support for the Medium Unmanned Surface Vehicle program under terms of a $60.5 million contract announced in July.

One year ago the Navy awarded L3Harris a $35 million contract to build a prototype MUSV, with options for eight more; the contract collectively could be worth as much as $281.4 million.

The MUSV is to be a pier-launched, self-deploying, modular open-systems architecture surface vessel capable of autonomous safe navigation and military operations. It will be 195 feet long, with displacement of about 500 tons — or about the size of a U.S. Coast Guard inland construction tender.

MUSVs will help the Navy deploy intelligence, surveillance, reconnaissance, and EW capabilities, and provide distributed situational awareness and sensing to the fleet.

The unmanned surface vessel will have the L3Harris ASView autonomy technology, and will maneuver autonomously and will comply with international collision regulations, even in operational environments.

L3Harris is the systems integrator and provides the mission autonomy and perception technology as the prime contractor on the program. The program team includes Gibbs & Cox, a Leidos company in Arlington, Va., and Incat Crowther Pty Ltd in Lafayette La., which will provide the ship design; and Swiftships in Morgan City, La., which will complete the vessel's construction.

The prototype MUSVs will be for experiments before the Navy moves into a follow-on effort to refine the program. L3Harris is to complete the first prototype MUSV as early as late 2022.

On this contract L3Harris will do the work in Morgan City, Jeanerette, New Orleans, and Lafayette, La.; Arlington, Va.; and Worthington, Ohio, and should be finished by December 2022.

The future Medium Unmanned Surface Vehicle (MUSV) will be 195 feet long, with displacement of about 500 tons — or about the size of a U.S. Coast Guard inland construction tender.

For more information contact the L3Harris Technologies online at www.l3harris.com; Gibbs & Cox at www.gibbscox.com; Incat Crowther at www.incatcrowther.com; Swiftships at https://swiftships.com; or Naval Sea Systems Command at www.navsea.navy.mil.

Researchers eye artificial intelligence (AI) and machine learning able to share experiences

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking industry to devise a new kind of artificial intelligence (AI) computer programming that enables computers not only to learn from their experiences, but also to share their experiences with other computers.

Officials of the U.S. Defense Advanced research Projects Agency (DARPA) in Arlington, Va., issued an artificial intelligence exploration opportunity (DARPA-PA-20-02-11) for the Shared-Experience Lifelong Learning (ShELL) project.

ShELL seeks to advanced computer sciences in lifelong learning by computers that share experiences with each other. Lifelong learning is a relatively new area of machine learning research, in which computers continually learn as they encounter varying conditions and tasks while deployed in the field.

This differs from the train-then-deploy process for typical machine learning systems, which often results in unpredictable outcomes; catastrophic forgetting of previously learned knowledge; and the inability to execute new tasks effectively, if at all.

Current lifelong learning research assumes one independent computer that learns from its own actions and surroundings; it has not considered populations of lifelong learning computers that benefit from each other's experiences.

The total award value for the combined phase-one base and phase-two option is limited to $1 million per proposal.

Algorithms used for lifelong learning typically require large amounts of computing resources, including server farms, graphics processing units (GPUs), and other resource-consuming hardware, and typically do not have to address communication resource limitations.

The Shared-Experience Lifelong Learning (ShELL) program extends current lifelong learning approaches to large numbers of originally identical computers. When these computers are deployed, they may encounter different input and environmental conditions, execute variants of a task, and therefore learn different lessons.

Other computers could benefit if one computer could share what it has learned with the other computers. Such sharing of experiences could reduce the amount of training required by any individual computer.

ShELL is distinct from approaches that reward a federation of computers for collaborating or competing on a common global task, either by dividing the task into pieces, by assembling alternative approaches to the same task, or by evolving specialized roles.

ShELL rewards computers individually according to their performance on their own tasks using lessons learned from their own actions combined with those acquired from other computers.

ShELL has three core challenges: what knowledge should be shared and incorporated; when and how should computers share their knowledge; and develop lifelong learning algorithms that account for the size, weight, computing, and communications constraints of the platforms supporting each learning computer.

DARPA researchers say they would like to award a ShELL contract by late September. Companies were asked to upload proposals by 27 July 2021 to the DARPA BAA portal at https://baa.darpa.mil. Email questions or concerns to Ted Senator, the ShELL program manager, at ShELL@darpa.mil. More information is online at https://sam.gov/opp/1afbf600f2e04b26941fad352c08d1f1/view.

Researchers are trying to create artificial intelligence (AI) computers that can learn from their experiences and share that knowledge with other computers.

Aurora to replace control surfaces on electric aircraft with actuators or effectors

BY **John Keller**

ARLINGTON, Va. — Electric aircraft designers at Aurora Flight Sciences Corp. in Manassas, Va. are moving forward with a project to push the bounds of future electric aircraft by eliminating control surfaces like ailerons, rudders, and flaps.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced a $12.4 million order to Aurora to move to phase-one of the Control of Revolutionary Aircraft with Novel Effectors (CRANE) project.

In this phase Aurora Flight Sciences electric aircraft experts will validate analytical predictions, carry out control loop analyses, and perform modeling verification. The company won a $7.1 million DARPA CRANE contract in June 2020 to craft configuration-agnostic designs, conduct geometric and technology trade studies, and produce process documentation.

Instead of using ailerons, rudders, and flaps for control surfaces on future electric aircraft, the CRANE project seeks to use actuators or effectors to add energy or momentum to the flow of air over the aircraft.

In the future the CRANE project will move to testing integrated subsystem components, and then fabricate, assemble, ground-test, and flight-demonstration.

Aurora engineers are trying to inject a disruptive technology early in aircraft design with new flow-control technologies and design tools. The idea is to configure and optimize an aircraft with active flow control to enhance efficiency and effectiveness of new commercial and military aircraft.

The DARPA CRANE project seeks to replace traditional control surfaces on all-electric aircraft with actuators or effectors.

Passive control involves geometrical modifications like vortex generators on an aircraft wing for flow separation control, or chevrons on an exhaust nozzle of an aircraft to mitigate noise. Passive control devices always are on, no matter the need or performance penalty.

Active flow control, on the other hand, involves energy or momentum addition to the flow in a regulated manner. It is more desirable than passive control because aircraft pilots can turn it on or off as necessary.

Active flow control alters the aircraft's aerodynamic flow field through mechanical actuators, or by ejection or suction on a wing, fuselage, inlet, or nozzle.

Effectors and actuators typically are the enabling technologies of active flow control, yet have been the weakest link in developing active flow-control technology. Despite their relatively high costs, effectors and actuators typically are light weight, have no moving parts, and are energy-efficient.

Aurora is demonstrating new active flow control on an X-plane, with a focus on the best ways to develop and flight demonstrate their flow-control technologies on a clean-sheet design or modification of an existing aircraft.

The CRANE project excludes large external moving surfaces like ailerons, rudders, flaps, elevators, and trim surfaces; mechanical vectoring of engine jet exhaust, or other traditional moving aerodynamic control devices.

CRANE's goal is to demonstrate in flight that active flow-control actuator technologies can maintain flight safely, and provide quantifiable aircraft capabilities.

On this order Aurora will do the work in Manassas, Va.; Tucson, Ariz.; St. Louis; and Los Angeles, and should be finished by April 2021. For more information contact Aurora Flight Sciences online at www.aurora.aero, or DARPA at www.darpa.mil.

Teledyne Brown to build undersea glider UUVs that gather data for hunting submarines

BY **John Keller**

SAN DIEGO — U.S. Navy anti-submarine warfare (ASW) experts needed unmanned underwater vehicles (UUVs) that gather data to help Navy surface ships, submarines, and aircraft find and attack enemy submarines.

Officials of the Naval Information Warfare Systems Command in San Diego announced a $27.4 million five-year contract in late June to Teledyne Brown Engineering Inc. in Huntsville, Ala. to build and upgrade UUVs for the Navy's Littoral Battlespace Sensing-Glider (LBS-G) program.

The Navy operates about 180 LBS-G systems, which are manufactured by Teledyne Brown for search, detection, navigation, and guidance. The UUVs can operate for as long as 90 days, dive as deep as 657 feet.

These undersea gliders use minute amounts of electric power by adjusting their buoyancy to glide from the surface to their maximum depths to cover large ocean distances in much the same way that an aircraft glider moves from high altitudes to their landing spots on the ground while covering as much distance as possible.

These gliders measure the sea's temperatures, salinity, and other qualities over large areas to provide Navy experts with data they need to hunt enemy submarines.

The contract calls for Teledyne Brown to provide program management, engineering support, production, maintenance, repairs, test, training, documentation updates, spares, system upgrades, and other logistics tasks for the LBS-G program.

Undersea gliders use minute amounts of electric power by adjusting their buoyancy to glide from the surface to their maximum depths to cover large ocean distances.

After the glider reaches its maximum depth, it alters its buoyancy to float to the surface, sticks antennas out of the water, and transmits the data it gathers to orbiting satellites.

The LBS-G unmanned gliders generally deploy from oceanographic survey ships and measure water conditions to help fleet operational planning or to help hunt enemy submarines.

On this contract Teledyne Brown will do the work in Huntsville, Ala., and should be finished by June 2026. For more information contact Teledyne Brown Engineering online at https://tbe.com/maritime, or the Naval Information Warfare Systems Command at www.navwar.navy.mil.

Navy may consider Expeditionary Fast Transport (EPF) as an autonomous UAV carrier

The U.S. Navy Expeditionary Fast Transport (EPF) surface vessel is a catamaran-like transport ship formerly dubbed the Joint High Speed Vessel. Now the Navy is exploring machine autonomy for this ship. Ordinarily, in addition to its passengers, an EPF carries a crew of 26 — but the USNS Apalachicola (EPF 13) will be designed to operate in autonomous mode either with a crew or without. The ship will include a perception and autonomy control suite, as well as several automation enhancements to reduce the number of personnel necessary for operations and maintenance at sea, say officials of the vessel's manufacturer, Austal USA in Mobile, Ala. The ship even could be operated entirely remotely as an unmanned surface vessel. Navy leaders may consider using the EPF for the Large Unmanned Surface Vessel (LUSV) by adding vertical missile launch cells to convert the ship to a robotic guided-missile cruiser. The flat-topped EPF also is designed to support helicopter operations, so it has potential to support unmanned helicopters for autonomous flight operations.

Walking vehicles need more maturation before they can come into their own

New work from the U.S. Army Research Laboratory in Adelphi, Md., suggests that while walking vehicles have made little progress so far, in the future they may stand tall beside other military vehicles. Even walking tanks may not be impossible. Pentagon leaders have looked at walkers before, perhaps most famously with the Boston Dynamics BigDog, a quadruped robot made famous by YouTube videos that was intended to be a robotic load carrier for foot soldiers. While it was popular with viewers, however, BigDog's successor LS3 was deemed too noisy to use in the field and the program was discontinued in 2015. Still, the past may not be a good guide. "Legged machines are by no means doomed," says Alexander Kott of the U.S. Army Research Laboratory (ARL), lead researcher on a new project. "This technology needs more maturation, and with maturation will likely come better tradeoffs between adaptability and efficiency."

Army starts testing unmanned aircraft with sensors and weapons payloads

The U.S. Army has released a new video giving the first look at a new and classified weapon called "Long Range Effect" — an unmanned aircraft with onboard sensors and weapons payload that flies under operator control to locate targets and then attacks them like a missile. The new weapon is part of a family of munitions known as Air Launched Effects (ALE). These munitions launch from helicopters or other Army light aircraft like the Future Attack Reconnaissance Aircraft (FARA), as well as from Army combat vehicles. The video was taken at the Experimentation Demonstration Gateway Event 2021, commonly known as Edge 21, at Dugway Proving Ground, Utah, in May. The appearance in the new video is of the blink-and-you'll-miss it type, just a handful of frames at the 48-second mark, plunging down and obliterating a dummy mobile radar system. These long-range weapons are in addition to the SwitchBlade munition, launched from a bazooka-like tube, which U.S. ground forces use against high-value targets in Iraq and Afghanistan for some years, and the new, larger SwitchBlade 600, which seems to be aimed at the ALE market.

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ships. Independence-class littoral combat ships, meanwhile, use a combat system developed by Northrop Grumman Corp.

The Lockheed Martin COMBATSS-21 architecture isolates shipboard sensors, communications, and weapons from core components of the command and control system to avoid large system bugs and speed software certification.

COMBATSS-21 can run on computer configurations ranging from one commercial processor running a commercial operating system to more distributed configurations, to enable the COMBATSS-21 system adaptable to vessels ranging from patrol craft to large-deck ships, Lockheed Martin officials say.

The Lockheed Martin COMBATSS-21 combat management system borrows technology from Navy Aegis cruisers and destroyers, as well as the U.S. Coast Guard Deepwater program.

The overall systems integrator for the future Constellation-class frigates is Fincantieri Marinette Marine in Marinette, Wis. The new ship will displace 6,700 tons of water, will be 496 feet long, 65 feet wide, and draw 26 feet of water. It will be able to steam faster than 26 knots, and will have a range of 6,000 nautical miles. The new frigate will have a 140-member crew.

Shipboard electronics will include the Lockheed Martin COMBATSS-21 combat management system; AN/SPY-6(V)3 Enterprise Air Surveillance Radar (EASR); AN/SPS-73(V)18 surface search radar; AN/SLQ-61 lightweight towed array sonar; AN/SQS-62 variable-depth sonar; AN/SQQ-89F undersea warfare and anti-submarine warfare combat system; and Cooperative Engagement Capability (CEC).

The Constellation-class frigate will accommodate 32 Vertical Launch System cells that can handle RIM-162 ESSM Block 2 and/or RIM-174 Standard ERAM missiles; RIM-66 Standard SM-2 Block 3C; the Naval Strike Missile; RIM-116 Rolling Airframe Missile; Mk 110 57-millimeter gun; and machine guns. The ship will be able to carry one MH-60R Seahawk helicopter and the MQ-8C Firescout unmanned helicopter.

On this order Lockheed Martin will do the work in Moorestown, N.J.; Marinette, Wis.; Bath, Maine; and Pascagoula, Miss., and should be finished by June 2022. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, Fincantieri Marinette Marine at https://fincantierimarinettemarine.com, or Naval Sea Systems Command at www.navsea.navy.mil.

A new generation of ultra-short-pulse fiber lasers may lead to future laser weapons small enough to fit aboard high-performance combat aircraft.

Air Force asks industry for ultra-short-pulse fiber lasers for future laser weapons

BY **John Keller**

KIRTLAND AIR FORCE BASE, N.M. — U.S. Air Force laser weapons experts are reaching out to industry for enabling technologies that could lead to ultra-short-pulse fiber lasers for future directed-energy weapons.

Officials of the Air Force Research Laboratory Directed-Energy Directorate at Kirtland Air Force Base, N.M., has issued a request for information (RFI-RDKP-2021-0003) in July for the Ultrashort High Average Power Technology Availability project.

Researchers want to develop and demonstrate new techniques for high-average-power laser radiation for future military applications that today are limited by the available laser technology.

Air Force researchers want information from industry concerning the maturity, availability, and rough estimate of cost of an ultra-short-pulse fiber laser system for future military applications that produce high average power at a high repetition pule rate.

Researchers interested in a ultra-short pulse laser fiber laser weapon capability for a future acquisition program that will use an ultra-short-pulse laser fiber laser to destroy or disable targets, as well as capitalize on non-linear propagation for high laser intensities at the target.

Proposed solutions should be low size, weight, and power consumption (SWaP), and may use either a monolithic or partly free-space architecture based on single-laser amplifier or beam-combining parallel amplifiers.

Air Force experts want to find out about fiber laser systems that are available or being developed that produce average power of more than 0.5 kilowatts at pulse repetition frequencies of more than 5 kHz, and use pulse widths narrower than 5 picoseconds. Such qualities could lend themselves to radiation bursts and particle beams able to disable or destroy military targets.

Companies interested were asked to upload five-page responses by 13 Aug. 2021 to the U.S. Department of Defense Secure Access File Exchange (SAFE) website at https://safe.apps.mil.

More information is online at https://sam.gov/opp/e39914720003417280d7285ec515f3b5/view.

Raytheon to build 565 AIM-9X Block II infrared-guided air-to-air missiles

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy aerial warfare experts are asking Raytheon Technologies Corp. to build 565 AIM-9X precision short-range infrared-guided air-to-air missiles for jet fighters and other combat aircraft under terms of a $328.2 million contract.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Raytheon Missiles & Defense segment in Tucson, Ariz., to build lot-21 AIM-9X block II and block II-plus air-to-air missiles.

These anti-aircraft missiles are for the U.S. Navy, Air Force, and foreign allies.

The order is for AIM-9X Block II and II-plus tactical missiles; captive air training missiles; special air training missiles; all-up round containers; spare advanced optical target detectors; spare advanced optical target detector containers; spare Block II guidance units; spare Block II-plus guidance units; guidance unit containers for U.S. allies; spare captive air training missile guidance units; spare Block I propulsion steering sections; spare Block II propulsion steering sections; spare Block II electronics units; classroom explosive ordnance disposal systems trainers; a practical explosive ordnance disposal systems trainer; multi-purpose training missiles; tail caps; tail cap containers; and spares assets.

The short-range AIM-9X is an infrared-guided heat-seeking missile that equips most U.S. jet fighters, fighter-bombers, and other offensive combat aircraft.

The AIM-9X is an infrared-guided heat-seeking missile that equips most jet fighters, fighter-bombers, and other offensive combat aircraft in the U.S. arsenal, and is for shooting down enemy aircraft close-by. The AIM-9X works by homing in on an enemy aircraft's hot engine exhaust. Variants of the AIM-9 Sidewinder have been deployed since the 1950s.

The AIM-9X is among the latest versions of the AIM-9 missile family. It entered service in 2003 on the Navy F/A-18C Hornet fighter-bomber and on the U.S. Air Force F-15C jet fighter. It has an imaging infrared focal plane array seeker with 90-degree off-boresight capability for accuracy.

The missile is compatible with helmet-mounted displays such as the U.S. Joint Helmet Mounted Cueing System, and features 3-D thrust-vectoring control for increased turn capability. The AIM-9X also includes an internal cooling system.

This contract involves the latest versions of the AIM-9X, called the AIM-9X Block II and AIM-9X Block II-plus. This newest version has lock-on after launch capability for use with the F-35 Lightning II joint strike fighter and the F-22 Raptor advanced tactical fighter.

The AIM-9X Block II-plus features specialized external materials to enhance aircraft survivability for the F-35. Until another version of the AIM-9X is developed that will fit inside the F-35's enclosed weapons bay, the AIM-9X Block II-plus has stealthy coatings and structures to help reduce the missile's radar cross-section when the F-35 carries these missiles externally.

On this contract Raytheon will do the work in Tucson, Ariz.; North Logan, Utah; Keyser, W.Va.; Niles, Ill.; Vancouver, Wash.; Ottawa; Goleta, San Jose, Valencia, Anaheim, Cajon, San Diego, Chatsworth, and Claremont, Calif.; Cheshire and Simsbury, Conn; Heilbronn, Germany; Cincinnati; Anniston, Ala.; Amesbury, Mass.; and Sumner, Wash., and should be finished by June 2024.

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

Lockheed Martin to build three MH-60R anti-submarine warfare (ASW) helicopters

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy anti-submarine warfare (ASW) experts are asking Lockheed Martin Corp. to build three MH-60R ASW helicopters as replacement-in-kind for the Navy under terms of a $129 million order.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station are asking the Lockheed Martin Rotary and Mission Systems segment in Owego, N.Y., to build the new MH-60R helicopters, one of the latest versions of the Sikorsky Seahawk, which is based on the U.S. Army Sikorsky UH-60 Black Hawk utility helicopter.

The multimission MH-60R helicopters have sophisticated sensors, and are designed for anti-submarine and anti-surface warfare. The MH-60R is designed to operate from frigates, destroyers, cruisers, and aircraft carriers. The helicopter has a hinged tail to reduce its necessary storage area aboard ships.

Among the avionics subsystems aboard the MH-60 is the Multi-Spectral Targeting System (MTS), a turreted forward-looking pod combining several visible-light and infrared video cameras for long-range surveillance and high-altitude target acquisition, tracking, and laser designation.

The MH-60R cockpit also has secure VHF/UHF communication; inertial navigation system; satellite communications; data link; and accommodation for forward-looking infrared sensors and night-vision goggles.

In addition to its anti-submarine and anti-ship capabilities, the helicopter can handle naval special warfare insertion; search and rescue; combat search and rescue; and vertical replenishment.

The Navy MH-60R helicopters have avionics that include the common datalink AN/SRQ-4 Hawklink shipboard terminal system from the L3Harris Communication Systems-West in Salt Lake City.

The AN/SRQ-4 Hawklink shipboard terminal enables surface ships like the Arleigh Burke-class destroyer and the MH-60R helicopter to share information from radar, video, network, and acoustic data interfaces, and enables naval personnel to use aircraft sensor data in real time to extend situational awareness over the horizon.

MH-60R pilots use helmet display tracker systems (HDTS) from Elbit Systems of America in Fort Worth, Texas, which provides situational awareness and targeting enhancements via pilot/copilot line-of-sight capability; continuously computed impact point for the 20-millimeter automatic gun helicopter armament subsystem; LAU-61C/A 2.75-inch unguided rockets; and LAU-61G/A precision guided digital rocket launcher.

The helicopter also has the AN/APS-153(V)1 automatic radar periscope detection and discrimination multi-mode radar from Telephonics Corp. in Farmingdale, N.Y., which is designed to detect and classify submarine periscopes as they pop briefly out of the water.

The MH-60R uses many sensors, including the ASE package, MTS-FLIR, the AN/APS-147 multi-mode radar/IFF interrogator, an advanced airborne fleet data link, and an airborne active sonar. The helicopter includes instrumentation based on the MH-60S glass cockpit, and uses digital monitors instead of an array of gauges and dials.

On this order Lockheed Martin will do the work in Owego, N.Y; Stratford, Conn.; and Troy, Ala., and should be finished by May 2025. For more information contact Lockheed Martin Rotary and Mission Systems online at www.lockheedmartin.com, or Naval Air Systems Command at www.navair.navy.mil.

British military seeks to develop cooperative missiles

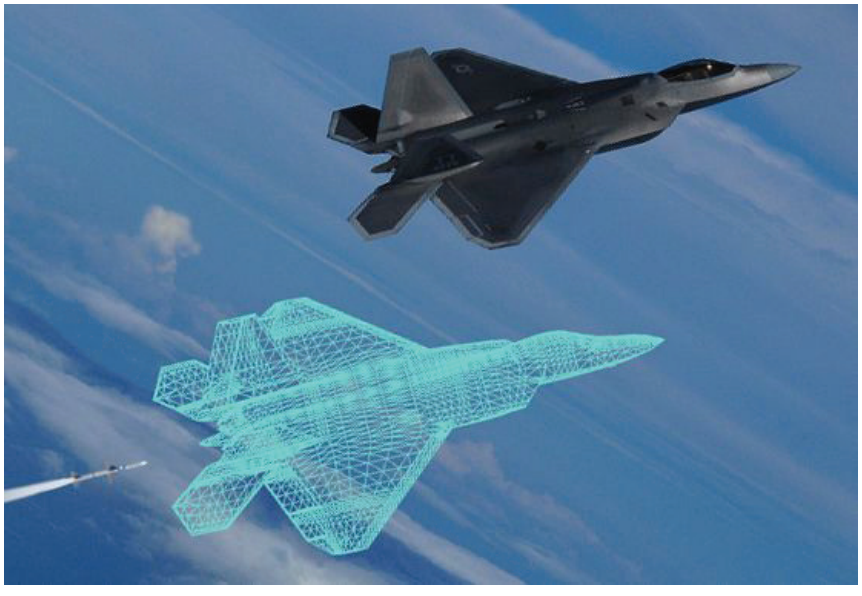
The United Kingdom Ministry of Defence is investing $4.8 million for the Co-operative Strike Weapons Technology Demonstrator (CSWTD) program to develop systems to enable missiles in flight to communicate with one another. Back in the 1960s, the first laser-guided munitions, nicknamed smart bombs, simply could be steered toward their target by a pilot or weapons officer Five decades later we're seeing an emerging generation of weapons that are smart enough to gather data, assess situations, and alter their plans to achieve their objectives. For such weapons to be effective, they need to operate as a team rather than in a top-down fashion. British military experts will look at developing new hardware and software that will make missiles more cooperative. The two-year project began in April 2021 and the new technology could be integrated into a smarter integrated network of missiles within five years.

U.S. Space Force sends wish list to Congress that includes space surveillance satellites

The U.S. Space Force is asking Congress for $832 million over its $17.4 billion budget request for its unfunded priority list — an annual wish list of spending every service sends lawmakers. The request sent June 3 to Congress includes additional funding for dozens of programs, repairs to Space Force facilities, and $279 million in classified spending to "develop a war fighting punch." The Space Force wish list sets aside $113 million to grow new missions. That includes $28 million toward radio frequency payloads for the Defense Advanced Research Projects Agency's Blackjack program, which seeks to demonstrate the utility of a proliferated constellation of networked satellites in low Earth orbit for the military. With this request, Space Force would test new space-based intelligence, surveillance and reconnaissance capabilities on orbit in fiscal 2022 and 2023 to inform future investment.

Army to compete Future Long-Range Assault Aircraft (FLRAA) between Bell- and Boeing-Sikorsky-led teams

U.S. Army officials have launched the service's Future Long-Range Assault Aircraft (FLRAA) competition, quietly releasing a request for proposals limited to two industry teams. The service has also homed-in on a schedule to deliver FLRAA prototypes after debating two different options to stay on schedule. Army officials weighed the option of pursuing both prototype builds for the airframe and the weapons systems at the same time, or on slightly separate schedules, which would have meant the difference between delivering full prototypes to the Army by the spring or the summer of 2025. The Army will choose a winner — after a faceoff between Textron's Bell and a Sikorsky-Boeing team — in winter or spring 2022. The Army scheduled a preliminary and detailed design review to take place from spring 2022 to winter 2024, but that timeline is not broken down.



ELECTRONIC WARFARE

Mercury to provide airborne electronic warfare (EW) technology to confuse enemy radar

Electronic warfare (EW) experts at Mercury Systems will continue work on DRFM-based airborne electronic attack technology for the U.S. Navy that can confuse enemy radar by projecting several different false radar images.

Officials of the U.S. Naval Air Systems command at Patuxent River Naval Air Station, Md., announced an $11.8 million order to the Mercury Defense Systems subsidiary in Cypress, Calif., last week for Advanced Digital Radio Frequency Memories (A-DRFM) systems and components.

This project is related to DRFM electronic jammers, which provide coherent time delay of RF signals in applications like radar and electronic warfare. It also produces coherent deception radar jamming by replaying a captured radar pulse with a small delay, which makes the target appear to move.

This order procures 12 type I.v1 A-DRFM production units, each configured with two 18 GHz radio frequency converter modules and two micro-DRFM modules; and seven Type II.v3 A-DRFM production units, each configured with four 7-11 GHz radio frequency converter modules and four micro-DRFM modules.

The contract also is for data for the Small Business Innovation Research (SBIR) Phase III effort for Advanced Techniques for Digital Radio Frequency Memories RF and microwave technologies for the U.S. Navy and Air Force.

DRFM also can modulate captured pulse data in amplitude, frequency, and phase to provide other affects. A Doppler shift correlates range and range rate trackers in the radar. DRFM also can replay captured radar pulses many times to fool the radar into perceiving many targets.

Mercury has developed the modular digital receiver exciter (MoDREx) to complement systems employing full EW suites under a previous Navy SBIR contract. MoDREx is a flight-qualified suite of subassemblies with capabilities researched and demonstrated under Navy SBIR N06-036 Advanced Techniques for DRFMs.

The system helps generate electronic attack (EA) techniques, ranging from individual emitters to several independently operated emitters. MoDREx emitter filtering separates several emitter signals, while its adaptive technique generation responds to emitter changes.

Mercury engineers derived MoDREx from the company's domain expertise in flight test and training DRFM subsystems and tactical DRFM solutions. It supports emerging EW applications that do not have or cannot afford a full EW radar warning receiver, Mercury officials say. The modular architecture of MoDREx enables systems integrators to tailor system capabilities to the application or mission.

MoDREx technology features integrated wideband digital; Receiver and Controller; one to six RF converter modules; one to twelve micro-DRFM modules; integrated wideband digital receiver/controller; emitter characterization and identification; a library of electronic attack techniques matched to input signal characteristics; ability to track as many as 12 simultaneous time coincident emitters; multi-threat signal sorting and routing to assigned RF converter and micro-DRFMs.

This technology also offers characterization and logging support; post analysis/verification/validation; tunable RF converter modules, each assigned to a tracked emitter; converts emitter band to micro-DRFM instantaneous bandwidth (IBW); Expandability to varying performance and bandwidth; modules that integrate a DRFM, techniques generator, and tracker; eight bits amplitude encoding at 1 GHz IBW; internal techniques against several emitters; several simultaneous electronic attack response and emitter signals; as many as eight independent electronic attack response/targets/modules; and programmable electronic attack response to targets for range, Doppler, amplitude, phase, noise, and arbitrary waveform generation.

Small packages, fast response, and large volumes of low-latency compute power define modern DRFM evolution, Mercury officials say. The company can produce DRFM modules as thin as 0.44 inches that capitalize on direct digital synthesizer (DDS) local oscillator (LO) technology.

DDS delivers sub-microsecond tuning speeds over a wide bandwidth, while advanced circuit design and simulation helps reduce spurious, inter-module and phase noise.

Mercury Defense Systems, formerly KOR Electronics, has developed the Mercury Airborne 1225 advanced DRFM electronic warfare (EW) jammers to support Navy and Air Force aircraft.

Mercury engineers developed the Mercury Airborne 1225 ruggedized air-cooled, airborne 3-bit miniaturized digital RF memory (DRFM) for airborne, pod, and unmanned aerial vehicle applications with as much bandwidth as 1200 MHz. It is self-contained with internal techniques and RF and power supplies.

On this order Mercury will do the work in Cypress, Calif., and West Caldwell, N.J., and should be finished by December 2022. For more information contact Mercury Systems online at www.mrcy.com, or Naval Air Systems Command at www.navair.navy.mil.

INTELLIGENCE ANALYSIS

DARPA asks Protagonist to track enemy propaganda campaigns in social media

U.S. military researchers needed a company to help military intelligence experts make sense of enemy propaganda campaigns on social media and other online multimedia content. They found a solution from Protagonist Technology LLC in San Francisco.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., announced a $5.4 million contract to Protagonist last week for the Influence Campaign Awareness and Sensemaking (INCAS) project.

INCAS seeks to uncover computational techniques and tools that help intelligence analysts detect and make sense of geopolitical online influence campaigns on social media and in other multimedia online content. Additional contracts may be awarded.

The U.S. is engaged with its adversaries in an asymmetric and continual war of weaponized influence narratives, DARPA researchers point out. Adversaries exploit misinformation and true information on blogs, tweets, and other online multimedia content.

INCAS seeks to develop computer tools to enable analysts to make sense of vast, noisy, and adaptive information to identify adversary influence campaigns.

Today, the ability to detect and make sense of geopolitical influence campaigns largely is a manual and ad hoc process. Analysts use social listening tools to formulate complex keyword queries; track trending keywords, hashtags, and topics; and read hundreds to thousands of documents to identify influence themes.

New or low-and-slow campaigns are difficult to detect early. Today's tools make it difficult to connect messages over time and across several platforms to track and assess evolving campaigns. Analysts must sift manually through many messages.

Marketing tools for analyzing audience demographics, interests, and personality, for example, lack explanatory and predictive power for deeper issues of geopolitical influence.

Instead, INCAS seeks to develop tools with automated influence detection to detect implicit and explicit indicators of geopolitical influence in multilingual online messaging. Protagonist Technology experts will develop tools that dynamically segment the responding population and identify psychographic attributes such as world views, morals, and sacred values.

INCAS primarily will use publicly available data sources including multilingual, multi-platform social media, online news sources, and online reference data.

INCAS has five technical areas: influence indicator detection; population response characterization; influence campaign modeling; data and testbed development; and program evaluation. For more information contact Protagonist Technology online at www.protagonist.io, or DARPA at www.darpa.mil.

TACTICAL NETWORKING

Navy asks ViaSat for secure data capability, Link 16, and cryptography for MIDS-LVT

Secure communications experts at ViaSat Inc. in Carlsbad, Calif., will modernize cryptography

and enhance data throughput in a U.S. military secure digital data and voice communications system under terms of a $19.5 million order.

Officials of the Naval Information Warfare Systems Command (NAVWARSYSCOM) in San Diego are asking ViaSat for Multifunctional Information Distribution System (MIDS) Low Volume Terminals (LVT) to procure secure data units (SDUs) that support MIDS-LVT terminals and Link 16 capabilities.

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

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

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

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

Link 16 is defined as one of the digital services of the JTIDS / MIDS in NATO's Standardization Agreement STANAG 5516. MIL-STD-6016 is the related United States Department of Defense Link 16 military standard.

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

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

On this order ViaSat will do the work in Carlsbad, Calif., and should be finished by June 2025. For more information contact ViaSat online at www.viasat.com, or NAVWARSYSCOM at www.navwar.navy.mil.

COMMAND AND CONTROL

Johns Hopkins to help design GBSD ballistic missile as Minuteman III replacement

U.S. Air Force strategic weapons experts are choosing John Hopkins University to provide research support for the next-generation U.S. intercontinental ballistic missile (ICBM) to replace the Minuteman III under terms of a 10-year contract worth more than half a billion dollars.

Officials of the Air Force Nuclear Weapons Center at Hill Air Force Base, Utah, are asking experts from the Johns Hopkins Applied Physics Laboratory for research and development services in support of the nuclear enterprise in a $530 million contract, as well as for research to support the Ground Based Strategic Deterrent (GBSD) weapon system, which will replace Minuteman III, in a $23.7 million order.

The GBSD missile is the follow-on to the aging LGM-30G Minuteman III ICBM and first became operational in 1970. The GBSD ICBM will have increased accuracy, enhanced security, and improved reliability.

These contracts provide research and development services in support of the two intercontinental ballistic missile systems. The Northrop Grumman Corp. Strategic Deterrent Systems division in Roy, Utah., won a $13.3 billion contract last September to design and build the GBSD.

The Northrop Grumman GBSD team includes Aerojet Rocketdyne in El Segundo, Calif.; Bechtel Corp. in Reston, Va.; Clark Construction Group in Bethesda, Md.; the Collins Aerospace segment of Raytheon Technologies Corp. in Cedar Rapids, Iowa; General Dynamics Corp. in Reston, Va.; HDT Global Inc. in Solon, Ohio; Honeywell International Inc. in Charlotte, N.C.; Kratos Defense and Security Solutions Inc. in

San Diego; L3Harris Technologies in Melbourne, Fla.; Lockheed Martin Corp. in Bethesda, Md.; and Textron Systems in Providence, R.I.

Also on the Northrop Grumman GBSD team are hundreds of small- and medium-sized companies from across the defense, engineering, and construction industries, Northrop Grumman officials say.

The GBSD design effort as a Minuteman III replacement will take 8.5 years and include weapon system design, qualification, test and evaluation, and nuclear certification, Northrop Grumman officials say. The Air Force wants the new missile to be operational by 2029.

The GBSD will have a 300-kiloton W87 Mod 0 thermonuclear warhead of unknown yield, capable of air- or ground-burst detonation. The silo-launched missile will have three-stage solid-fuel rocket propulsion with inertial and GPUS guidance.

The GBSD will replace the U.S. Minuteman III fleet at 450 missile sites in Colorado, Montana, Nebraska, North Dakota, and Wyoming. The missiles themselves are in underground silos and are ready for launch on very short notice. ICBMs constitute one-third of the nation's nuclear weapons deterrent. Other U.S nuclear warheads are on submarine-launched ballistic missiles and on manned jet bombers.

Each Minuteman III missile is 60 feet tall, 5.5 feet in diameter, and powered by three solid rocket motors that can launch the 80,000-pound missile to altitudes of 700 miles to deliver nuclear warheads as far away as 6,500 miles. Each missile contains as many as three independently targeted warheads in separate reentry vehicles.

The Minuteman III originally was equipped with a Rockwell Autonetics D37D flight computer, but as of 2008 had been upgraded as part of the Minuteman-III Guidance Replacement Program (GRP).

On the GBSD research support contract Johns Hopkins will do the work in Laurel, Md., and should be finished by July 2031. For more information contact the John Hopkins Applied Physics Laboratory online at www.jhuapl.edu, or the Air Force Nuclear Weapons Center at www.afnwc.af.mil.

ELECTRONIC WARFARE

Raytheon to build three midband airborne EW jammers for Navy EA-18G aircraft

Airborne electronic warfare (EW) experts at Raytheon Technologies Corp. will build three advanced electronic jammers for U.S. Navy EA-18G Growler EW jets under terms of a $171.6 million contract.

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 three Next Generation Jammer NGJ) midband (NGJ-MB) low-rate initial production lot-one 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 can also 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 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 last December 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 Dallas; Forest, Miss.; El Segundo, Calif.; Ft. Wayne, Ind.; and Andover, Mass., and should be finished by October 2023. For more information contact Raytheon Intelligence and Space online at www.rtx.com, or Naval Air Systems Command at www.navair.navy.mil.

VETRONICS

Army picks Oshkosh to build 30-millimeter cannon and vetronics for Stryker vehicles

U.S. Army armored combat vehicles experts are choosing Oshkosh Defense LLC in Oshkosh, Wis., to build the weapon system for the General Dynamics Stryker wheeled fighting vehicle equipped with an armor-piercing or high-explosive 30-millimeter cannon.

Officials of the Army Contracting Command at Detroit Arsenal in Warren, Mich., announced a $942.9 million contract to Oshkosh to build and support the Stryker Medium-Caliber Weapon System. This version of the eight-wheel Stryker combat vehicle will have the 30-millimeter cannon for attacking lightly armored vehicles and bunkers.

The Addition of a 30-millimeter cannon turret to the Stryker can boost the vehicle's firepower substantially. A 30-millimeter cannon bullet is about 10 inches long, while a .50 caliber machine gun bullet is about five inches long, and a 7.62 millimeter machine gun bullet is about three inches long.

The 30-millimeter cannon fires a shell slightly more than one inch in diameter that comes in armor-piercing, high-explosive, or practice rounds. The weapon has a barrel diameter of 1.18 inches.

This newest version of the Stryker joins other variants for missions that include armored personnel carrier; battlefield reconnaissance; light main battle tank with a 105-millimeter cannon; mortar carrier; commander's vehicle; fire support; medical evacuation; and anti-tank missile launcher.

Stryker is a deployable fighting vehicle that is more lethal than light vehicles like Humvees, yet is lighter and more maneuverable than heavyweight combat vehicles like the M1 Abrams main battle tank.

Most Stryker vehicles and vetronics today can have the Protector M151 Remote Weapon Station with .50-cal M2 machine gun, 7.62 mm M240 machine gun, or Mk-19 automatic grenade launcher. Some heavily armed versions have a 105-millimeter main gun, similar to a tank.

The Stryker also establishes the framework for the Vehicular Integration for C4ISR/EW Interoperability (VICTORY) vetronics architecture for networking integration and data sharing among the vehicle's common crew stations. The new Stryker version also provides Gigabit Ethernet capability.

The modern version of Stryker has a 910-amp alternator to support future electrical power upgrades for future network equipment; an enhanced power distribution unit chassis upgrade; increased chassis payload capacity from 55,000 pounds to 63,000 pounds; and upgrades to its driveline to support an in-vehicle network architecture.

The Stryker armored combat vehicle is named for two American servicemen who posthumously received the Medal of Honor: Private First Class Stuart S. Stryker, who died in World War II, and Specialist Four Robert F. Stryker, who died in the Vietnam War.

On this contract Oshkosh will do the work at locations be determined with each order, and should be finished by June 2027. For more information contact Oshkosh Defense online at https://oshkoshdefense.com,or U.S. Army Contracting Command-Detroit Arsenal at https://home.army.mil/detroit.

POWER ELECTRONICS

Zero-voltage switching flyback switcher for introduced by Power Integrations

Power Integrations Inc. in San Jose, Calif., is introducing the InnoSwitch4-CZ family of high-frequency zero-voltage switching (ZVS) flyback switcher integrated circuits (ICs) for ultra-compact power chargers suitable for phones, tablets, and laptop computers. Targeting high-efficiency compact USB PD adapters, high-density flyback designs of as much as 110 Watts, and high-efficiency CV/CC power supplies, InnoSwitch4-CZ ICs provide variable-output voltage and constant-current profiles. Devices are protected featuring auto-restart or latching fault response for output over-voltage and under-voltage protection, multiple output under-voltage fault thresholds and latching or hysteretic primary over-temperature protection. InnoSwitch4-CZ zero-voltage switching (ZVS) flyback switcher incorporate a 750-volt primary switch using the company's PowiGaN technology and a high frequency active clamp flyback controller. The InnoSwitch4-CZ family incorporates 750-volt switch, primary and secondary controllers, ClampZero interface, synchronous rectification, and safety-rated feedback in a compact InSOP-24D package. A steady state switching frequency to 140 kHz minimizes transformer size and increases power density. Power electronics pursue goals in SWaP and efficiency In contrast with older active clamp flyback approaches, the InnoSwitch4-CZ and ClampZero combination provides as much as 95 percent efficiency and maintains high efficiency across variations in line voltage, system load, and output voltage. This comes from variable frequency asymmetrical control of the active clamp with intelligent zero-voltage switching, enabling discontinuous and continuous conduction modes of operation. The flyback switcher ICs enable exceptional CV/CC accuracy, independent of external components, and consume less than 30 milliwatts no-load including line-sensing safety and protection features. For more information contact Power Integrations online at www.power.com.

BOARD PRODUCTS

FPGA mezzanine card for radar, electronic warfare (EW), and SATCOM introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing the FMC165 field-programmable gate array (FPGA) mezzanine card (FMC) for applications with direct RF down conversion such as radar, sonar, software defined radio, and ultra-wide-band satellite digital receivers for electronic warfare (EW), medical equipment, and test instrumentation. The FPGA mezzanine card offers high analog sampling rates, improved signal to noise ratio, and enhanced multi-board synchronization processes compared to earlier generations of these cards. Designers of radar, EW , and similar systems can integrate the FMC165 with any FMC- or FMC Plus- compatible carrier in an air-cooled configuration, and in either air-cooled or conduction-cooled environments with Abaco FPGA carrier cards. This card controls the clock source through serial communication buses and is equipped with power supply and temperature monitoring. This offers several power-down modes to switch off unused functions to reduce power consumption. The FMC165 extends the life cycle of the existing FMC160 product with a technology upgrade for applications such as radar and electronic warfare (EW). The addition of the Texas Instruments ADC32RF4x A/D converter can increase in the sampling rate and dynamic range to improve analog input capabilities. For more information contact Abaco Systems online at www.abaco.com.

SPACE ELECTRONICS

Radiation-hardened power MOSFET for space applications qualified by Microchip

Microchip Technology Inc. in Chandler, Ariz., has qualified the company's radiation-hardened M6 MRH25N12U3 MOSFET for power electronics applications on commercial and military satellites. Space power supplies operate in environments that require enhanced radiation technology to withstand extreme particle interactions and solar and electromagnetic

events. These events degrade space-based systems and disrupt operations. To meet this requirement, Microchip has qualified its M6 MRH25N12U3 radiation-hardened 250-volt, 0.21 Ohm Rds(on) MOSFET for commercial aerospace and defense space applications. Microchip's radiation-hardened M6 MRH25N12U3 MOSFET provides the primary switching element in power conversion circuits including point-of-load converters, DC-DC converters, motor drives and controls, and general-purpose switching. The MOSFET withstands the harsh environments of space, extends reliability of power circuitry, and meets all requirements of MIL-PRF19500/746 with enhanced performance. Microchip completed testing for Defense Logistics Agency (DLA) review and qualification for the device's sourcing in the U.S. military supply chain in June. The device can withstand total ionizing dose radiation of as much as 100 and 300 kilorads, and single event effects with linear energy transfer to 87 MeV/mg/cm2. It provides 100-percent wafer lot radiation hardness assurance in validation tests. For more information contact Microchip online at www.microchip.com.

CONNECTORS

RF and microwave adapters for mobile radios introduced by Cinch

Cinch Connectivity Solutions in Wesaca, Minn., is introducing 1.85-to-2.92-millimeter between series adapters in rugged stainless-steel construction. The Cinch 134-1000-020, 134-1000-021, 134-1000-022, and 134-1000-023 are for microwave subsystems, base stations, mobile radios, test and measurement labs, printed circuit board testing, and manufacturing labs. These adapters provide repeatable high-frequency performance for engineers involved in RF and microwave product design, test, and manufacturing environments. The Cinch Johnson adapters are popular with test and research labs, supporting RF and microwave frequencies to 46.5 GHz. Johnson offers various high-frequency adapters that cover all configurations of 1.85 millimeters, 2.4 millimeters, 2.92 millimeters, SMPM, SMP and SMA. These adapter series are the broadest in the industry supporting 5G and IoT applications operating at millimeter wave frequencies. For more information contact Cinch Connectivity Solutions online at www.belfuse.com/cinch.

DATA RECORDERS

Radiation-tolerant solid-state data recorder introduced by Mercury

Mercury Systems Inc. in Andover, Mass., is introducing the RH3480 radiation-tolerant solid-state data recorder (SSDR) for radiation-intensive space and terrestrial applications, including low-earth orbit (LEO) satellites, high-altitude aircraft, missiles, launch vehicles and scientific missions. Featuring horizontal error correction, industrial-grade flash memory, and a fault-tolerant design, the RH3480 provides long-term data integrity to match the operational life of a satellite or life of a space mission. "As data from satellites advances in complexity and the sizes of satellite designs become smaller and smaller, we need trusted, compact solutions to store and transmit large amounts of data quickly and efficiently," says Tom Smelker, vice president and general manager of Mercury Data. "Our line of solid-state data recorders, purpose-built to answer the demand for agile, radiation-tolerant storage devices rugged enough for space applications," Smelker says. Mercury's latest modular form factor is small and supports a high data capacity. Its low power consumption enables on-orbit sensor digital data processing and storage to transfer data. For more information contact Mercury Systems online at www.mrcy.com.

DATA STORAGE

Self-encrypting SSD data storage for trusted computing introduced by DIGISTOR

DIGISTOR, a CRU Data Security Group (CDSG) company in Campbell, Calif., is introducing the DIGISTOR Citadel secure self-encrypting solid-state drives (SSDs) for military, intelligence, and critical infrastructure applications. The Citadel data storage systems are powered by CipherDrive, and deliver a security layer to encrypt and protect data at rest in a low-cost, deployable form factor. The drives meet standards of the National Security Agency (NSA) Commercial Solutions for Classified program (CSfC). The proliferation of sensor and Internet of things data, cross-domain computing, and information aggregation are driving a rapid increase in cyber attacks, company officials say. Citadel SSDs are based on data storage technology that is certified to FIPS 140-2 Level 2 and Common Criteria, and are available in standard M.2 and 2.5-inch form factors, as well as SATA and NVMe interfaces, for commonly used laptops, desktops, and tactical servers. In addition to helping meet cost targets, Citadel self-encrypting SSDs contain pre-boot authentication, which requires that an authorized user unlock the SSD with a password or smart card before the computer can see the drive or boot up. Citadel's authorization acquisition and encryption engine capabilities make Citadel SSDs suitable for a trusted computing CSfC solution to secure information up to the

U.S. government's secret classification level. Concurrently, CDSG announced that Trenton Systems Inc. in Lawrenceville, Ga., will offer Citadel SSDs in the company's next and future generations of rugged servers, workstations, embedded systems, data storage systems, and other products for the government market. For more information contact CDSG DIGISTOR online at https://digistor.com/citadel.

RF AND MICROWAVE

Digital attenuator for military and commercial UHF introduced by Comtech PST

Comtech PST Corp. in Melville, N.Y., is introducing the model LA01-001 digital attenuator for RF and microwave military or commercial applications in UHF band. The design operates over the 400 to 500 MHz frequency range, and provides 0 to 60 dB of range for accuracy when changing attenuator steps. Switching speed is fast when attenuation needs to be changed. Other RF and microwave frequencies, attenuation ranges, and performance characteristics are possible for other applications. Features include TTL-controlled attenuation level; 4 bit attenuation control; 60 dB attenuation range; amplitude/phase matched state to state; attenuation accuracy; fast switching speed; +5-volt DC and -15-volt DC input. The attenuator UHF applications has a frequency range of 400 to 500 MHz; maximum input power of 20 dBm; voltage standing wave ratio (VSWR) of 1.4:1 max, any state; insertion loss of 1.4 dB max; attenuation range if 0 to 60 dB, 6 dB steps; attenuator accuracy (to 36 dB) of ±0.25 dB max switching speed of 1 microsecond max; and impedance if 50 ohms. For more information contact Comtech PST online at https://comtechpst.com.

SATCOM

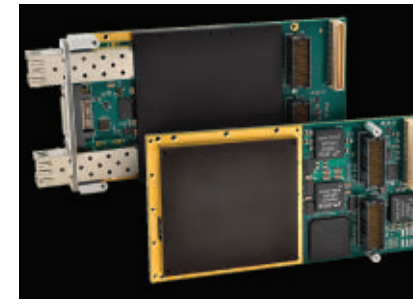
L-Band SATCOM for Iridium Certus 200 satellite communications introduced by Thales

Thales Defense and Security Inc. in Clarksburg, Md., is introducing the MissionLINK 200 and VesseLINK 200 L-band communications systems for Iridium Certus 200 services. The systems, which are part of the ThalesLINK 200 series, operate on a network of 66 satellites to provide always-on connectivity anywhere in the world for those looking for increased-mobility Iridium satellite communications (SATCOM) services. The high-performing small-form-factor MissionLINK 200 and VesseLINK 200 solutions bring Iridium Certus services to users on land and at sea. The MissionLINK 200 and VesseLINK 200 provide 176 kilobits per second of upload and download speed for voice and data communications in temperatures from -40 to 55 degrees Celsius. The SATCOM systems have small lightweight antennas and are suitable for racing sailboats to public safety vehicles. For more information contact Thales Defense and Security online at www.thalesdsi.com.

EMBEDDED COMPUTING

XMC FPGA cards with enhanced security introduced by Acromag

Acromag in Wixom, Mich., is introducing the XMC-7AWP and XMC-7KWP switched mezzanine card (XMC) modules, each with a user-programmable Xilinx Artix-7 or Kintex-7 field-programmable gate array (FPGA) for hardware simulation, communications, signals intelligence (SIGINT), adaptive filtering, and image processing. Designed with data security for defense and aerospace embedded computing, these commercial off-the-shelf (COTS) FPGA cards are for algorithmic acceleration, protocol conversion, simulation, HIL test, motor control, image analysis, and sensor fusion applications. The XMC mezzanine cards plug into host single-board computers or non-intelligent carrier cards for use in PCI Express servers, VPX, or CompactPCI Serial chassis, and small-form-factor embedded computers. The air-cooled embedded computing cards operate reliably across a wide ambient temperature range. The modules also can accommodate conduction-cooled systems. Each module's FPGA feature write-protected flash memory to secure the configuration files, and offer high-speed interfaces for PCI Express, 10 10-Gigabit Ethernet, Low Voltage Differential Signaling (LVDS), serial, and other I/O signals. The XMC-7KWP FPGA cards offer a choice of Kintex-7 FPGAs for 325,000 or 410,000 logic cells. Dual SFP+ ports offer support for 10-gigabit Ethernet with fiber or copper transceivers. A 36-pin VHDCR connector provides JTAG, USB, global differential clock pairs, and LVDS signals to the FPGA. The rear I/O XMC port offers a four-lane high-speed serial interface and supports SelectIO channels for single-ended or differential I/O. A PMC-style port supports additional SelectIO channels. The XMC-7AWP models feature a user-configurable Artix-7 FPGA with 200,000 logic cells. The rear I/O provides an eight-lane high-speed serial interface on the P16 XMC port with support for 34 single-ended SelectIO or 17 LVDS channels. The P4 port adds another 60 SelectIO or 30 LVDS and global clock lines. For more information contact Acromag online at www.acromag.com.



RF AND MICROWAVE

Gallium nitride (GaN) low-noise amplifiers for radar offered by Fairview

Fairview Microwave Inc., an Infinite Electronics brand in Lewisville, Texas, is introducing a series of low-noise amplifiers (LNAs) for use in electronic warfare (EW), radar, space systems, microwave radio, satellite communications (SATCOM), and test and measurement applications. The gallium nitride (GaN) LNAs offer a power-to volume ratio for broadband high-power applications, and feature a breakdown voltage that allows for high toleration of RF input power signal levels while maintaining low noise figure performance. These LNAs cover microwave and millimeter-wave frequency bands, and offer high gain to 46 decibels typical, high RF input power handling to 10 Watts continuous wave, broadband frequencies ranging from 1 to 23 GHz, and noise figures as low as 1.5 decibels typical. These RF and microwave components offer rugged military-grade compact coaxial designs, excellent thermal properties, and SMA connectors. Fairview Microwave's input-protected low-noise amplifiers are in-stock and available for immediate shipping. For more information contact Fairview Microwave online at www.fairviewmicrowave.com.

PRODUCT & LITERATURE SHOWCASE

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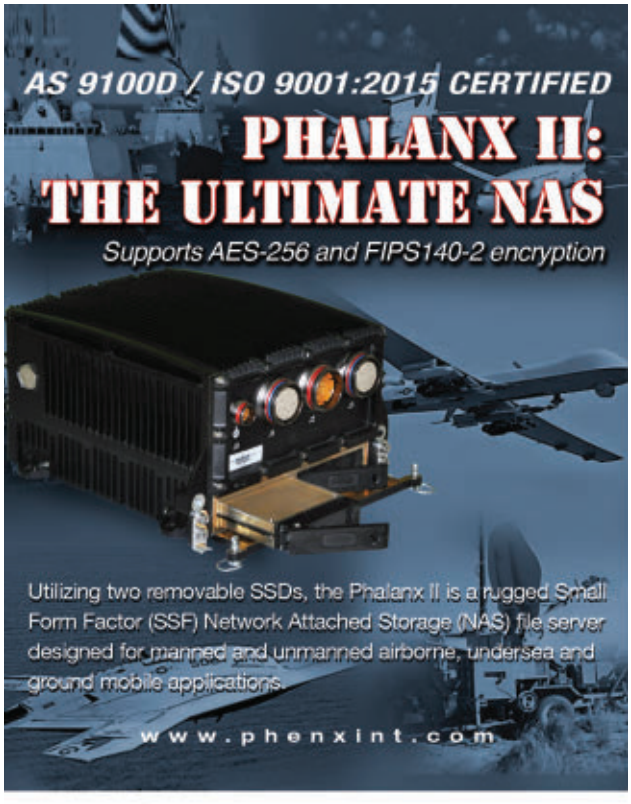

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