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BY **JOHN KELLER**, EDITOR IN CHIEF

DARPA LongShot takes another step towards putting unmanned vehicles in the thick of warfare

Firing weapons with unmanned aerial vehicles (UAVs) is a new and somewhat ticklish subject. U.S. military leaders typically are uncomfortable with enabling autonomous systems to shoot missiles or bullets without a human being in the loop who ultimately makes the decision to fire.

It has to do with the so-called "human-in-the-loop" doctrine in which military leaders want humans — not machines — making life-or-death decisions.

It's not clear, however, if or for how long this human-in-the-loop requirement can stay in place, given the speed and ferocity that modern technology brings to the battlefield. Wait for a human to make a fire-or-no-fire decision, and valuable targets could vanish or move out of range, electronic defenses could be activated, or enemy weapons seemingly could come out of nowhere. Give a human the responsibility to fire, in other words, and crucial life-critical decisions could come too late.

It's not a direct violation of the human-in-the-loop doctrine to place weapons on unmanned vehicles; it's been done for quite a while. The Reaper UAV, for example, carries the GBU-12 Paveway II laser-guided bomb, the AGM-114 Hellfire II air-to-ground missile, the AIM-9 Sidewinder air-to-air missile, and the GBU-38 Joint Direct Attack Munition (JDAM).

Safety measures can be put in place to prevent the machine itself from pulling the trigger. Still, launching weapons from unmanned systems where there's no human actually there to put eyes on procedures and results is a step away from this long-held doctrine, and another step toward putting warfare in the hands of machines.

Now comes another development with the U.S. Defense Advanced Research Projects Agency (DARPA) LongShot project, which seeks to develop a UAV that is launched from aircraft, like a missile, but with the ability to deploy several of its own air-to-air weapons.

The three companies working on the first phase of the LongShot project are General Atomics Aeronautical Systems Inc. in Poway, Calif.; Northrop Grumman Corp. in Falls Church, Va.; and Lockheed Martin Corp. in Bethesda, Md.

The LongShot aircraft, essentially, will be an unmanned jet fighter-bomber with missiles attached to hardpoints underneath the wings, on the fuselage, or possibly in internal weapons bays for enhanced stealthiness.

Military air superiority today relies on advanced manned fighter aircraft to provide a penetrating counter-air capability to deliver weapons effectively, DARPA officials say. The LongShot will enable piloted aircraft to fire the UAV from standoff ranges far away from enemy threats. The unmanned LongShot, meanwhile, can fly closer to enemy targets to increase precision, while keeping human pilots out of harm's way.

Would the LongShot UAV take a human out of the loop in making the decision on whether or not to fire weapons? Probably not — at least in its early stages. Yet does this kind of unmanned aircraft move us closer to a day when machine automation and learning take a bigger role in crucial battlefield decisions? Maybe yes.

Look at artificial intelligence (AI) technology today. It doesn't represent human-quality thinking yet, but it's getting closer all the time. Ever-more-powerful general-purpose graphics processing units (GPGPUs) are making embedded parallel processing of supercomputer speeds a reality today. What about the new frontier of quantum computing that's under development right now?

It's not a far leap for trusted embedded supercomputers with the ability to reason and learn to move from complex logistics tasks to firing weapons from unmanned aircraft. Given the likelihood that AI technology will become more powerful and trusted in the near future, letting machines do the fighting may be too great a temptation to ignore.

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Sierra Nevada Corp. will provide capability for Special Forces MC-130J aircraft to send and receive secure mission-critical data via the Airborne Mission Networking (AbMN) project.

Sierra Nevada moves to low-rate production on secure Special Forces networking

BY **John Keller**

ROBINS AIR FORCE BASE, Ga. — U.S. Air Force avionics experts are asking Sierra Nevada Corp. in Sparks, Nev., to enable a Special Forces version of the Lockheed Martin C-130J four-engine turboprop aircraft to send and receive secure mission-critical data.

Officials of the Air Force Life Cycle Management Center at Robins Air Force Base, Ga., have announced a $29.8 million two-year order to Sierra Nevada for the MC-130J Airborne Mission Networking (AbMN) low-rate initial production (LRIP).

The AbMN enables aircrew and mission personnel aboard MC-130J aircraft to send and receive mission-critical data to and from tactical and operational nodes in the battlespace. This order is for production kits, spare parts, and weapon system trainer support.

LRIP describes production of a system in limited quantity to provide articles for operational test and evaluation. This is to establish an initial production base, and to permit an orderly increase in production rate that leads to full-rate production.

AbMN capabilities include secure line-of-sight and beyond-line-of-sight voice and data communications, friendly force identification, mission tracking, threat identification, full-motion video, collaboration, chat, email, and data links.

AbMN enables Special Operations Forces (SOF) to streamline command and control, improve situational awareness, and reduce operational risk through real time exchange of digital information among aircraft, SOF components, and other tactical and operational nodes.

The special operations MC-130J Commando II aircraft flies clandestine, or low-visibility single or multi-ship low-level air refueling missions for special operations helicopters and tiltrotor aircraft.

The MC-130J also performs infiltration, exfiltration, and resupply of Special Forces by air or by land inside of politically hostile territories.

The MC-130J primarily flies missions at night to reduce probability of visual acquisition and intercept by airborne threats. Its secondary mission includes the airdrop of leaflets.

On this order Sierra Nevada will do the work in Centennial, Colo., and should be finished by January 2023. For more information contact Sierra Nevada Corp. online at www.sncorp.com, or the Air Force Life Cycle Management Center-Robins at www.robins.af.mil/Units/AFLCMC.

Sikorsky to build five new VH-92A presidential helicopters and avionics

U.S. Navy helicopter aviation experts are ordering five new VH-92A presidential helicopters for the U.S. president and other high-ranking government dignitaries under terms of an order worth nearly a half-billion dollars. Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking Sikorsky, a Lockheed Martin company in Stratford, Conn., to build five low-rate initial production lot three presidential helicopters in a $478.6 million contract modification. The Sikorsky/Lockheed Martin VH-92 will replace the U.S. Marine Corps VH-3D and VH-60N helicopters that transport the U.S. president, while operating under the name of Marine One. The VH-92 presidential helicopter has an executive interior and military mission support avionics, including triple electrical power and redundant cockpit flight controls. This contract includes interim contractor support, two cabin interior reconfiguration kits, support equipment, spare parts, and system parts replenishment in support of the Presidential Helicopter Replacement Program. These helicopters are part of the 23-aircraft program of record for the U.S. Marine Corps.

Northrop Grumman to upgrade launch control for Minuteman III nuclear missiles

Missile command-and-control experts at Northrop Grumman Corp. will upgrade launch control centers for Minuteman III nuclear intercontinental ballistic missiles (ICBMs) at Malmstrom Air Force Base, Mont. under terms of a $7.8 million order. Officials of the Air Force Nuclear Weapons Center at Hill Air Force Base, Utah, are asking the Northrop Grumman Defense Systems segment in Herndon, Va., to carry out Minuteman III Launch Control Center Block Upgrade production at the 341st Missile Wing at Malmstrom Air Force Base, Mont. — also known as Malmstrom Wing I. The Minuteman III Launch Control Center Block Upgrade project is part of

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Raytheon to develop algorithms and sensor network for combat airspace management

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are looking to Raytheon Technologies Corp. to help develop a virtual and live testbed for combat airspace management.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., have announced an $7.6 million contract to the Raytheon Intelligence & Space segment in Tewksbury, Mass., as part of the Air Space Total Awareness for Rapid Tactical Execution (ASTARTE) program.

Raytheon experts will develop the Airspace TacticaL Automation System (ATLAS) for the ASTARTE program, in which they will develop and demonstrate a virtual and live testbed for airspace management systems, algorithms for airspace planning and operations, and a sensor network for real-time spatial and temporal tracking of manned and unmanned aircraft.

Raytheon joins Systems & Technology Research LLC (STR) in Woburn, Mass., on the ASTARTE program. STR won an $8.3 million ASTARTE contract in January.

The U.S. Air Force is developing a system to automate how manned and unmanned combat aircraft will coordinate operations in congested airspace over battlefields.

Raytheon engineers will develop a virtual lab testbed to help model, simulate, and virtualize current joint military airspace management systems with interfaces to connect real-world hardware and software in a common software framework that supports virtual and real-world environments.

The overall ASTARTE program seeks to provide real-time, low-risk joint deconfliction between airspace users and joint fires at an Army division-level to enable responsive support to tactical units and build a resilient air picture in an anti-access/area denial (A2/AD) environment while conducting joint all-domain command and control (JADC2) operations.

ASTARTE enabling technologies will handle sensor tasking, data processing, multi-modal data fusion, and near-real time dissemination to enable dynamic spatial and temporal airspace management and operations.

The ASTARTE program has three parts. First is understanding and decision algorithms that identify and predict airspace usage conflicts, determine restricted operating zones, propose alternative airspace de-confliction courses of action with assessed risk levels, and dynamically planning and tasking sensors to create an airspace picture.

Second, the project will develop sensors that in real time can detect and track manned and unmanned aircraft, missiles in-flight, unmanned balloons, and other potential flight hazards.

Third is a virtual lab testbed that enables modeling, simulation, and virtualization of military airspace management systems, and connects to connect real-world hardware.

The current approach to airspace planning and control predominately involves manual and static procedures that allocate lanes and zones over the battlefield, which can prohibit adaptive re-tasking and reapportionment.

This approach also can be over-previsioned to provide any flexibility, but can cause very inefficient use of available airspace, causing slow or inaccurate coordination between fires and airspace users, which allows an adversary to fire and maneuver unchallenged.

Prior attempts to create a more dynamic, joint picture of the airspace relied on an overly complex and burdensome centralized approach that attempted to force all operations, data, command, and control into a common framework.

Instead, ASTARTE seeks to gather data, form a refined airspace picture, and re-plan by exception as necessary to support dynamic joint-service operations.

ASTARTE focuses on the most challenging airspace problem: the airspace above an Army division under battlefield airspace that measures about 360 square miles, and extends from the ground to about 18,000 feet in altitude.

This area contains Army, Air Force, Navy, Marine Corps, Special Operations, allied, and enemy manned and unmanned aircraft and munitions passing through the airspace. It also contains forces conducting fire missions and close air support. The airspace also may include commercial aircraft and other hazards.

Still, the system must be aware of adjacent air spaces and the airspace above the division airspace to include high-altitude aircraft, satellites and manned spacecraft.

On this first phase of the ASTARTE program, Raytheon will do the work in Tewksbury and Cambridge, Mass; Cedar Rapids, Iowa; Fulton, Md.; Dulles, Va.; and Durham, N.C., and should be finished by February 2022. For more information contact Raytheon Intelligence & Space online at www.rtx.com, Systems & Technology Research at www.stresearch.com, or DARPA at www.darpa.mil.

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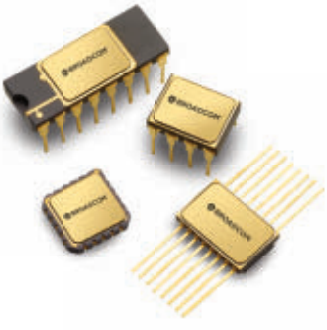

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the Minuteman Ground and Communications Equipment program, which replaces obsolete and unsupportable ground-based weapon system equipment necessary to continue Minuteman III operations through 2030. The Minuteman III fleet constitutes one-third of the nation's nuclear weapons deterrent. Other U.S nuclear warheads are on submarine-launched ballistic missiles and on manned jet bombers. The Minuteman III Launch Control Center Block Upgrade also will help reduce the technological risks of replacing the Minuteman III nuclear missiles with the next-generation Ground Based Strategic Deterrent (GBSD).

U.S. military leaders schedule counter-UAV demonstrations for April

The Pentagon aims to field a low-collateral effects unmanned aircraft interceptor — part of its evolving and enduring solution to countering small drones — by fiscal 2022, according to the joint office in charge of the effort. Leaders of the U.S. Department of Defense (DOD) established the Army-led Joint Counter-Small Unmanned Aircraft Office (JCO) a little more than a year ago. Experts laid out a path for how they will develop a system to counter small unmanned aerial vehicles (UAVs), and approving requirements that guide industry how to plug into one command-and-control system. The JCO also identified systems that make up an interim counter-UAV solution last year. In April industry will demonstrate the program's UAV-defense technology for the first time at Yuma Proving Ground, Ariz. Officials will schedule about two such demonstrations each year. The Air Force Research Laboratory and the Army's Rapid Capabilities and Critical Technologies Office will run the demonstrations.

Canadian military eyes materials for camouflage and self-repairing clothing

From chameleon-inspired camouflage to clothing that mends itself when damaged, the Canadian Department of National Defence (DND) is looking to outfit Canadian troops with next-wave gear that provides better protection — and less detection — on the battlefield. Adaptable camouflage and self-repairing clothing are just two technologies in a long list of cutting-edge scientific advancements that DND is spending $9 million over three years to research, spearheaded by five Canadian universities. Each university is researching what's known as advanced materials. Some of those materials can be fashioned into clothing that repairs itself. McLaughlin said a capsule could be embedded in a self-repairing shirt or armored vest that, when the garment or gear is damaged, bursts and releases a liquid or foam that solidifies and seals the hole. Research is also being done on new materials that may one day replace Kevlar and ceramics as the chief components of body armor.

Navy and General Atomics developing ASW unmanned aircraft to help P-8A Poseidon with submarine hunting

The U.S. Navy and General Atomics in November used sonobuoys dropped from an MQ-9A Block V Reaper unmanned aerial vehicle (UAV) to track a simulated submarine target on a U.S. Navy Pacific test range. The Reaper deployed a mix of 10 sonobuoys — deployed to measure water conditions and listen for submarine targets — then received and transmitted the data in real time to a monitoring station at Laguna Flight Operations Facility located at Yuma Proving Ground in Arizona. The test

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DISA chooses Perspecta Enterprise solutions to provide secure digital networking

BY **John Keller**

SCOTT AIR FORCE BASE, Ill. — U.S. military information technology (IT) specialists needed a company to deliver secure digital content over the Defense Information System Network (DISN). They found their solution from Perspecta Enterprise Solutions LLC in Chantilly, Va.

Officials of the Defense Information Technology Contracting Organization at Scott Air Force Base, Ill., announced a potential $201.5 million contract last month to Perspecta Enterprise Solutions for the Global Content Delivery Services II (GCDS II) project.

GCDS II fulfills military secure networking tasks by deploying content delivery capabilities at DISA-owned and other DISA-approved processing locations inside and outside the Continental U.S. The objective is to obtain reliable, responsive, and cost-effective content

Photo (above): Perspecta Enterprise Solutions will deliver secure digital content like video teleconferencing, electronic whiteboarding, and distributed warfighting simulations over the Defense Information System Network (DISN).

delivery services that are dynamically scalable, and use an on-demand service approach.

The DISN is the U.S. Department of Defense (DOD) enterprise network for providing data, video, and voice services like video teleconferencing, electronic white-boarding, and distributed warfighting simulations.

The Defense Information Technology Contracting Organization is awarding the contract to Hewlett-Packard on behalf of the U.S. Defense Information Systems Agency (DISA) at Fort Meade, Md.

The GCDS II program capitalizes on commercial Internet technology and best practices to deliver DOD web content and applications across the Nonsecure Internet Protocol (IP) Router Network (NIPRNet), Secret Internet Protocol Router Network (SIPRNet), and CENTRIX-ISAF (CX-I).

The GCDS II enables users of the DISN to perform tasks ranging from downloading security patches, checking email, viewing information portals, supporting decision making, and analyzing geospatial data dynamically.

The GCDS II is a global platform of hundreds of military servers that helps the DISN deliver rich, dynamic, and interactive content, transactions, and applications. The GCDS detects and avoids DISN problem spots and vulnerabilities to deliver mission-critical software downloads, and ensure that software applications perform reliably.

Users of the GCDS II include web-based applications and video streams; users on the NIPRNet, SIPRNet, and CX-I; those who need speed and reliability; commanders who need actionable information; and network operators need to scale on-demand for peak loads during expected and unexpected events.

The GCDS helps improve delivery of mission content to warfighters globally; provides capacity on-demand to meet peak loads without added IT infrastructure; enhance user experience and minimize response times; reduce infrastructure costs while meeting mission requirements; and provide service and support from commercial and government experts.

The GCDS II contract has a three-year base period and three one-year option periods. Hewlett-Packard Co. in Herndon, Va. won the original six-year GCDS I contract in April 2015. For more information contact Perspecta Enterprise Solutions online at https://perspecta.com, or DISA at www.disa.mil.

Continued from page 9

was part of developing the General Atomics MQ-9B SeaGuardian submarine-hunting UAV. The Reaper managed to acquire and track an expendable ASW training target for three hours using UYS-505 acoustic processing software from General Dynamics Mission Systems in Fairfax, Va.

Army upgrading EMARSS turboprop recon aircraft

Army experts at Aberdeen Proving Ground, Md., are refining aerial surveillance technology by upgrading the Enhanced Medium Altitude Reconnaissance and Surveillance System (EMARSS) reconnaissance plane. The goal with EMARSS aircraft was to enable a surveillance aircraft to gather and disseminate valuable intelligence to warfighters in real time with cameras, sensors, communications, signals intelligence (SIGINT), and a data-link with ground-based intelligence databases.

Navy ship building and shipboard electronics strive to do more with less

U.S. naval fleet size falling behind that of China, as priorities emerge for new ballistic missile submarine, seagoing frigate, and unmanned undersea vehicles.

BY **Edward J. Walsh**

Photo (above): A Marine Corps F-35B Lightening fighter lands aboard the Wasp-class amphibious assault ship Makin Island (LHD-8) in the Indian Ocean.

In late April 2020, Navy leaders started an order-of-magnitude shift in their surface warfare vision by awarding a $795 million contract to Fincantieri Marinette Marine Corp. in Manitowoc, Wis., for detail design and construction of the first ship of a new class of guided-missile frigates. The contract contains an option for nine more ships. In October, the Navy announced that the new frigates would be the Constellation class, with lead ship Constellation (FFG 62) to be delivered in 2026. The Navy plans to build 20 ships.

The frigate award addressed long-simmering tensions within the service, among defense analysts, and in Congress aroused by the littoral combat ship (LCS) program. The Constellation class, called FFGX since it started in 2017, represents a huge retreat from the thinking behind the LCS, which has divided Navy planners for nearly 20 years.

The LCS was conceived in 2001 as a multi-mission ship to back up the Navy's new "From the Sea" strategy that stressed close-to-shore "littoral" operations in unstable regions. The Navy funded design of two ship types, a conventional destroyer-like design called Freedom (with odd

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hull numbers), by Marinette Marine and a trimaran, the Independence variant (even hull numbers), by Austal USA. Separately developed "packages" of surface and anti-submarine warfare and mine countermeasures sensors and weapons would enable the ships to conduct all three missions.

Since the program started in 2004, both teams experienced serious cost overruns and delays. LCSs have had expensive system failures. Both hull types were criticized as poorly designed, under-armed, and unsurvivable in combat. Despite improvements, the criticism persists, and the Navy continues to build the ships.

In January Rear Adm. Casey Moton, program executive officer for unmanned and small combatants, acknowledging the problems, said the ships would get a "lethality upgrade" that includes a new common combat management system and the naval strike missile built by Kongsberg Gruppen in Kongsberg, Norway, teamed with Raytheon Technologies Corp. Missiles & Defense segment in Tucson, Ariz.

Funding constraints

Meanwhile, persistent funding constraints have caused serious fleet-support problems. The Navy's fiscal year 2021-2023 Business Operations Plan reported in October that "the Navy was challenged by a combination of high-tempo operations and a reduced fleet size. These factors resulted in a maintenance backlog and reduced readiness."

The funding shortfalls and maintenance backlogs developed as China threatened U.S. interests in the Pacific. The Secretary of Defense Annual Report to Congress on military and security developments by the People's Republic of China, released last September, said "the PRC has the largest navy in the world, with an overall battle force of approximately 350 ships and submarines, including over 130 major surface combatants. In comparison, the U.S. Navy's battle force is approximately 293 ships as of early 2020."

Intelligence sources also have cited aggressive operations by Russia's navy worldwide. The New York Times reported that in August 2020 three Russian ships entered the U.S. economic zone in the Bering Sea and ordered U.S fishing vessels to leave the area. The Coast Guard advised the American vessels to comply. The Washington Institute, a foreign policy think tank, reported late last year that Russia has added ships, including the guided-missile cruiser Moskva, to its 10-ship Mediterranean Fleet.

In mid-January Chief of Naval Operations Adm. Michael Gilday released his 2021 Navigation Plan, declaring that "We are engaged in a long-term competition that threatens our security and way of life." He announced that the Navy will "execute a tri-service maritime strategy" with the Marine Corps and Coast Guard based on four priorities—readiness, capabilities, capacity, and sailors.

Gilday said that strategy means retiring older assets: "To remain ahead of our competition we will divest ourselves of legacy capabilities that no longer bring sufficient lethality to the fight. This includes divestment of experimental LCS hulls, legacy cruisers, and older dock landing ships. It also includes divesting non-core Navy missions like Aegis ashore."

Shipbuilding

The new Business Operations Plan cites the need for a new 30-year shipbuilding plan and a long-range maintenance and modernization plan. The plan aims at a fleet of 355-ships within 10 years, a target established by a 2016

The U.S. Navy's front-line Virginia-class fast attack submarines are prime candidates for electronics technology insertion and upgrades.

Navy Force Structure Assessment and adopted by the 2018 National Defense Authorization Act.

Navy officials have said the new force structure will consist of fewer cruisers, destroyers, and amphibious-assault ships, and more frigates and LCSs. The 355-ship goal does not include unmanned surface or undersea vehicles operated from manned ships.

In 2019 the Navy initiated a new future force-level goal called "Battle Force 2045." Last October then-Defense Secretary Mark Esper revealed that the goal of Battle Force 2045 is 500 manned and unmanned ships, including the 355 manned ships by 2035. That fleet could include as many as 50 to 60 amphibious ships to support Marine Corps operations, and six light aircraft carriers.

The Navy 2021 budget request sought $19.9 billion for seven new ships: one Columbia-class ballistic-missile submarine (SSBN); one Virginia-class attack submarine (SSN); two Arleigh Burke-class destroyers; one FFGX; and two salvage/rescue ships — four fewer ships than the 11 requested for 2020. The $19.9 billion requested is $3.9 billion less than the amount sought in 2020, when Congress actually approved $24 billion for shipbuilding.

The 2021 five-year shipbuilding plan calls for 42 new ships — 13 fewer than the 55 sought in the 2020 five-year plan, and 12 fewer than in the 2020 30-year plan.

The 12-ship Columbia-class of SSBNs is billed as the service's number-one acquisition program. In early November the Navy awarded a $9.5 billion contract to General Dynamics Electric Boat for construction and testing for the first two boats, Columbia (SSBN 826) and Wisconsin (SSBN 827). The award pays all construction costs for Columbia and advance procurement, advance construction, and engineering for Wisconsin.

Ballistic missile submarines

The new class will replace the older Ohio-class boomers, with Columbia scheduled for delivery in 2027, and to enter active service in 2030. The Navy says the Columbia class will be built with a "life-of-ship" reactor that allows shorter maintenance periods to enable the Navy to meet its requirement with the 12 subs versus 14 Ohios.

Also in November Electric Boat awarded a $2.2 billion contract to Huntington Ingalls Industries for design and construction of six module sections of Columbia and Wisconsin, with delivery of the first in November 2022 and the final module in January 2028.

The frontline surface combatant program remains the Arleigh Burke-class (DDG-51) Aegis destroyer, with 68 ships now at sea. The Navy is building new Flight III Burkes, designed around a new SPY-6(v) air-defense radar, new weapons, and mechanical and electrical upgrades.

Huntington is building the first and third Flight III ships, Jack H. Lucas (DDG 125) and Ted Stevens (DDG 128), and has contracts for five more. General Dynamics Bath Iron Works is building Louis H. Wilson (DDG 126) and in December started fabrication work on William Charette (DDG 130). Bath has four Flight III ships under contract.

The two yards are finishing the Flight IIA construction, with DDG-121 and DDG-123 at Huntington Ingalls. Bath is building DDGs 122, 124, and 127.

The Navy will field three Zumwalt-class (DDG-1000) destroyers for land attack and air defense. In October Zumwalt conducted a successful live test launch of an SM-2 air-defense missile from its Mk 57 vertical launch system. The ship will start fleet service this year. Michael Monsoor (DDG 1001) is going through testing at San Diego. General Dynamics Bath is building Lyndon B. Johnson (DDG 1002).

LCS builders Fincantieri Marinette Marine and Austral USA continued to stamp out new ships. In June the Navy took delivery of Independence variant Oakland (LCS 24) and in August christened Savannah (LCS 28). In October Austal laid the keel for Santa Barbara (LCS 32), the 16th Independence type. That month Mobile (LCS 26) completed an acceptance trial in the Gulf of Mexico.

Austal also is building LCS 34 and will start work on two more ships this year. In August Minneapolis-Saint Paul (LCS 21) completed an acceptance trial. In November Fincantieri Marinette Marine launched LCS 25 and soon will deliver LCSs 27, 29, and 31.

The Navy continues to build two variants of the littoral combat ship, but will divest older ships. Shown here is the Independence-variant Gabriele Giffords (LCS 10).

Amphibious assault ships

In July Huntington Ingalls administratively commissioned the America-class amphibious assault ship Tripoli (LHA 7). The yard is building Bougainville (LHA 8) and is under contract to build LHA 9.

The four-America-class ships replace five Tarawa-class LHAs, now all decommissioned. The America-class ships, which would support F-35B fighter aircraft, use the same propulsion system as the last Wasp-class amphib Makin Island (LHD 8), a combination of two gas turbine engines and two auxiliary motors for low-speed propulsion. The Navy is considering building an additional LHA to replace the Bonhomme Richard (LHD 6), which was decommissioned after being damaged in a fire last July.

Huntington Ingalls also is building four 684-foot-long San Antonio-class (LPD 17) amphibs, LPD 28, LPD 29, LPD 30 and LPD 31. In 2018 the Navy started an LPD Flight II program of 13 ships starting with LPD 30 to bring the class to a total of 26 ships. The company has delivered 11 San Antonios.

Flight II ships LPDs 30 and 31 will have relatively the same capabilities as the Flight Is but cost less. Flight II would replace the Flight I composite mast with a steel one.

CRS reports that the 50 to 60 amphibious ship force envisioned for Battle Force 2045 could include a new 28-to-30-ship class of amphib called the Light Amphibious Warship or LAW. The LAWs would be smaller and less expensive than the LHA/LPD/LHD ships.

The Navy-Marine Corps team is strengthening the ability to move men and materiel through replacement of its fleet of 91 105-ton landing

craft, air-cushion (LCACs), which ride on an air-filled fabric skirt. Textron Marine Systems delivered two new Ship-Shore Connectors (SSCs) last fall.

The SSCs will be built with fly-by-wire steering controls, new composite materials to eliminate corrosion, an improved skirt to reduce drag, and Rolls Royce M7 gas turbine engines — a variant of the V-22 Osprey aircraft engine. The SSC will be able to haul 75-ton payloads, or 145 Marines, at 35 knots. Like the LCACs, the SSCs will deploy from welldecks of all the big-deck amphibious ships.

Weapon systems

In December the Navy awarded Raytheon Missiles &Defense an $82.7 million contract for new options on production support and systems integration for the SPY-6(v) air and missile defense radar — the centerpiece of the DDG-51 Flight III rebuild and the foundation of the fleet's new ballistic missile-defense architecture.

For the Flight III Burkes, the Raytheon-built SPY-6(v) will replace Lockheed Martin's SPY-1(v) phased-array radar now aboard all the Burkes and Ticonderoga-class (CG 47) cruisers.

Raytheon says the use of gallium nitride (GaN) semiconductor technology for the new radar's transmit-receive modules will permit huge increases in signal processing speed. The company says the faster processing will enable the 360-degree coverage necessary to detect high-speed ballistic and anti-ship missiles. The greater processing speed also permits fabricators to use less of it, achieving major weight and cost savings.

The Flight III ships will get a (v)1 variant, consisting of 37 radar assembly modules. In November, Huntington Ingalls had installed two of four SPY-6(v) arrays on the deckhouse of Jack H. Lucas (DDG 125).

In October Raytheon delivered a SPY-6 live test array to the Navy's Combat Systems Engineering Development Site (CSEDS), near Lockheed Martin's Moorestown N.J., facility, which produces the Aegis combat system computer software programs.

The combat system is the architecture of computer hardware and software that controls shipboard weapons and sensors. The Aegis system, in numerous versions, is aboard all the Burkes and Ticonderogas.

Advanced sensors

When the live array arrived at CSEDS, Capt. Phillip Mlynarski, commanding officer of the Aegis Techrep team, said "we're ushering in a new age of advanced sensor technology and a leap forward in combat power and lethality ... we are integrating game-changing technology and cutting-edge combat system algorithms to sharpen the tip of the sword."

The new test array will be integrated with the Aegis Baseline 10 program, developed specifically for the Flight IIIs.

Other SPY-6(v) configurations are the Enterprise Air Surveillance Radar (EASR), which will be fielded throughout the surface fleet. America-class LHAs and Nimitz-class aircraft carriers will get an EASR SPY-6(v)2 — a rotating radar with nine radar modules — for cruise missile and anti-air and anti-ship defense and air-traffic control.

A (v)3 system, with three arrays, will go aboard Ford-class carriers and Constellation-class frigates. The system scales up to a (v)4, with four array faces and 24 radar modules for the BMD and cruise-missile and airborne defense missions for backfit to fielded Burke DDGs.

In July Raytheon won a $125 million contract for options for low-rate initial production for four EASR (v)2 units and two (v)3s. Bougainville (LHA-8) and will be the first (v)2 ship followed by John C. Stennis (CVN-74), Richard M. McCool Jr., (LPD-29), and Harrisburg (LPD-30). The (v)3s are set for John F. Kennedy (CVN-79) and Constellation (FFG-62).

The Knifefish unmanned underwater vehicle from General Dynamics is to be an important component of Navy integrated counter-mine systems.

The three Zumwalt-class (DDG 1000) destroyers will be capable of anti-air and anti-land operations.

An engage on remote exercise last November provided critical validation of the SPY-6(v) and Aegis interface for ballistic missile defense. The U.S. Missile Defense Agency, the Program Executive Office for Integrated Warfare Systems, and Navy labs collaborated to launch an SM-3 block IIA missile from the Burke destroyer John Finn (DDG-113) to destroy an ICBM target near Hawaii. The ship used Aegis baseline 9.C2.0K to pass the targeting data to the missile from the Army's Reagan Test Site on Kwajalein Atoll in the Marshall Islands.

New radar

The SPY-6(v) is the linchpin for a longer-term initiative to develop a single combat system for the surface fleet by using advanced software and hardware to enhance sensor responsiveness and weapons lethality.

Lockheed Martin Rotary and Missile Systems has moved ahead with two major sensor initiatives, the high-energy laser with integrated optical-dazzler and surveillance (HELIOS) and SPY-7 radar. The company delivered a production HELIOS to the Surface Combat Systems Site at Wallops Island, Va., in December for Navy testing. The laser, officials say, is ready for integration with ship combat systems. Unlike a missile system or gun, the laser draws on ship power and never "runs out" of ammunition.

Lockheed Martin says the SPY-7 potentially could backfit to fielded DDGs and other Navy surface combatants and those of Canada, Japan, and Spain, which use Aegis. The SPY-7 solid-state GaN technology is derived from the company's development of the Missile Defense Agency's long-range discrimination radar (LRDR), to be installed at the Clear Air Force Station, Alaska.

Navy and industry officials are discussing plans for a surface combatant combat systems engineering agent (SCCSEA) for the Burkes, Ticonderogas, Constellation-class FFGs, and LCSs and Australian, Japanese, Norwegian, South Korean, and Spanish Aegis ships.

A SCCSEA would oversee the engineering needed for definition, design, systems integration, testing, and support for combat systems. A 10-year SCCSEA contract could commence when current combat systems contracts expire. Lockheed Martin now acts as CSEA for Aegis and for the LCSs and Constellation-class combat systems and the ship self-defense system aboard carriers, LHDs, and LPDs.

Computer consoles

To support new combat systems the Navy is taking delivery of computer consoles, displays, and peripheral equipment (CDP) built by Leonardo DRS under a five-year contract, potentially worth more than $460 million. The award follows deliveries of similar equipment under an earlier Common Display System contract.

The CDP equipment includes consoles, thin-client displays, and peripherals that run "software agnostic" programs in support of open-architecture combat systems aboard several ship classes.

Shipboard weapon system development moved forward in December with a $145 million Naval Air Systems Command award to Raytheon for 90 full-rate production Block V ship-and submarine-launched Tactical Tomahawk missiles. Also in December the company and the Navy conducted two flight tests of the new Block V Tomahawk from the Burke destroyer Chafee (DDG 90).

The company is developing a Block V(a) variant for a maritime strike capability and a Block V(b) with a programmable warhead for more accurate land attack. Both will be deployed in 2021. Raytheon is managing a Tomahawk modernization program to extend the Tomahawk service life by 15 years.

Raytheon also is building components of the Cooperative Engagement Capability (CEC) — a system of computers and sensors that generate a single composite track of airborne targets, enabling CEC-equipped ships to operate as an integrated air-defense network. CEC processors and antennas are aboard most Aegis DDGs, CGs, and the E-2CB Hawkeye surveillance aircraft. In September 2020 the company won funding for contract options for CEC design-engineering support.

Shipboard electronic warfare

Northrop Grumman won a new production contract last fall for new Block 3 units of the SLQ-32(v)7 shipboard electronic warfare system under the Surface Electronic Warfare Improvement Program (SEWIP) — a phased upgrade of the Navy's old SLQ-32 with involvement of several companies. The new award is for Block 3 production for the Burkes. SEWIP Block 3 adds an active electronic attack capability to the system.

In a related effort Lockheed Martin, prime for the Block 2 SEWIP work, in October awarded Cobham Advanced Electronic Solutions a $50 million contract for antenna array panel assemblies for the Block 2 system.

On the undersea warfare front, Raytheon Technologies in December won a $26.7 million award for production options for the Mk 54 Mod 0/Mod 1 lightweight torpedo common parts kits for the Belgian, Netherlands, and New Zealand navies. Northrop Grumman builds the nose arrays for both the Mk 54 lightweight torpedo and the Mk 48 heavyweight torpedo.

Northrop Grumman tested the first industry-built prototype of a "very lightweight torpedo," (VLWT) based on a Navy design developed by Penn State's Applied Research Lab. Northrop Grumman funded the VLWT research. The Penn State design is based on a compact rapid-attack weapon (CRAW) program funded by the Office of Naval Research. Barber-Nichols Inc. of Denver has built a stored chemical-energy propulsion system for the VLWT.

Unmanned Systems

Navy leaders in 2020 pushed to implement concepts spelled out in the service's March 2018 Strategic Roadmap

The Arleigh Burke-class destroyer John Finn (DDG 113) helped prove the use of the SM-3 mission integrated with Aegis for ballistic missile defense.

for Unmanned Systems, which consists of three components: a medium unmanned surface vehicle (MUSV); a large USV or LUSV, and an extra-large unmanned USV, the XLUUSV.

In September the Navy awarded six contracts, roughly $7 million each, to Huntington Ingalls, Lockheed Martin, Bollinger Shipyards (Lockport, La.), Fincantieri Marinette Marine, Austal USA, and naval architect Gibbs & Cox for studies of the LUSV. The companies will develop specifications and requirements, aiming at a design and construction contract. Capt. Peter Small, manager of unmanned maritime programs at NAVSEA, said that the studies "will allow the Navy to harvest the learning from our land- and sea-based prototyping efforts ... to refine requirements for an affordable, reliable, and effective LUSV."

L3/Harris Technologies Maritime Systems unit will deliver a prototype MUSV in early 2023, company officials say. The Navy awarded the company $35 million in July to act as MUSV systems integrator and to build one MUSV with options for eight more. The Navy says the MUSV will be a pier-launched self-deploying modular surface vessel capable of autonomous navigation and provide intelligence and situation awareness data.

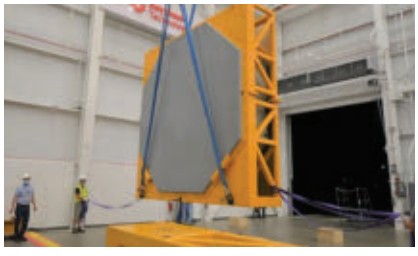
Dave Zack, Maritime Systems president, says the MUSV will be a modified version of a commercial-crew vessel built by Incat Crowther for resupply of oil rigs. Swiftships will built the vessels.

In other unmanned systems work, in July General Dynamics Mission Systems won a $13. 5 million award for support work for the surface mine countermeasures UUV (SMCM UUV) also called Knifefish. The Knifefish vehicle when fielded, will provide volume and bottom mine-hunting in a tactical environment. The work includes engineering support, test and evaluation, and system upgrades.

Textron Systems received a May contract worth $20.7 million for engineering support for the Unmanned Influence Sweep System (UISS). Operating from the LCSs, the UISS conducts mine countermeasures sweeping and targeting for acoustic and magnetic mines.

In August four companies won orders to support the unmanned surface vehicle Mk-18 Family of Systems. Advanced Acoustics Concepts LLC, Arete Associates, Northrop Grumman Systems, and Peraton Inc. will provide trade and test and verification studies, and other deliverables. The Navy says the Family of Systems includes systems that comprise the future unmanned surface fleet in such areas as payloads, non-payload sensors, mission support systems, vehicle control systems, among others. In a related effort, Hydroid Inc., of Pocasset, Mass., won a $39 million contract for production support for the Mk-18 system.

In December Northrop Grumman Systems won a $22 million award for options for sustainment for the MQ-8 Fire Scout helicopter-like unmanned aerial vehicle, which takes off and lands on surface ships. A newer Fire Scout, the MQ-8C next-generation UAV is based on the Bell 407 helicopter. The company received an award in June for production and delivery of three MQ-4C Triton long-range high-altitude UAVs and ancillary main operating bases and a forward operating base. The Triton provides intelligence, surveillance, and reconnaissance over wide ocean areas.



the Raytheon SPY-6(V) shipboard radar will serve as the baseline for future surface combatant air and missile defense. Shown here is the SPY-6(V) array face.

The ever-shrinking world of small-form-factor embedded computing

New computer boards offer high performance, thermal management, and peripherals in a smaller size than 3U VPX, with artificial intelligence (AI) and GPGPU processing.

BY **Jamie Whitney**

Open-systems standards like C4ISR/EW Modular Open Suite of Standards (CMOSS), Sensor Open Systems Architecture (SOSA), and Future Airborne Capability Environment (FACE) are helping drive development of small-form-factor (SFF) embedded military and aerospace hardware.

Open systems standards help to ensure components share a common platform and can interchange information across military branches.

Experts at Curtiss-Wright Defense Solutions of Ashburn, Va., say the SOSA committee aims to define the entire connector interface for 3U and 6U VPX.

"SOSA started a small form factor sub-committee a little over a year ago or so, and they were originally considering VITA 74 as the base standard from which they were going to work," says Ivan Straznicky, chief technology officer for advanced packaging at Curtiss-Wright Defense Solutions.

"Recently, though, they've also opened it up to 'Short VPX,' which has been kicked off within the VITA Standards Organization (VSO), and Curtiss-Wright is participating in and monitoring that effort. Short VPX is basically, exactly as the name implies - a shorter version of 3U VPX: 100 millimeters deep instead of 160 millimeters.

"But the card edge is the same as 3U VPX, which is great, since it can leverage all of the work that's been done for 3U VPX, in terms of pin-outs, voltages and thermal management," Straznicky says. "All of the standardization work that's been done on 3U VPX ports offer to the Short VPX form factor."

There also are industry discussions about increasing the pitch of the form

This VITA 48.4 liquid-flow-through ATR box from Elma Electronic has a 6U OpenVPX backplane to accommodate as many as eight computer boards and two VITA 62 plug-in power supplies.

The Systel Kite-Strike embedded computing system supports centralized sensor ingest and data fusion and enable real-time AI inferencing and deep learning (DL) capabilities.

factor so there isn't a loss of usable real estate on printed circuit boards (PCBs).

"Part of the effort is creating a form factor that can go into smaller spaces than 3U VPX can, like round enclosures," Straznicky says. "That's emerged as a big requirement within SOSA. We're currently talking about standardizing on a 1.2-inch pitch instead of the 0.8-inch or 1.0-inch pitch typical of VPX today."

The Microchip PolarFire SoC Icicle kit is a low-cost development platform that enables evaluation of the five-core Linux capable RISC-V microprocessor subsystem, real-time execution, low-power capabilities, and peripherals of the PolarFire SoC FPGA.

A smaller computer board has several advantages, Straznicky says. "With a 1.2-inch pitch, you can put mezzanine cards on the board and provide roughly the same amount of PCB space as you do with 3U VPX. To do that, you go taller in the Z dimension, while reducing depth. That makes it possible, for example, to fit the board into something like a 6-inch diameter tube.

Short VPX

This relatively small form factor also has its downside, Straznicky points out. "It won't support XMC or PMC cards, since they are too long, but it will support FMC or FMC+ mezzanine modules. Another benefit of Short VPX is that it would be as rugged, if not more rugged, than 3U or 6U VPX, because of its small size. I would imagine that two-level maintenance would turn out to be an option for Short VPX, but it likely won't be as attractive as 3U/6U VPX for two-level maintenance, but it's hard to say at this point."

Justin Moll, vice president of sales and marketing at embedded computing specialist Pixus Technologies in Waterloo, Ontario, says he agrees that open standards are driving development of SFF systems.

"The military/aerospace sector is pushing for significant performance upgrades in modular open standard architectures that provide more interoperability, efficient and quicker acquisition, and sustainment through increased commonality," Moll says. "The SOSA effort is the primary driver in our industry to achieve these goals. From a backplane/chassis perspective, this means that the faster and hotter boards require more heat dissipation. Also, the backplanes are increasing in speeds to 40 Gigabit Ethernet, PCIe Gen4/5, and 100 Gigabit Ethernet levels. Especially with optical (VITA 66) and RF (VITA 67) interfaces on the backplane, there is less space for routing these high-speed signals. The SOSA requirements also allot for clocking, timing modules, and chassis managers."

In 2019, the then-secretaries of the U.S. Army, Navy, and Air Force signed the Modular Open Systems Approach (MOSA) tri-service memo which states common standards enables information's sharing between machines in different branches of the military is the natural continuation of SOSA's efforts.

Mike Southworth, a senior product manager at Curtiss-Wright, says the tri-service memo has a rippling effect in U.S. Department of Defense (DOD) requests for quotation (RFQ) and requests for proposals for new platforms.

"The Government's mandate and continued push for open architectures is now becoming explicit in RFQs," Southworth says.

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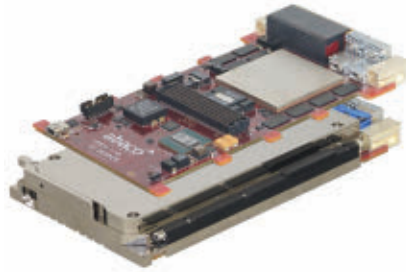
Curtiss-Wright Parvus DuraCOR AGX-Xavier is a small-form-factor commercial off-the-shelf (COTS) modular mission computer integrating the NVIDIA CUDA-core accelerated graphics processing, artificial intelligence (AI) / deep learning (DL) inference.

AI and small form factor

Artificial intelligence (AI) and robotics in the aerospace and military market will help drive the growth of small-form-factor embedded computing between 2021 and 2025, says Dan Mor, director of video and GPGPU product line for Aitech Defense Systems Inc. in Chatsworth, Calif.

"Much of this is driven by recent trends of using robotics in the space industry as well as the integration of AI in avionics, ground mobile, and ground-fixed platforms," Mor says. "AI is running on GPGPU [general-purpose graphics processing unit] boards and systems, and NVIDIA is dominating this market today. When we talk about AI, we are basically talking about AI on GPGPU-based platforms," Mor says.



The Abaco Systems VP889 3U VPX field-programmable gate array (FPGA) board offers 100 Gigabit Ethernet for military, aerospace, and commercial embedded computing.

"Real-time response applications, as often found in military and defense environments, are requiring systems that can perform AI processing at the sensors for AI at the edge and for autonomous operations — exponentially increasing computing requirements. This means rugged, SFF systems with exceptionally high processing abilities," Mor continues. "Common challenges when performing complex computations, from load balancing and CPU choking to upgrading and overclocking, hinder the higher processing requirements of today's military systems, which keep increasing the number of data and video inputs that need to be managed. And the footprint keeps getting smaller.

Blending AI and GPGPU has provided tremendous advantages for aerospace and defense systems designers, Aitech's Mor points out. "Systems powered by AI using GPGPU can quickly perform many tasks, such as object recognition, classification, making conclusions and predictions, that not long ago were assumed to require human cognition. The use of parallel processing enables exceptional computation, lower power consumption and ultra-compact, rugged systems that go almost anywhere. The implementation of AI and the changing of conventional weapons to 'smart' battlefields will enhance the performance of existing platforms of armed forces around the world."

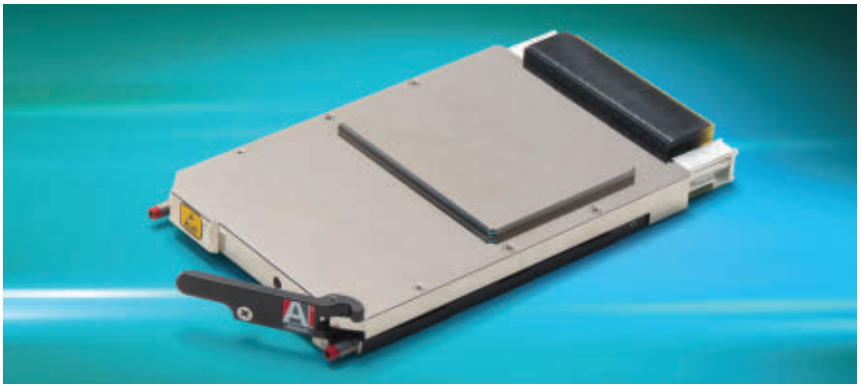
Aneesh Kothari, vice president of marketing at Systel Inc. in Sugar Land, Texas, says AI and other technologies are driving performance demands even from SFF systems.

"With the proliferation in platform sensor integration, data collection, and immediate-future technologies involving AI and autonomy, customers require data center performance at the edge," Kothari says. "Additionally, there is a significant need for reduced size, weight, and power (SWaP). Systel is meeting these demands by providing high-performance, fully rugged embedded edge computers, purpose-built for deployment in austere environments."

In addition, Paul Quintana, associate director of global aerospace and defense business unit at Microchip Technology in Chandler, Ariz., says that 5G technology is helping to leverage AI and machine learning capabilities in SFF systems.

"For example, edge compute leveraging artificial intelligence and machine learning (ML) drives the

trend to highly integrated and compute dense, secure, and low power microelectronics enabled by SOC and SOM [system-on-module] technologies. Second tier edge aggregation embedded compute needs will process increasing amounts of data within the same thermal envelop making use of the flexibility and power efficiency of SoC FPGA's to meet the needs of near-term system needs, as well as future needs as requirements change."



The Aitech C530 3U VPX GPGPU board incorporates the NVIDIA Turing architecture and offers 16 lanes of high-throughput Gen 3 PCI Express and four independent video outputs.

Mix and match

Pixus's Moll says industry is able to combine 3U and 6U OpenVPX boards in the same chassis. This is done by leveraging a horizontal-mount chassis configuration 3U segment so that it can sit side-by-side with a 6U segment.

"For example, a 3U tall OpenVPX horizontal-mount chassis can support five sets of 3U OpenVPX boards and five sets of 6U OpenVPX boards, all at 1-inch pitch," Moll says. These boards can be plugged into one monolithic backplane with options for VITA 66 and/or VITA 67 interfaces. Alternatively, the same enclosure can just be loaded in 3U OpenVPX boards."

Placing more SFF computing power can be put into rugged chassis results in the need for greater cooling capabilities, points out Ram Rajan, the senior vice president of engineering at Elma Electronic in Fremont Calif.

"The most significant trends Elma is seeing in SFF is increasing the I/O options out of the box, of course, as we, as an industry, move more towards interoperability as well as continuing to deal with the challenges of heat dissipation," Rajan remarks. "Thanks to ever-shrinking electronics, systems can be used in more compact environments, but this poses two major design hurdles:

- Components are being consolidated into multi-purpose units, so that more components, aka capabilities, can then be added. But as more components are added, the result is more heat and less places for it to flow out of the system.
- SFF platforms seek to house the most functionality in the smallest footprint. By design, as overall real estate condenses, the designer is left with less space for heat to be dissipated.

Rajan continues, "Enclosures are generally cooled through air cooling or conduction cooling, but recently the concepts of liquid and vapor cooling have come about, allowing for effective thermal management that can be tailored to specific applications."

Lee Brown, senior director of C4S at Curtiss-Wright Defense Solutions concurred with Elma's Rajan on the need to keep things cool in SFF systems like system-on-chip (SOC) and system-in-package (SIP) technologies.

"As things continue to miniaturize and power becomes more condensed thermal management expertise becomes all the more important. We have addressed and developed mitigating approaches for these challenges, so that boards using SOC and SIP devices can optimally perform and survive in military environments, as they ramp from cold to hot."

Thermal management

Systel's Kothari agrees that thermal management can be a challenge when it comes to embedded computers.

"From a backplane and chassis perspective, this means that the faster and hotter boards require more heat dissipation. Also, the backplanes are increasing in speeds to 40 Gigabit Ethernet, PCIe Gen4/5, and 100 Gigabit Ethernet levels. Systel utilizes proven thermal design board and chassis-level cooling methods to effectively and efficiently manage heat dissipation," Kothari says. "Systel's small form factor embedded computers can easily approach 200 Watts, all in a super dense, fully sealed system. Thermal management is of paramount importance, especially with system operating temperature ratings of up to +71 C."

Moll from Pixus agrees with the need for heat management. "From a backplane/chassis perspective, this

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Huntsville, Ala.
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Aitech
Chatsworth, Calif.
https://aitechsystems.com

Crystal Group Inc.
Hiawatha, Iowa
www.crystalrugged.com

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

Elma Electronic
Fremont, Calif.
www.elma.com

Extreme Engineering Solutions (X-ES)
Verona, Wis.
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General Micro Systems (GMS) Inc.
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Systel Inc.
Sugar Land, Texas
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VadaTech Inc.
Henderson, Nev.
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ZMicro
San Diego
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means that the faster and hotter boards require more heat dissipation," Moll says. "Also, the backplanes are increasing in speeds to 40 Gigabit Ethernet, PCIe Gen4/5, and 100 Gigabit Ethernet levels. Especially with optical (VITA 66) and RF (VITA 67) interfaces on the backplane, there is less space for routing these high-speed signals. The SOSA requirements also allot for clocking, timing modules, and chassis managers."

In addition to thermal management in SFF systems, Curtiss-Wright's Marc Couture, who is the company's director of its ISR business segment, says that signal integrity is also very important in an industry that is embracing a "commercial off-the-shelf" (COTS) mindset.

"Today, we have to use very expensive tools from a variety of vendors in order to solve cutting edge signal integrity problems," says Couture. "It's not just about routing power. There are other signaling issues, such as those involving memory lanes. Going from PCIe Gen 3 to Gen 4, and dealing with the associated higher data rates, will become increasingly difficult for smaller board vendors unless they can invest in these costly tools and they have the engineering staff with the requisite expertise. Leading COTS suppliers will continue to move forward, but smaller board houses will likely have a tough time keeping up with anything more than simpler, less challenging designs."

Processing power

Luis Esparza, product manager for Abaco Systems Inc. in Huntsville, Ala., rugged systems segment, says that customers are asking for an increase in processing density while combining application specific processing with general purpose processing.

"Supporting advanced and sometimes very specific signal processing requirements on top of traditional compute routines. Enabling a diverse set of customer missions and tasks on a relatively common set of hardware," says Esparza. "Customers from various markets are looking to Abaco to provide these sophisticated solutions that can survive the environments in an efficient high performing card or system product. We are seeing more combinations on-die of CPUs, GPUs, FPGAs, Analog, AI cores, etc. The close proximity of these functional blocks brings benefits in higher interconnect speeds, lower latency and lower power than equivalent discrete devices. SOSA is increasingly a driving force in the standardization of I/O and pinout.

"The trends are driven by customers and underlying technological advances. At Abaco we are rising to meet the challenge," Esparza continues. "The budgets are quite constrained given the expanse of performance and pressure from near pears requires novel efforts to ensure a lower overall cost of ownership to advance the technology in the Military and Aerospace sector. Abaco is in a unique position to transform the commercial technologies into products that can enable our Military and Aerospace customers to develop, advance and Deploy in a timely and cost-effective manner. Many of our customers have decades invested in Intellectual Property and cannot afford to start new software development efforts every time a technology or sensor advances. We need to re-use IP where it makes sense and re-fresh or Invent what is needed to truly outpace competitors and adversaries. The need to do the same function at lower power or more work at the same power, combined with diminishing returns from Moore's Law-type advances drives the need to go parallel, and to tailor the architecture to the task at hand."

Northrop to build EW jammers to protect warfighters from improvised explosives

BY **John Keller**

WASHINGTON — Electronic warfare (EW) experts at Northrop Grumman Corp. are building additional open-architecture RF jammers for infantry, land vehicles, and fixed sites to protect Australian warfighters from radio-controlled improvised explosive devices (IEDs).

Officials of the U.S. Naval Sea Systems Command in Washington announced a $329.9 million order to the Northrop Grumman Mission Systems segment in Herndon, Va., for Joint Counter-Radio-Controlled Improvised Explosive Device Electronic Warfare (JCREW) increment one block one (I1B1) systems for Australia.

The JCREW I1B1, formerly known as JCREW 3.3, is the first-generation system that develops a common open architecture across all three capabilities and provides protection with RF jammers for worldwide military operations, officials say.

The order includes dismounted systems, mounted systems, mounted auxiliary kits, operational level spares, depot level spares, and engineering support services.

This integrated design for RF jammers makes the most of commonality across all capabilities, reduces life cycle costs, and provides increased protection against worldwide threats.

CREW systems protect combat troops from radio-controlled improvised explosives, and are designed to provide protection for foot soldiers, vehicles, and permanent structures, Navy officials say.

Among the JCREW I1B1 systems is the Northrop Grumman Freedom 240 for Counter Radio-controlled IED Electronic Warfare Marine Expeditionary Unit Special Operation Capable (SOC), or CREW MEU.

The system jams a wide range of IEDs and creates a protective barrier around Marine Corps infantry and their equipment while minimizing disruption to friendly communications systems.

On this order Northrop Grumman will do the work in San Diego and should be finished by December 2022. For more information contact Northrop Grumman Mission Systems online at www.northropgrumman.com, or Naval Sea Systems Command at www.navsea.navy.mil.

Northrop Grumman is building Joint Counter-Radio-Controlled Improvised Explosive Device Electronic Warfare (JCREW) systems for Australia.

DARPA asks industry to enable unmanned vehicles to operate at manned speeds

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are kicking-off a potential $19.5 million project to develop machine autonomy that enables unmanned ground combat vehicles to maneuver safely over rough off-road terrain at speeds a human driver could achieve.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., issued an updated broad agency announcement (HR001121S0004) for the Robotic Autonomy in Complex Environments with Resiliency (RACER) program.

Such a vehicle should be able to operate quickly over unstructured off-road terrain at speeds limited not by the autonomy software or processing time, but only by onboard sensor limitations, vehicle mechanical limits. Its speed should be similar to that of a human driver or a tele-operated vehicle.

The self-driving car industry is making rapid advances in on-road autonomous mobility of commercial cars, yet military off-road autonomy algorithms and capability development has lagged because of the increased complexity of the off-road problem, DARPA researchers say.

Military off-road must deal with 3D surfaces, hundreds of obstacles, incomplete mapping data, no defined road networks, and no driving rules. RACER seeks to develop machine autonomy algorithms that enable unmanned ground vehicles (UGVs) to operate at high speeds in open and complex terrain, with minimal interventions.

The DARPA RACER project focuses on developing, maturing, and demonstrating algorithms on lightweight tactical all-terrain vehicles (LTATV), shown above, in field experiments.

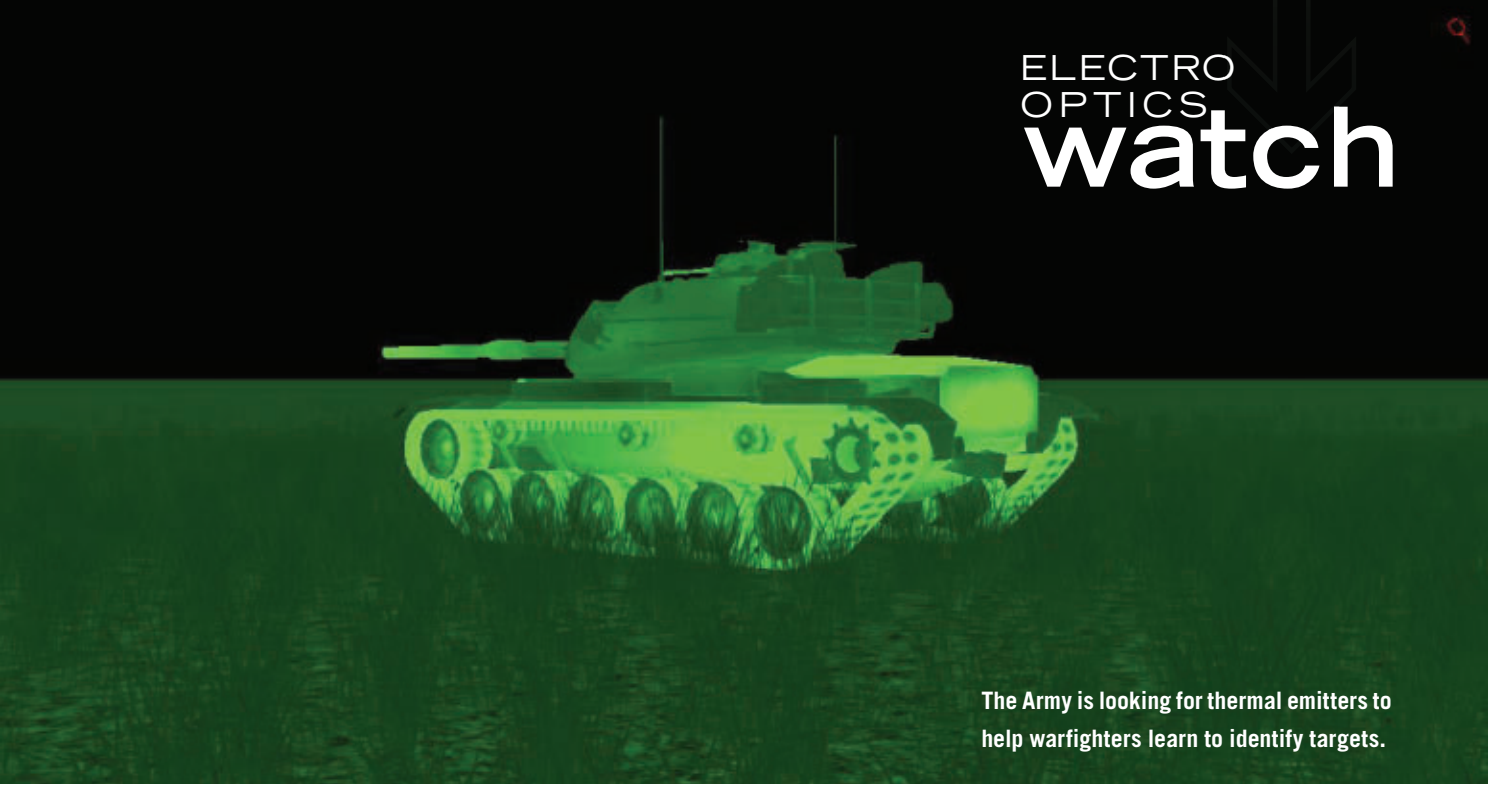
RACER phase-one will focus on developing, maturing, and demonstrating algorithms on lightweight tactical all-terrain vehicles (LTATV) in three DARPA-hosted field experiments.

RACER phase-two will mature technology, and increase system speeds over long off-road distances and complex maneuver terrain with a decreasing number of human interventions. Phase-two, moreover, will use a combat-size vehicle for field demonstrations, while keeping to the LTATV for algorithm maturation.

DARPA will provide LTATVs equipped with a sensor suite, computing resources, an optional baseline autonomy stack, vehicle and sensor models, and initial data sets.

Companies interested in participating were asked to submit abstracts by early November, and those submitting promising ideas were asked to submit full proposals by 14 Jan. 2021. Email questions or concerns to DARPA at HR001121S0004@darpa.mil.

More information is online at https://beta.sam.gov/opp/27e7a28ba5674144910ac1f-2d73ef987/view.



The Army is looking for thermal emitters to help warfighters learn to identify targets.

Army eyes rapidly deployable thermal emitters for target identification

BY **John Keller**

NATICK, Mass. — U.S. Army researchers are surveying industry to find companies able to provide electro-optical thermal emitters to represent commercial and military assets for target identification training.

Officials of the Army Combat Capabilities Development Command Soldier Center in Natick, Mass., issued a request for information (W911QY-21-R-TSTR) for the Thermal Signature for Targeting Representation project.

Army researchers want thermal emitters that are rapidly deployable, self-sustaining, and efficient. This announcement also seeks to help the Army evaluate the state of the technology readiness and state of the market.

Army experts primarily are interested in emitters that currently are under evaluation in commercial settings, other government agencies, or related applications.

The emitters should have a modular design configurable to different shapes and forms, and exhibit zone-controlling features that could be programmable to different shapes, forms, and signature profiles.

Thermal emitters should comprise several modular components no larger than six inches on any geometric dimension, be able to mimic a surface area of at least three feet wide and two feet long, and weigh no more than 50 pounds when assembled.

The Army wants emitters should have the capability of remote control and activation from as far away as 100 meters. Timed activation and deactivation also will be considered.

The device should aim to mimic thermal signatures as hot as 250 degrees Fahrenheit while operating between the mid-to high- infrared range. It also should have an operation time between six to eight continuous hours, and operate in temperatures from -20 to 120 F.

Unpowered, battery-powered and wired power solutions will be considered where appropriate, and setup and deployment should take less than 15 minutes, with no specialty tools. Devices should be reusable for at least 25 times, explore stationary and mobile options, and offer two-man transport and deployment.

Companies were asked email 5-page white papers in .pdf form by 9 March 2021 to the Army's Luis Padilla at luis.padilla23.civ@mail.mil. More information is online at https://beta.sam.gov/opp/e154e56e358e-4087bab75af91ec5b44e/view.

UNMANNED CONTROLLERS

Persistent Systems chooses unmanned controller system from Tomahawk Robotics

Unmanned vehicle communications specialist Persistent Systems LLC in New York needed an unmanned control system for the company's MPU5 Android-based MANET radio and Rugged Display and Controller (RDC). They found their solution from Tomahawk Robotics Inc. in Melbourne, Fla.

Tomahawk Robotics will make the company's Kinesis Android-based common control system for unmanned ground vehicles (UGVs) and unmanned aircraft systems available for Persistent's MPU5.

This agreement results from Tomahawk's joining of the Wave Relay Ecosystem, an industry alliance of unmanned systems and sensor companies that use Persistent's Wave Relay mobile ad hoc network (MANET) as their preferred network.

The MPU5 runs the Android operating system, enabling applications like Kinesis to load onto the radio, while the RDC provides the touch screen, joysticks, and game pad buttons in a package the size of a commercial smart phone.

"Basically, this provides a universal controller for unmanned systems that reside on the MPU5 and is accessed with the RDC, both of which the dismounted warfighter would already be carrying," says Brian McDonald, field operations director at Persistent Systems. "You eliminate the weight and cost of extra hardware, and you bring Tomahawk's all-encompassing Kinesis capability to everyone on the tactical team."

The MPU5 and RDC can operate seamlessly with the Tomahawk Robotics Mimic spatial controller for the fine manipulation of the arm of a bomb-disposal robot.

For more information contact Tomahawk Robotics online at www.tomahawkrobotics.com, or Persistent Systems at www.persistent-systems.com.

ELECTRONIC WARFARE

BAE Systems to provide electronic warfare (EW) for Navy and foreign F-35 aircraft

U.S. Navy aerial warfare experts needed multifunction electronic warfare (EW) systems for F-35 fighter-bomber combat jets of the U.S. Navy and allied foreign military forces. They found their solution from the BAE Systems Electronic Systems segment in Nashua, N.H.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $81.3 million order to BAE Systems to provide 1,512 radio frequency (RF) countermeasures systems as part of Lot 12 for the F-35.

BAE Systems designs and builds the AN/ASQ-239 EW avionics to provide the F-35 with 360-degree situational awareness and end-to-end capabilities. The AN/ASQ-239 provides offensive and defensive options to enable the F-35 to identify, monitor, analyze, and respond to threats like radar-guided anti-aircraft missile batteries and air-search radars.

The RF countermeasures system makes the most of detection ranges and gives the F-35 pilot evasion, engagement, countermeasure, and jamming options. The AN/ASQ-239 provides broadband protection to help the F-35 reach well-defended targets and suppress enemy radars.

This system can operate in signal-dense environments and provide the F-35 with radio frequency and infrared countermeasures, and rapid response capabilities. The AN/ASQ-239 has an electronics architecture that enables designers to add new capabilities.

The AN/ASQ-239 has Integrated radar warning, targeting support, and countermeasures; reduced long-term life cycle cost; increased situational awareness; rapid response capabilities to protect the aircrew; threat warning; and ability to reach well-defended targets.

On this order BAE Systems will do the work in Nashua, Dover, and Londonderry, N.H.; Landenberg, Pa.; Topsfield and Chartley, Mass.; City of Industry and Carson, Calif; Hamilton, N.J.; and other U.S. locations, and should be finished by March 2024.

For more information contact BAE Systems Electronic Systems online at www.baesystems.com, or Naval Air Systems Command at www.navair.navy.mil.

CHASSIS AND ENCLOSURES

Liquid-cooled 6U VPX rugged embedded computing chassis introduced by Elma

Elma Electronic Inc. in Fremont, Calif., is introducing a rugged ATR chassis that complies with VITA 48.4 for liquid flow-through (LFT) cooling in a variety of aerospace and defense applications. The chassis's backplane can move data as fast as 10 gigabits per second and can handle 300 Watts per slot to accommodate the intense thermal management necessary high-density embedded computing systems. The liquid-cooled chassis also offers configurable front I/O connectors on a removable panel and a filtered power input connector. The chassis is one ATR tall with a rugged, bolted construction. Individual card coolant flow rates are adjustable with selectable orifices. The backplane features eight 6U slots on a 1.2-inch pitch, including two VITA 62-compliant power supply slots, four 6U slots, and two 6U payload slots populated with J1-J6 connectors. Clockable guide pins are at each slot for easy keying. The VITA 48.4 standard establishes the mechanical design, interface control, outline, and mounting requirements to ensure the mechanical intermateability of 6U VPX liquid-flow-through cooled plug-in modules within associated sub-racks. For more information contact Elma Electronic online at www.elma.com.

RUGGED COMPUTERS

Rugged computer for embedded edge supercomputing introduced by Systel

Systel Inc. in Sugar Land, Texas, is introducing the Kite-Strike next-generation rugged computer for embedded edge supercomputing for deployment in harsh environments. The Kite-Strike integrates the NVIDIA Jetson AGX Xavier system-on-module, comes in a compact form factor, and enables real-time artificial intelligence (AI) inferencing, deep learning, and machine learning capabilities. The rugged computer provides centralized sensor ingest and data fusion support for mission-critical applications, and is configurable and modular. Kite-Strike is engineered and manufactured for low size, weight, and power consumption (SWaP), and offers data center performance in a compact, rugged embedded edge computer. In addition to the NVIDIA Jetson AGX Xavier SOM, the Kite-Strike offers the Volta Architecture graphics processing unit with 512 CUDA cores and 64 Tensor cores; an eight-core Carmel ARM v8, 64-bit CPU; 32 gigabytes of system memory; 32 gigabytes of eMMC 5.1 data storage; Gigabit Ethernet, USB, and CAN I/O; ARINC 429 and MIL-STD-1553 databus interfaces; and 4G LTE GPS. The computer operates in temperatures from -40 to 71 degrees Celsius; meets MIL-STD-810H for resistance to the effects of shock and vibration, altitude, humidity, sand, dust and rain; meets MIL-STD 461G for electromagnetic interference; and MIL-STD-1275E/704F for power. For more information contact Systel online at www.nvidia.com.

STANDARDS-BASED COMPUTING

Rugged SOSA-aligned 3U OpenVPX FPGA card introduced by Annapolis Micro

Annapolis Micro Systems Inc. in Annapolis, Md., is introducing the WILDSTAR 3XR0 3U OpenVPX field-programmable gate array (FPGA) processor card for military and other rugged embedded computing applications. The card is aligned with the Sensor Open Systems Architecture (SOSA) open-systems standard. It offers 100-gigabit Ethernet FPGA that combines the processing and A/D and D/A converting power of two Gen 3 Xilinx UltraScale+ radio frequency system-on-chip (RFSoC) FPGAs with the ability to incorporate 18+ GHz digitization. The WILDSTAR 3XR0 3U OpenVPX card has a full-length coax-connected analog interface mezzanine site, which users can populate with a direct RF digitization mezzanine, or a third-party analog superheterodyne tuner to digitize 18+ GHz signals. An integrated tuner delivers lower size, weight, power consumption, and cost (SWaP-C) than a separate standalone tuner, while enabling separate upgrades of tuner, digitizer, and processor separately. In addition to two Gen 3 RFSoC FPGAs, an on-board XCZU5EV Xilinx MPSoC power-efficient ARM cores. For more information contact Annapolis Micro Systems online at www.annapmicro.com.

REAL-TIME SOFTWARE

FACE conformance for real-time software introduced by DDC-I

DDC-I Inc. in Phoenix is introducing Future Airborne Capability Environment (FACE) 3.0 software conformance for the company's Deos safety-critical DO-178 real-time operating system (RTOS) and OpenArbor development tools running on ARM and x86 processors. The certification covers the FACE Technical Standard Edition 3.0 Safety Base and Security Profiles for the Operating System Segment (OSS). The Deos RTOS Platform for FACE Technical Standard 3.0 combines the time- and space-partitioned Deos RTOS and SafeMC multi-core technology with RTEMS (Real Time Executive for Multiprocessor Systems), a mature, deterministic, open systems, hard-real-time POSIX executive. Deos provides ARINC 653 APEX interfaces and multi-core scheduling. A para-virtualized implementation of RTEMS, which runs in a secure Deos partition, provides POSIX interfaces and scheduling. The integrated platform combines the strengths and pedigree of both ARINC 653 and POSIX RTOSs, providing industry-standard interfaces and feature set for conformance with the FACE Technical Standard Safety Base and Security and Operating System Profiles in a time and space partitioned, hard-real-time, multi-core execution model. More information on the FACE standard is online at www.opengroup.org/face. For more information contact DDC-I online at www.ddci.com.

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