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SIGINT upgrades for Triton UAV

MQ-4C maritime patrol unmanned aircraft to receive sophisticated signals intelligence capability. PAGE 4

Unmanned vehicle sensor payloads

Electro-optical and radar sensors to provide unprecedented reconnaissance and surveillance capabilities. PAGE 22

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Mobile electronic warfare

New technologies take the electronic spectrum battle to the enemy's doorstep. PAGE 10

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COVER STORY

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BY **JOHN KELLER**, EDITOR IN CHIEF

Triton maritime surveillance UAV technology upgrades: Navy's just getting started

The U.S. Navy Northrop Grumman MQ-4C Triton long-range maritime patrol unmanned aerial vehicle (UAV) first became operational this year, yet the unmanned aircraft continue to evolve and add capabilities with upgrades that include signals intelligence (SIGINT) and sense-and-avoid radar.

The Triton officially entered the Navy fleet at Unmanned Patrol Squadron 19 (VUP-19) at Naval Base Ventura County at Point Mugu, Calif., in its primary mission of maritime patrol to augment the Navy's P-8A Poseidon manned maritime patrol aircraft.

The MQ-4C, a variant of the Northrop Grumman RQ-4 Global Hawk long-range reconnaissance UAV, is designed primarily for wide-area surveillance over vast ocean areas. Compared to the Global Hawk, Triton has a reinforced air frame and wing, de-icing systems, and lightning protection.

The Triton can descend through clouds for a closer look at ships and other targets at sea. Its sensors enable the UAV to track ships over time by gathering information on their speed, location, and type.

The UAV also has basic electronic surveillance capability to monitor radar signals from ships at sea.

In addition to broad-area maritime surveillance, the Triton also supports search-and-rescue missions, and assists the P-8 aircraft in anti-submarine warfare (ASW) using a variety of electro-optical sensors and a surface-search radar system.

The Triton's next fundamental evolution began in July with a $19.3 million order to Northrop Grumman to buy unique materials in preparation for outfitting the Triton with sophisticated signals intelligence (SIGINT) capability. The aim is to replace the Navy's EP-3 manned SIGINT aircraft with the Triton.

The SIGINT upgrade, called Triton integrated functional capability (IFC) 4.0, is installing a SIGINT sensor payload with components from Boeing Argon ST in Fairfax, Va., and Sierra Nevada Corp. in Sparks, Nev. Navy plans call for delivering the IFC 4.0 version of the Triton UAV in 2021 to coincide with the Navy's retirement of the EP-3.

The EP-3 aircraft is based on the Lockheed Martin P-3 Orion four-engine turboprop airframe.

After its SIGINT upgrade to take over the role of the EP-3, long-term plans for improving the Triton UAV will continue. The Navy is working with industry to equip the MQ-4C with a small-but-powerful sense-and-avoid radar system to enable the UAV not only to avoid collisions with other manned and unmanned aircraft, but also to operate safely in controlled airspace alongside commercial aircraft.

Last fall Navy officials moved forward with a plan to refine a sense-and-avoid radar system for the Triton UAV from RDRTec Inc. in Dallas. This system results from a project begun four years ago for RDRTec to design a sense-and-avoid radar system for the Triton and the Navy MQ-8 Fire Scout unmanned helicopter.

RDRTec experts refined the company's Radar Autonomous Collisions Avoidance System (RACAS) Sense and Avoid (SAA) radar technology into the Common RACAS (C-RACAS) that can serve the Fire Scout and Triton UAVs.

C-RACAS is a C-Band radar that provides the UAVs not only with sense-and-avoid capabilities, but also with the ability to avoid dangerous weather. C-RACAS provides the Triton with situational awareness of surrounding aircraft by determining airborne object location and estimated flight path.

The Triton UAV with sense-and-avoid radar is expected to join the fleet in 2023 — two years after the SIGINT version joins the fleet.

It's likely the Triton UAV will remain in the Navy inventory for many years to come, and these will not be the only enhancements for the unmanned aircraft. Future improvements might include hyperspectral electro-optical sensors for surveillance and weather monitoring, real-time networking for blending sensors from other aircraft with the Triton's sensor suite, and communications relay packages to provide beyond-line-of-sight long-haul military communications. ←

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news

Lockheed Martin gets Army Contract to commence development of small artillery interceptor

Lockheed Martin will proceed with developing a rocket interceptor to destroy incoming artillery, mortars, and rockets under a $2.6 million contract from the U.S. Army. Lockheed Martin officials say they have completed the science and technology phase of the Extended Mission Area Missile Program for the Miniature Hit-to-Kill (MHTK) interceptor. Work for the next phase will include several test flights for the evaluation and demonstration of the MHTK interceptor's readiness for the manufacturing stage. A test in January validated the MHTK's agility and the performance of the airframe and electronics, which are common to the interceptor's semi and active radio frequency seeker configurations. The interceptor is warhead-free and destroys incoming munitions using its own kinetic energy.

Will Lockheed Martin re-compete F-35 communications, navigation, and electronic warfare

A shake-up may be coming for the F-35 supply base, as Lockheed Martin considers opening up new competitions for the jet's electronic warfare and communications systems. The goal of re-competing these military avionics systems is to drive down the life-cycle costs of key F-35 technologies — especially during operations and sustainment — by forcing defense firms to face off against each other. Lockheed Martin has sent out a request for information to a handful of defense contractors who specialize in such advanced avionics technologies. BAE Systems currently provides *[PAGE 6]*

Demand for military batteries worldwide to grow by 31 percent over the next five years

LYON, France — Worldwide demand for military batteries should grow by 31 percent over the next five years, driven primarily by international army modernization programs and rising demand for military unmanned vehicles, predict analysts at market researcher ReportLinker in Lyon, France.

International army modernization programs and rising demand for military unmanned vehicles are driving growth in the military battery market.

This project growth in the global military battery market represents a combined annual growth rate (CAGR) of 5.57 percent over the next five years, analysts say.

The military battery market over the next five years should increase from $2.42 billion this year to $3.17 billion by 2023. Military batteries power military electronic equipment like aircraft, vehicles, soldiers, operating bases, ships, submarines, and unmanned vehicles.

Military batteries also act as back-up in conditions wherein electricity sources may fail.

The original equipment manufacturer (OEM) market segment should lead the military battery market in 2018, driven by army modernization programs to replace technologically obsolete systems.

Land applications should lead the military battery market in 2018, due to the adoption of unmanned vehicles and procurement of ground vehicles. Rechargeable military batteries should be the most popular type because of their reduced logistics costs and reduced burden of carrying extra batteries. The 12-to-24-volt segment also should lead the military battery market in 2018.

Lithium batteries should be the most popular with the military over the next five years because of its high density, power, and recharge cycle as compared to traditional batteries such as lead acid, analysts say. The U.S. and Canada should lead demand in the military battery market in 2018. Leading applications in this region should be guided munitions and military aircraft.

Key players in the military battery market include EnerSys in Reading, Pa.; Arotech Corp. in Ann Arbor, Mich.; EaglePicher Technologies in St. Louis; Bren-Tronics Inc. in Commack, N.Y.; and Saft Groupe S.A. in Île-de-France, France, analysts say. ←

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[FROM PAGE 4] electronic warfare (EW) systems for the fighter aircraft, while Northrop Grumman supplies communications, navigation, and identification (CNI) systems for the F-35. In its quest to cut costs on the program, Lockheed already has re-competed several systems, including the aircraft's memory system and the panoramic cockpit display. Most notably, the company confirmed in June that Raytheon would produce a new version of the distributed aperture system, or DAS, which would save $3 billion over the cost of the program.

Tempest 6th-generation jet fighter mock-up unveiled at Farnborough

United Kingdom Defence Secretary Gavin Williamson announced development of a new combat aircraft called Tempest last month at the Farnborough International Airshow in Farnborough, England. The Tempest jet fighter will feature all the most interesting technologies currently being developed and fielded, like artificial intelligence, machine learning, drone "swarming," and directed-energy weapons. The Tempest concept model bears some resemblance to current stealth fighters, especially the American F-22 and F-35. It features a cranked kite design, and canted vertical stabilizers indicate a preference for fighter-like agility. Team Tempest seems to prefer agility against low-observability. Noteworthy on the Tempest is a cockpit to accommodate a pilot: the 6th generation aircraft will be "optionally manned." Although next-generation aircraft will be able to fly as drones, there is still a future for combat pilots.

Bell-Boeing to build 58 new V-22 aircraft and avionics in $4.2 billion order

U.S. military aviation officials are ordering versions of 58 V-22 tiltrotor aircraft and avionics from the Bell-Boeing [PAGE 8]

Northrop Grumman to upgrade Navy's AN/AQS-24 airborne and surface mine-hunting sonar system

BY **John Keller**

PANAMA CITY, Fla. — Undersea warfare experts at Northrop Grumman Corp. will upgrade and repair the U.S. Navy AN/AQS-24 airborne and surface mine-hunting and -detection sonar system under terms of a $9.9 million order announced in July.

The AN/AQS-24 can be towed through the water by surface vessels and helicopters in areas where naval commanders believe enemy anti-ship mines may be present. The system can work at speeds as fast as 18 knots.

It uses high-resolution side-scan sonar for real-time detection, localization, and classification of bottom and moored mines at high area coverage rates. Its laser line scanner provides precision optical identification of underwater mines and other objects of interest.

Northrop Grumman Corp. is upgrading the U.S. Navy AN/AQS-24 airborne and surface mine-hunting and -detection sonar system, including modifications, maintenance, and depot-level repair for currently deployed systems.

Officials of the Panama City division of the Naval Surface Warfare Center in Panama City, Fla., are asking the Northrop Grumman Naval Systems segment in Annapolis, Md., provide modifications, maintenance, and depot-level repair for currently deployed AN/AQS-24 systems.

Northrop Grumman will provide depot repairs, carry out engineering change proposals, and integrate logistics support documentation to support AN/AQS-24 conversions and sustainment.

Its sonar and laser line scanner can work at the same time to detect and identify sea mines and other underwater objects. The system offers target box cuing and high-speed operation to provide high-resolution optical imagery for target identification.

The AN/AQS-24 offers synthetic aperture sonar and advanced navigation

controls and digital signal processing for target positioning. The system is rapidly deployable, and has been towed from aircraft, surface ships, and remotely operated vehicles.

Digital electronics in the system's towed body enable onboard beamforming for increased resolution at extended ranges in shallow and deep water. Its operator console has two 21-inch 3MP medical-grade flat-panel displays for viewing laser video and sonar imagery.

The system has high-end commercial off-the-shelf (COTS) computer server-based processing with high-speed digital recording and high-bandwidth telemetry.

In late 2016 Northrop Grumman delivered the first AN/AQS-24B upgrade kits to the Navy for upgrading 27 AQS-24A mine hunting systems into the more advanced AQS-24B system.

The upgrades were to increase the systems's performance by adding a high-speed synthetic-aperture sonar, which increases sonar resolution by a factor of three while maintaining 18-knot speed performance, Northrop Grumman officials say. The upgrades also eliminate parts obsolescence issues.

The synthetic aperture sonar enables the device to scan the ocean floor at three times the resolution of the earlier system. The Navy operates the AQS-24B from MH-53E helicopters and Mine Hunting Unmanned Surface Vessels (MHU).

On this order Northrop Grumman will do the work in Annapolis, Md., and should be finished by April 2019. ←

For more information contact ***Northrop Grumman Naval Systems*** *online at* www.northropgrumman.com, *or the* ***Naval Surface Warfare Center-Panama City*** *at* www.navsea.navy.mil/Home/Warfare-Centers/NSWC-Panama-City.

Curtiss-Wright enables use of VxWorks with Xeon D processor in HPEC applications

ASHBURN, Va. — The Curtiss-Wright Defense Solutions division in Ashburn, Va., is announcing a performance breakthrough for high-performance embedded computing (HPEC) by enabling use of Wind River VxWorks real-time operating system software with the Intel Xeon D high-performance processor.

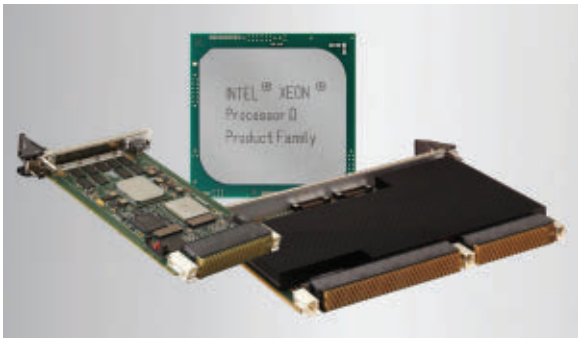
Software drivers in Curtiss-Wright's board support package (BSP) for the

[FROM PAGE 6] Joint Project Office (JPO) in St. Louis under terms of a $4.2 billion order last month. Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Bell-Boeing JPO to build 39 CMV-22B aircraft for the Navy; 14 MV-22B aircraft for the Marine Corps; 1 CV-22B for the Air Force; and 4 MV-22B aircraft for the government of Japan. The Bell-Boeing JPO is a joint venture of Bell Helicopter in Fort Worth, Texas, and the Boeing Co. Defense, Space & Security segment in St. Louis. The V-22 Osprey uses tiltrotor technology to combine the vertical performance of a helicopter with the speed and range of a fixed-wing aircraft. It features vertical take-off and landing (VTOL) and short take-off and landing (STOL) capabilities, and is designed long-range high-speed missions.

Lockheed Martin to build corvette-sized MMSC surface warship for Saudi Arabia

Naval experts at Lockheed Martin Corp. will start building four corvette-sized small surface warships for the government of Saudi Arabia, under terms of a $451 million order last month. Officials of the U.S. Naval Sea Systems Command in Washington are asking Lockheed Martin Corp. to buy long-lead materials and continue designing the Multi-Mission Surface Combatant (MMSC) for Saudi Arabia. The MMSC is a variant of the Lockheed Martin Freedom-class littoral combat ship (LCS) that can be configured with a variety of sensors and weapons that help enable interoperability among U.S. naval forces and those of allied navies during joint operations. Long-lead materials are difficult and time-consuming to obtain, and are funded early in the ship design process to keep overall production on schedule. The MMSC will have an open-architecture design with a

Intel Xeon D processor enable VxWorks to access the Intel Xeon D processor's QuickData Technology DMA engine, freeing the multi-core processor from devoting critical resources to communications handling.



Curtiss-Wright may have a solution for using VxWorks real-time software with the popular Intel Xeon D in high-performance embedded computing.

This provides HPEC system designers with the deterministic hard-real-time attributes of VxWorks, access to the Intel Xeon D processor architecture for multi-core and multi-board HPEC systems, and VxWorks support for the Intel Xeon D processor's QuickData Technology DMA engine.

Before this, designers who wanted to use the Intel Xeon D processor had little or no support for the VxWorks real-time operating system. Instead, they typically used Linux, which has issues with performance determinism. "With Linux there is a fair amount of code overhead, so you have to give yourself margin, explains Marc Couture, Curtiss-Wright's director of engineering. "In some EW techniques, however, you are worried about nanosecond accuracy. VxWorks is where that really shines. Timing is everything in many EW systems."

As a result, some aerospace and defense systems designers were switching to the Linux operating system to take advantage of the Linux support for the Xeon D.

"Any Intel processor out of the box will give you Linux support, but for defense applications that use VxWorks for real-time capability, they need determinism," says Denis Smetana, Curtiss-Wright's senior product manager of DSP products. "Anything that delays the processor also delays your response to a real-world event that could be a life- or death matter."

This software support can facilitate use of the Intel Xeon D and VxWorks operating system for aerospace and defense hard-real-time applications like electronic warfare (EW), radar, signals intelligence (SIGINT), and intelligence, surveillance, and reconnaissance (ISR).

Curtiss-Wright's software support enables the systems integrator to match the equivalent development system he needs to the appropriate stage of his program, while enabling application transfer between the stages with minimal effort, Curtiss-Wright officials say.

Curtiss-Wright's software also supports Mellanox Ethernet controllers, previously available only for Linux. These controllers deliver 40-Gigabit Ethernet on Curtiss-Wright's Fabric40 CHAMP-XDx modules rated at about 37 gigabits per second near line-rate.

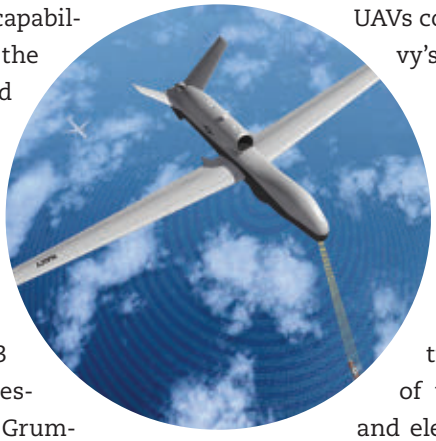
The first Curtiss-Wright single-board computers involved in this software support for using VxWorks with the Intel Xeon D processor are the Curtiss-Wright CHAMP-XD1 3U OpenVPX and CHAMP-XD2 6U OpenVPX digital signal processing (DSP) modules. ←

For more information contact ***Curtiss-Wright Defense Solutions*** *online at* www.curtiss-wrightds.com.

Northrop Grumman prepares for SIGINT upgrades to the MQ-4C Triton maritime patrol UAV

BY **John Keller**

PATUXENT RIVER NAS, Md. — Signals intelligence (SIGINT) experts at Northrop Grumman Corp. are preparing to upgrade the U.S. Navy MQ-4C Triton long-range unmanned aerial vehicle (UAV) with SIGINT capability to match that of the Navy's EP-3 manned SIGINT aircraft.



Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $19.3 million order Wednesday to the Northrop Grumman Aerospace Systems segment in San Diego to buy unique materials necessary to integrate the Triton integrated functional capability (IFC) 4.0.

The MQ-4C Triton, built by Northrop Grumman Aerospace, is a maritime patrol version of the Northrop Grumman RQ-4 Global Hawk long-range reconnaissance UAV. The Triton provides real-time intelligence, surveillance, and reconnaissance missions (ISR) over vast ocean and coastal regions.

The unmanned aircraft is designed to perform continuous maritime surveillance, conduct search and rescue missions, and to complement the Boeing P-8 Poseidon maritime patrol aircraft.

Compared with the Global Hawk, the Triton has a reinforced airframe and wing, de-icing systems, and lightning protection to enable it to descend through cloud layers to gain a closer view of ships and other targets at sea. It can track ships over time by gathering information on their speed, location, and type.

The Triton IFC 4.0 project seeks to upgrade the Triton UAV with multi-intelligence capabilities that include SIGINT, such that Triton IFC 4.0 UAVs could replace the Navy's fleet of EP-3 aircraft.

The EP-3 aircraft are based on the Lockheed Martin P-3 Orion four-engine turboprop airframe, and are scheduled to be retired in 2021. Much of the EP-3's mission and electronic equipment is secret and is conducted in high-threat areas where long-range standoff is necessary.

The Triton program is installing a SIGINT sensor payload with components from Boeing Argon ST in Fairfax, Va., and Sierra Nevada Corp. in Sparks, Nev. Navy plans call for delivering the IFC 4 version of the Triton UAV in 2021 to coincide with the Navy's retirement of the EP-3.

On this contract Northrop Grumman will do the work in San Diego, Menlo Park, Placentia, and San Clemente, Calif.; Waco, Texas; New Town, N.D.; West Chester, Ohio; Middletown, Wis.; Malabar Fla.; Medford, N.Y.; Bridgeport, W.Va.; and various locations in the continental U.S., and should be finished by July 2020. ←

For more information contact ***Northrop Grumman Aerospace*** *online at* www.northropgrumman.com, *or* ***Naval Air Systems Command*** *at* www.navair.navy.mil.

semi-planing mono-hull made of steel and an aluminum superstructure, and feature the Lockheed Martin COMBATSS-21 combat management system (CMS) to integrate the ship's sensors, communications, and armament. Sensors will include a TRS-4D surveillance and target acquisition radar, a modern fire control radar, a multi-function phased array radar, an identification friend or foe (IFF) system, towed hull-mounted and dipping sonars, and a compact low-frequency active and passive variable-depth sonar.

Australia to make major investment in anti-submarine warfare (ASW) frigates

Australia is sinking 35 billion Australian dollars ($28.84 billion U.S.) into the purchase of nine ultra-modern frigates. So what is it that makes them so necessary, and what will be their place in the battlefields of the future? The BAE Systems Type 26 Global Combat Ships, on which the new Australian frigate are based, are an unproven force. The first British-owned example of this surface warship is yet to take to the water. The design will form the basis of Australia's next generation anti-submarine frigate, dubbed the Hunter class. The outlay is enormous, so the Royal Australian Navy will want to get as much bang for its buck as possible. So what are the capabilities of these ships, and will they be able to respond to the rapid pace of strategic and technological change? China is already regarded as the world leader in next-generation hypervelocity missiles. These are so fast they can appear and destroy their target in the blink of an eye — far quicker than any human reaction can counter. Beijing is also on the brink of putting railguns on warships with the capability of firing guided hypersonic shells immense distances. Will Australia's new Type 26 frigates be up to such a challenge? ←

Electronic warfare technology heading-up the battlefield

Signals intelligence, electronic jamming, and electronic protection incorporating software-defined radio and artificial intelligence to stay ahead of adversaries.

BY **J.R. Wilson**

For thousands of years, combat was a relatively simple operation; warriors were on foot, in chariots, on horses, and in ships clashing in close and bloody conflict with swords, spears, and arrows. The tools of war began evolving more quickly in the 19th Century, then the 20th Century saw more advances in weaponry and concepts of operation (CONOPs) than the previous 10,000 years of warfare combined.

The closing decades of the last century also saw the rise of electronics and their evolution into the heart of military capabilities at all levels, in all domains, and across all services worldwide.

Evolving with those capabilities were two new realms of war cyber warfare (CW) and electronic warfare (EW), which began to encompass older, legacy efforts such as signals intelligence (SIGINT), human intelligence (HUMINT), imagery intelligence (IMINT), measurement and signatures intelligence (MASINT), electronic intelligence (ELINT), satellite intelligence (SATINT), communications intelligence (COMINT) and open source intelligence (OSINT).

Cyber warfare officially became a domain of war for the U.S. with the 2009 creation of U.S. Cyber Command (CYBERCOM) and, in May 2018 its elevation to a full and independent unified combatant command, comprising the Army Cyber Command, Fleet Cyber Command/Tenth Fleet, Air Forces Cyber/24th Air Force, and Marine Corps Cyberspace Command.

Meanwhile, EW, broadly defined as any action involving the offensive or defensive use of the electromagnetic spectrum (EMS), also was growing in prominence across the armed forces. NATO, however, adopted a more comprehensive approach to EW, recognizing it as an operational maneuver space and warfighting domain similar to the alliance's maritime, land, air, and space domains.

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"We live in the electromagnetic spectrum, from cell phones to radars," says Andrew Dunn, vice president of the international electronic warfare systems business development at the Harris Corp. Electronic Systems segment in Clifton, N.J."

The Army is trying to get the concept of EMS to be another maneuver space. If I'm unable to transfer information to anybody, from warfighters to aircraft, that's a problem," Dunn says. "Control of the EMS is vital to survival on the future battlefield. And if somebody disrupts that maneuver space, chaos will ensue. You cannot conduct any operations unless you have the ability to maneuver in the EMS.

Easier said than done

Dominating the electromagnetic spectrum, however, is easier said than done. "There is capability now, but there is no point in time where we can say we own the spectrum because the bad guys will continue to come up with counters," Dunn continues. "The U.S. Army is taking this very seriously now and the Air Force and Navy have ongoing efforts to ensure we have freedom of movement in the electromagnetic domain. OSD [U.S. office of the secretary of defense] is trying to manage how to solve each service's problems, looking at their different missions and threats. The core technologies – various levels of AI, for example – will be common across the services, but each will have different threat spaces."

The EA-18G Growler is the only advanced airborne electronic attack (AEA) platform in production today.

A prime example of mobile EW at the tactical edge is the Boeing/U.S. Navy EA-18G Growler electronic warfare combat aircraft, the only advanced airborne electronic attack (AEA) platform in production today. A variant of the combat-proven F/A-18F Super Hornet, the Growler provides tactical jamming and electronic protection to U.S. and allied military forces. The Navy has committed to continuing investments in advanced Growler capabilities to further protect all strike aircraft during high-threat missions for decades to come.

A replacement for the Navy's EA-6B Prowler, the Growler also is being acquired by the Royal Australian Air Force (RAAF) under a U.S. Foreign Military Sales agreement. Those 12 aircraft make Australia the first country to be offered this level of AEA technology by the United States, greatly enhancing electronic awareness and attack capabilities for the RAAF and its allies in the South Pacific/Southeast Asia region.

Proponents say the Growler brings fighter aircraft speed and maneuverability, and the ability to defend itself against air-to-air attack, to an electronic attack aircraft, enhancing the provision of critical intelligence, surveillance, and reconnaissance (ISR) data to other U.S. and joint force aircraft.

The U.S. Joint Chiefs of Staff have defined EW as a capability – applied from air, land, sea and space manned and unmanned systems – supporting military operations involving detection, denial, deception, disruption, degradation, destruction, and protection. Those are accomplished using electro-optical (E/O), infrared (IR), and radio frequency (RF) countermeasures; EM compatibility

and deception; communications jamming, radar jamming and anti-jamming; electronic masking, probing, reconnaissance and intelligence; electronics security; EW reprogramming; emission control; spectrum management and wartime reserve modes.

The Naval Air Warfare Center Weapons Division at Point Mugu, Calif., supports Fleet EW from concept development to year-round EW Intelligence operational support. The organization has developed a distributed, adaptable network capability called the Electronic Warfare Services Architecture (EWSA) to integrate several EW technologies on manned and unmanned aircraft. When fully implemented, EWSA will enable horizontal integration of multiple payloads across the services and air, land, sea, space and cyber domains for enhanced EW operational situational awareness to all levels of command.

Not a replacement

EW is not a replacement for kinetic weapons, but when the system offers an edge over enemy defenses, it can reduce the number of bombs and mortars required to suppress those capabilities.

"A lot of integrated air defense systems are networked; if you can disrupt those, you can make the radar system inoperable without firing a shot. So you don't attack the radar itself, but the infrastructure around the radar," explains Harris's Dunn.

"It all gets back to EM dominance. The first thing you want to do is disable the ability of someone to react. You do that by confusing them, disrupting their communications, using deceptive means, all through either a cyber attack or an attack on the EMS."

At a January 2018 Army Cyber Quest exercise, Raytheon demonstrated its new Cyber and Electromagnetic Battle Management (CEMBM) system, designed to help navigate the electromagnetic battlefield by bringing electronic warfare, cyber and the EMS together in one tool to plan, coordinate and manage EW and tactical cyber activities.

"This isn't about someone sitting at a desk and hacking into a system," says Travis Slocumb, vice president of Raytheon Electronic Warfare Systems. "It's about the ability to plan, defensively or offensively, while maneuvering through a battlespace undetected.

"The road ahead is full integration, a convergence of cyber and electronic warfare. Tools such as CEMBM will protect our forces from adversaries that are quickly advancing their ability to take over and interfere with the spectrum."

Marine Corps EW

While still relying on the Army to provide the bulk of research and acquisition for current and future EW systems, the Marine Corps is adapting the capabilities to fit their small-unit expeditionary operations. That includes adding an and electronic warfare and unmanned aerial vehicle (EW/UAV) specialist to its 13-person rifle squad — the anchor of Corps ground combat capability.

That change grew out of a growing U.S. Department of Defense concern about a "hybrid warfare" strategy in which the enemy attacks across multiple domains – land, sea, air, space and cyber. It's a concept Russia demonstrated with devastating effect in its 2014 attack on, and annexation of, Crimea by using a mix of cyber attacks, disinformation, propaganda, and conventional warfare to overwhelm its opponent quickly.

In a handbook on the new structures and capabilities of the Russian military, the Army's Asymmetric Warfare Group notes Russia has invested significant money and effort on EW capabilities, especially those designed to shut down FM, SATCOM, cellular, GPS, and other signals the military and civilian worlds both rely on.

"In Eastern Ukraine, these EW systems have proved devastating to Ukrainian radio communications, are capable of jamming unmanned aircraft systems, and can broadcast false GPS signals," the handbook noted. In addition, many are able to spot and locate enemy signals during jamming, which can be paired with artillery to attack high priority targets.

"Certain platforms are used for protection, emitting a signal designed to overload electronic fuses on incoming fires. Guided munitions, both direct and indirect, will either detonate early or change course once they come in contact with one of these bubbles," the report says. "Cyber attacks can effectively shape the battlefield and require very little risk on the part of the perpetrator. Since U.S. formations operate under self-imposed restrictions like ethical hacking and prioritizing protective measures over offensives in the cyber realm, they are limited in their capabilities compared to Russian counterparts."

Accessible technology

But various levels of EW and CW are not limited to peer and near-peer opponents; with easily acquired technologies and Internet manuals, they also are being used by small nation-states with limited conventional military capability, as well as non-state threats such as ISIS.

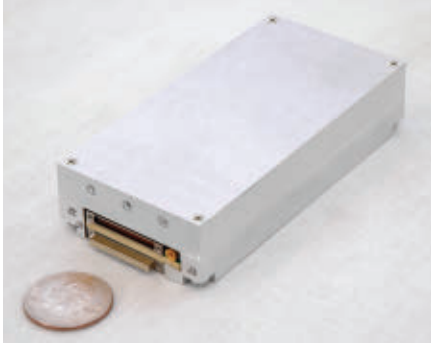
To deal with this evolving new threat, in March 2018 Marine Corps Commandant Gen. Robert Neller ordered the creation of a Marine cyberspace field and the recruitment of an additional 1,100 active-duty Marines to perform new jobs involving cyber weapons and offensive and defensive CW/EW operations. Many of the new Marines are with the new Marine Expeditionary Force Information Group (MIG).

A planning document for the still developing MIG indicates it will provide Marines with the ability to conduct hybrid electronic and cyber warfare tasks, including spreading misinformation, providing electronic battlefield awareness, and attacking enemy networks.

As CW and EW have grown in importance, areas where they overlap have increased, leading some to suggest merging them into a single operational capability. For the U.S. military, that effort is being led by the Army.

"EW and Cyber can enable each other and the common piece tying them together is spectrum," says Army Col. Marty Hagenston, project manager for EW and Cyber in the Army's Program Executive Office of Intelligence, Electronic Warfare, and Sensors.

Electronic warfare essentially has several components, Hagenston says: software-defined radios (SDR); antennas and apertures; techniques; and command and control. "SDR, which are the brains and power amplifiers; antennas and apertures, both directional, direction finding and receiving; techniques, where the state-of-the-art in EW are the refined exquisite techniques, and command and control



The Harris Disruptor SRx is an example of small size, weight, and power consumption (SWaP) in modern mobile electronic warfare systems. It offers adaptive, reprogrammable multifunctional capability for a changing EW environment.

battle management, the ability to visualize the spectrum. In all of this, it becomes an integration effort, not only within the technologies, but within adjacent systems."

EW integration

During a cyber security panel discussion hosted in January 2018 by the Association of the United States Army's Institute of Land Warfare, some of the Army's top EW and CW officers discussed how they are approaching the integration of CW, EW, SIGINT, and other military intelligence operations. It centers on the integration of Army cyber, EW, SIGINT, and military intelligence operations to tackle growing cyber threats from around the globe.

Maj. Gen. John B. Morrison Jr., commanding general of the Army's Cyber Center of Excellence at Fort Gordon, Ga., told the conference all of those elements need to be brought together to deliver the desired results effectively. To that end, EW professionals are moving into the Army's cyber branch — a move that could be completed by October.

"The reality is that we're already moving in that direction now and have begun doing mobile training teams for our EW professionals," he added. "The service is planning to prioritize flexibility. It was an unnatural act for the Army to sit there and see two disparate centers of excellence bring together one integrated requirement, but I'm very pleased with how the Army reacted to it."

Maj. Gen. Patricia A. Frost, director of cyber at the Army's Office of the Deputy Chief of Staff, told the conference the Army also is working rapidly to develop CW/EW technologies in close cooperation with industry and academia.

"We're not going to wait the six to ten years of building the perfect piece of kit. We're going to look at prototyping and a risk reduction and risk mitigation methodology," she said.

The requirements going to those partners also will be open to new approaches, Morrison says: "What you're going to see inside these documents are operationally based requirements. We are going to set it in such a manner that we can do iterative development."

Integrating EW and CW

Cooperation and collaboration in future EW and CW capabilities by the U.S. Army are being driven by the actions of others, such as Russia and China, who

have openly announced their intentions to become dominant in those areas as quickly as possible.

China, for example, recently established the Strategic Support Force (SSF) within the People's Liberation Army (PLA) to fight and win in the information space as a single entity to conduct electronic, information and cyber warfare. While few details have emerged, it is expected that CW, EW, space, and possibly psychological operations forces will merge into a single information warfare service, tasked with network attack and defense, ISR, navigation, jamming, and disruption of adversary command, control, communications, computers, surveillance, and reconnaissance (C4ISR). Successful implementation also could improve the flow of information across the PLA and be a driving force for research on advanced EW capabilities.

With EW and CW becoming ubiquitous components of modern conflicts – and especially Russian and Chinese efforts to seize the technology lead – the U.S. is in a position it has not experienced in decades – playing catch-up.

"In the '90s, the Army sort of gave up on EW, with an eye on joint systems that could provide those," Hagenston explains. "As the Army went through 15 years of war, EW came up again, somewhat differently in the counter-terrorism fight in Iraq and Afghanistan, mostly in a defensive nature. The Army has turned the corner, now facing near-peers. EW has taken on a whole new meaning for the Army as it is integrated into tactical formations.

"As the Army is trying to figure it out through the requirements process and research efforts, we're actually delivering against operational problems from units that are forward-deployed against those near-peers," Hagenston continues. "Those operational-needs statements help us inform the SOTA [state of the art] and programs of record. The Army has committed to making those investments and deploying limited capability to targeted units to get direct user feedback so we can refine our programs and get them out to the whole Army."

The nature of the CW/EW relationship remains one of debate and complexity, however.

CW and EW relationship

"There is a constant conversation on what is Cyber EW or does it stand alone," says Harris's Dunn. "Using cyber attack, EW provides the bullet using the RF spectrum, so EW can be used both defensively and offensively to insert cyber attacks into threat networks. Where the lines are between the two has not yet been settled."

Luc Dondainas, business development manager for communications intelligence and counter-electronic support measures for Rohde & Schwarz GmbH in Munich says he does not see a merger of EW and CW, despite growing levels of interaction.

"It's more a matter of complementary rather than overlap — the physical environment that enables EW to get closer to cyberspace," Dondainas says. "They are working closer, with more and more coordination, but sometimes it is better to have them separated. So far, I don't see them becoming combined," he says, adding that also can be part of the disconnect between what is wanted and what is possible.

"The shortfalls in terms of what the customers want and what industry can provide can be a weird situation, Dondainas continues. "From a receiver or signal-processing point-of-view, it is conceivable to have what the customer wants, but from an integration perspective, it is not possible to fit everything on a small long-endurance platform. So it is an integration effort not only to have the most modern system, but also to have them integrated into the constraints of the sensor platform."

As with nearly every aspect of military weaponry and capabilities, EW began as large comparatively limited fixed systems on large manned aircraft, ships, and land vehicles. The first two decades of the 21st century, however, saw increasing miniaturization, extended range, and mobility, which has become a primary goal.

"For the Army, a common dismounted platform is being developed for soldiers to carry around. At the mobile level, our major constraint is those platforms already in the Army as part of the maneuver capability that EW supports," The Army's Hagenston says. "If you are in a Stryker-based formation, the EW system should be Stryker-based. So it depends on the formation – some heavy platform for a heavy brigade combat team, some manpacked stuff, and lighter-weight vehicles that can be air-landed or airdropped for a light infantry formation."

The AN/ALQ-214 Integrated Defensive Electronic Countermeasures (IDECM) system is the next-generation integrated countermeasures system carried by the U.S. Navy and Royal Australian Air Force F/A-18 jet fighter-bomber. It blends sensitive receivers and active countermeasures to form an electronic shield.

EW is all about the threats and being one step ahead of them, Harris's Dunn adds.

Staying ahead of the threat

"EW systems continue to evolve as weapons systems evolve, and we need to be ahead of those in terms of situational awareness: where are the threats, what are their intentions, and what do we do to counter those threats," Dunn says. "From the perspective of where technologies are going, EW is moving to where the world is moving – software-defined (SD) technology."

Software-defined technology "allows you to be reconfigurable," Dunn says. "For example, if you're doing an ISR mission with 10 disrupters collecting data and move into

contested airspace, you currently have three options: go home, continue the mission and hope you don't get shot down, or call for help. With a small-form-factor SD system, you can reprogram one or two modules to do electronic attack, so the system is now protecting the platform while in contested airspace. And you can reprogram them back to ISR when you leave contested airspace."

David C. Jedynak, chief technology officer at Curtiss-Wright Defense Solutions in Ashburn, Va., says a lot of new EW systems are being reduced to boards that are embedded with high-performance onboard computing, data fusion, and greatly improving mobility.

"If you are able to do EW in smaller sizes than in the past, you can add that capability to platforms that couldn't handle them before," Jedynak says. "You also can do high-end number crunching and increase the performance of traditional platforms."

Processing, he ways, is critical for mobile electronic warfare systems. Enabling technologies included general-purpose graphics processing (GPGPU) boards and field-programmable gate array (FPGA) boards. "With an FPGA, you can really optimize the data path. If you are worried about jamming, you need a low latency rate from the input to output, which FPGA is very good at."

Curtiss-Wright Defense Solutions offers a pre-integrated rugged embedded computer to help speed development of deployed software-defined radio (SDR) and electronic warfare (EW) applications.

Jedynak says systems designers can visualize electronic warfare in terms of RF waveforms and cyber warfare in terms of bits that ride on waveforms. In this way, signals intelligence could become part of an offensive cyber attack. "If you also can start inserting things into the signal, rather than just listening to it, attacking a system through its use of some waveform, is it EW or is it Cyber? You're manipulating the waveforms, but you're also doing things at the bits level."

Future of mobile EW

The future evolution of mobile EW will see more advances in those areas, especially miniaturization, giving EW capability a presence at all levels, throughout the battlespace.

"SDR and its miniaturization are really the enabling technologies that have advanced EW, ground SIGINT, communications," the Army's Hagenston notes. "That's probably the number-one technology. The other, which will never go away, are antennas and apertures to collect and transmit things at different waveforms, which cause your SWaP [size, weight, and power consumption] to increase or decrease, depending on the waveform you're trying to get. Techniques are hosted on the SDR and it also can be used for command and control."

Now consider adding advanced technologies like machine learning and artificial intelligence (AI), he suggests. "The single biggest thing is convergence, which comes with machine learning to handle all the data. With an EW system, as capabilities become more and more digitized, you start to look at one component doing multiple functions. You're heading more toward SDR-type concepts. From a SWaP standpoint, if you can do multifunction from one system rather than using separate systems, that can be a

big benefit in terms of acquisition cycles, platform integration, and training costs. It may be much more complex, but it has a lot more capability."

The ever-increasing amount of raw data gathered from various intelligence capabilities is leading many to see some level of artificial intelligence as integral to the long-term requirements of EW systems.

The Northrop Grumman MQ-4C Triton long-range maritime patrol unmanned aerial vehicle (UAV) is getting in on the electronic warfare game with a scheduled advanced signals intelligence package to enable the UAV to replace the manned EP-3 SIGINT aircraft.

The role of artificial intelligence

"For the next generation, integration of AI, neural networks, to offload the cognitive burden from the analyst/operator, will be key. Cognitive EW is nirvana for EW," Hagenston says.

"There is no doubt AI will play an important role in mobile EW systems," Dunn agrees. "It's all about being able to react quicker, identify faster, and suppress effectively. All the AI efforts and algorithms are being driven to provide those capabilities faster, from threat identification as soon as possible to where is it and where is it going.

"Being able to understand intent faster is a needed capability, along with the fastest way to suppress it. Radar technology is moving as quickly as the EW side, using all those algorithms to better see their threats. But you always want your EW technology to stay ahead of that technology curve."

Lothar Kisling, director of signals intelligence and electronic warfare at Rohde & Schwarz in Munich, is less impressed with the current and near-term potential of AI, however.

"The advanced algorithms and AI we have looked at so far are not really suitable to deal with the raw data generated by many sensors," Kisling says. "A lot of people think AI is the go-to thing if you have that much data, but it turns out it currently is better to have a classic processing approach, then apply AI to look for patterns and identify similarities or new things coming up. Both are very helpful now and even more so in the future, when they can turn processed data into something that is readable by the analysts. But I don't see AI being used directly after the analog-to-digital converter in the near future."

As the U.S. works to maintain the technology lead it has long enjoyed, the current trend – certainly for the Army – is multifunction, being able to adjust to offense or defense on the fly, with the help of SDR technology.

"Active and passive engagement systems are part of the multifunctional system," Hagenston says. "Platform range for the Army is always tactically relevant – very close for the infantry. Networking will have to be some kind of protected communications so you can collect and communicate in a denied environment. Onboard computing and fusion, especially in a saturated spectrum, will be necessary to sense the environment and pick needles out of needle stacks."

Sensor payloads for unmanned vehicles

Designers of unmanned vehicles are using a variety of electro-optical and radar sensors to provide unprecedented reconnaissance and surveillance capabilities for deployed military forces.

BY **John Keller**

A growing number of unmanned vehicles — in the air, on the ground, and at sea — represent a vast universe of sensors and sensor processing that, combined, could provide some of the most detailed intelligence information to U.S. and allied military forces.

Some of the chief enabling technologies for this new generation of connected unmanned vehicle sensor payloads include electro-optical sensors like infrared sensors, visible-light cameras, multispectral, and hyperspectral sensors.

Also important are small power-efficient radar systems suitable for unmanned vehicles, digital signal processing to make sense of sensor information and pull out relevant information for battlefield commanders, and sophisticated networking to blend information from many different unmanned sensor payloads to provide a rich information picture for battlefield commanders.

One prominent company involved in electro-optical unmanned vehicle sensor payloads is FLIR Systems in Wilsonville, Ore. FLIR has introduced the UltraForce 275-HD compact multi-sensor gyro-stabilized surveillance system for weight, power and footprint-constrained platforms like unmanned aerial vehicles (UAVs). The gimbal weighs slightly more than 33 pounds.

Octopus ISR Systems in Riga, Latvia, offers the Epsilon 175 small gyro-stabilized electro-optical four-sensor payload for UAVs for military applications, order control, and civil uses.

Electro-optical sensors

This sensor payload has applications in military surveillance and reconnaissance, as well as counter-drug operations, homeland security, and search and rescue. The sensor package has a continuous-zoom 3-to-5-micron thermal imager with 640-by-512-pixel resolution, high-definition color camera with low-light functionality for dawn-to-dusk use, four-axis active stabilization, and options for laser range finders.

The system also comes with backlit and night vision goggle-compatible remote controller with integrated multi-mode auto-tracker to track moving or stationary targets.

Two years ago FLIR introduced the Star SAFIRE 380-HLDc airborne thermal imaging system for use on manned and unmanned aircraft. It offers multispectral imagers with precision laser designation in a relatively small size, weight, and power consuming (SWaP) package. The high-definition electro-optical and infrared targeting system has a 1280-by-720-pixel indium antimonide medium-wave infrared focal plane array, with 40-to-1-degree continuous zoom

The Star SAFIRE 380-HLDc also has a charge coupled device (CCD) high-definition color visible-light camera with 1280-by-720-pixel resolution, as well as an optional indium gallium arsenide shortwave infrared camera with 720-by-1080-pixel resolution and 33-to-0.28-degree fields of view. It has four-axis stabilization with digital inertial measurement unit and Global Positioning System receiver for geo-pointing and target geo-location capability.

Another electro-optical sensor supplier for UAVs is Hood Tech Vision Inc.

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in Hood River, Ore. Hood Tech offers the SWaP-optimized Alticam 05EO5 gimbal turret imaging payload for small UAVs. The gimbal turret system offers pan-over-tilt imaging system has low-power video that uses less than 20 Watts of power and weighs less than two pounds.

This small design offers extra space and power aboard the aircraft for several additional intelligence sensors and on-board digital signal processing, company officials say. The four-axis gyro-stabilized gimbal includes embedded video stabilization and tracking with an embedded video server and optional network interface.

Dual-mode operation provides network, serial, or analog video. The sensor turret is isolated from vibration, and can serve as a drop-in replacement for earlier Alticam 06 and Alticam 07 turret models.

Octopus ISR Systems in Riga, Latvia, offers the Epsilon 175 small gyro-stabilized electro-optical four-sensor payload for UAVs, which weighs 5.7 pounds, and measures 6.8 by 8.1 inches. The medium wave infrared (MWIR) gimbal has a 30x optical zoom electro-optical (EO) sensor, 15x optical zoom MWIR sensor, laser range finder, and laser illuminator, this gimbal is an ideal choice for unmanned aerial vehicles (UAV) used for border control, military purposes, and a variety of civil applications.

Its infrared sensor uses a 3-to-5 micron cooled staring array, has an 18-to-275-millimeter 15x zoom lens with a 24.5-by-1.5-degree vertical field of view, 640-by-512-pixel resolution, and runs at 30 frames per second.

The Epsilon 175 decreases the weight of the sensor payload, which increases UAV endurance to enable longer missions or more spare capacity for other equipment, Octopus officials say.

The UAV sensor payload operates in temperatures from -40 to 50 degrees Celsius; offers 360 degrees of continuous pan, as well as -90 degrees to 30 degrees elevation; a slew rate of 120 degrees per second, and typically uses 35 Watts of power.

Hood Tech Vision in Hood River, Ore., provides the SWaP-optimized Alticam 05EO5 gimbal turret imaging payload for small UAVs like the military ScanEagle.

Radar for unmanned systems

Electro-optical sensors aren't the only kinds of for unmanned vehicles. Radar systems are becoming available for large- and medium-sized UAVs for surveillance, as well as for sense-and-avoid applications for UAVs operating in controlled airspace.

Fortem Technologies Inc. in Pleasant Grove, Utah, earlier this year introduced the TrueView R20 drone radar, a compact, high-performance detect-and-avoid radar to help UAVs detect and prevent potential air-to-air collisions and navigate safely beyond-visual-line-of-sight day or night and in clouds, fog, smog, and other challenging weather conditions.

Using artificial intelligence (AI) algorithms, TrueView provides situational awareness for safe unmanned aircraft operations. The system weighs 1.5 pounds.

Another UAV radar supplier is IMSAR LLC in Springville, Utah, which specializes in small radar systems, digital signal processing, radar, manufacturing, and inertial measurement systems. The NSP-5 ER from IMSAR provides radar resolution ranging from very fine to 10 meters, and can detect large targets at sea from as far away as 62 miles. Its typical radar range is about 27 miles at 1-meter resolution. This UAV radar is shorter than 5 feet, is 5.5 inches in diameter, 8.5 inches high, and weighs 24 pounds.

IMSAR also provides the NanoSAR B UAV radar, which measures 6.2 by 7.2 by 4.5 inches, weighs 3.5 pounds, and transmits 1 Watt of power. On board firmware compresses real-time SAR data and transmits it to a ground station that generates and archives the imagery. The system operates day or night, in rain, snow, fog, dust, or smoke.

IMSAR also provides the NanoSAR C for detection, location, and classification of targets. The unit measures 5.5 by 3.5 by 2 inches, weighs 2.6 pounds, and transmits 1 Watt of power. NanoSAR C provides detailed real-time aerial radar images from a payload small and light enough to be mounted in a Tier I or II UAV.

NanoSAR C is integrated with IMSAR's Lisa ground station and Viper communication link, and operates day or night, in rain, snow, fog, dust, or

IMSAR LLC in Springville, Utah, offers the NSP-5 ER radar for UAVs, which provides resolution ranging from very fine to 10 meters, and can detect large targets at sea from as far away as 62 miles.

smoke. Its radar, turret, antenna, and cabling total less than 86 cubic inches, and can mount in a 7-inch-diameter wing-mounted pod, or inside the aircraft fuselage.

Four years ago IMSAR won a $99 million contract from the U.S. Army's Natick Soldier System Center (NSSC) in Natick, Mass., to develop synthetic aperture radar (SAR) systems for UAVs.

Another UAV radar provider is UAV designer is General Atomics Aeronautical Systems segment in Poway, Calif. General Atomics builds the Lynx synthetic aperture radar for the MQ-9 Reaper hunter-killer drone.

The Lynx multi-mode radar provides high-resolution, photographic-quality radar imagery through clouds, rain, dust, smoke, and fog. The radar consumes minimal Size, Weight, and Power (SWAP) while delivering precision

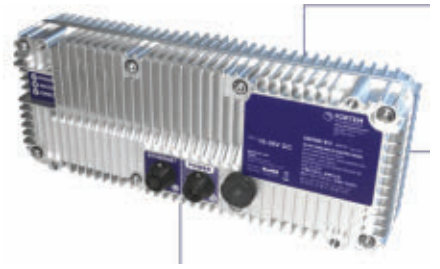
General Atomics Aeronautical Systems in Poway, Calif., builds the Lynx synthetic aperture radar to provide the MQ-9 Reaper UAV with high-resolution photographic-quality radar imagery through clouds, rain, dust, smoke, and fog.

air-to-surface targeting accuracy and superb wide-area search capabilities, General Atomics officials say.

Lynx features SAR, ground/dismount moving target indicator (GMTI/DMTI), and maritime wide area search (MWAS) modes. Lynx's search modes provide the wide-area coverage and allow for cross-cue to a narrow field-of-view (FOV) electro-optical/infrared (EO/IR) sensor.

Lynx includes two spotlights and two strip map SAR modes. Spotlight mode produces high-resolution imagery on a defined point. Strip map mode mosaics several spot SAR images together to form one large image.

SAR imagery can help detect subtle changes in a scene by overlaying two images taken at different times. Coherent change detection (CCD), amplitude change detection (ACD), and automated man-made object detection (AMMOD)



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algorithms rapidly highlight the differences between the first and second SAR image for analysis.

The GMTI mode helps locate moving vehicles, while DMTI enables operators to detect very slow-moving vehicles and people on foot. In addition, operators can select a GMTI/DMTI target and automatically cross-cue to the EO/IR sensor in narrow FOV for visual identification of the target.

Lynx's maritime mode detects ship and boat traffic in various sea states; it also integrates automated identification system (AIS) information for target correlation and identification. MWAS is suitable for coastal surveillance, drug interdiction, long-range surveillance, small target detection, and search and rescue operations.

Special-purpose sensor payloads

In addition to general-purpose surveillance sensors, some companies are building specialized electro-optical unmanned sensor payloads for specific military jobs. Multispectral UAV sensor payloads at Arete Associates in Tucson, Ariz., are designing a system to help military unmanned helicopters detect and pinpoint mines and obstacles in beach surf zones to help keep U.S. Marines safe during amphibious attacks.

The sensor payload is called the AN/DVS-1 Coastal Battlefield Reconnaissance and Analysis (COBRA) block 1, which supports the Navy Littoral Combat Ship (LCS) mine-countermeasures mission. Carried on the Navy Northrop Grumman MQ-8B Fire Scout unmanned helicopter, the sensor system surveys the surf zone and beach zone to detect and localize mine fields and obstacles prior to amphibious assault.

The AN/DVS-1 COBRA passive multispectral sensor system offers off-board processing and includes stabilized step stare digital gimbal, high-resolution multispectral imaging digital camera with spinning six-color filter wheel, a processing unit, and a solid-state data storage unit.

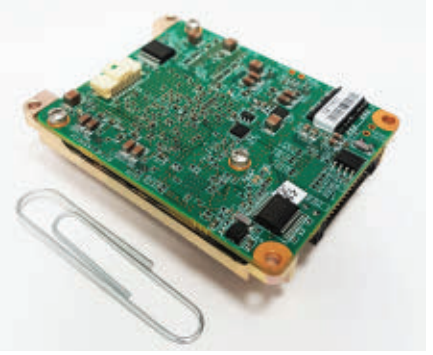
The gimbal is about 19 inches long and 11 inches in diameter, and collects six different color-band images across a large area using a step-stare pattern. At the mission, personnel load its data storage unit into a post mission analysis station.

The COBRA Block I system has two airborne payloads, the post mission analysis station, and the tactical control system segment for the UAV ground control station to plan the flight tracks for the COBRA mission, monitor the mission, and reprogram the flight path if necessary.

COBRA began as a U.S. Marine Corps advanced technology program in the 1990s. The system uses incremental development, with three initial blocks of development planned with each introducing new or enhanced capabilities. COBRA Blocks II and III are in concept refinement and technology development.

Unmanned sensor networking

Just as important as gathering sensor information from unmanned vehicles is the ability to network sensors to blend information and bring this information quickly to the fighting forces that need it. Commtact Ltd. in Yavne, Israel, offers the open-architecture Mini-Micro Data Link System (M2DLS) combined digital data link system for micro size platforms like unmanned vehicles and sensors.



Commtact Ltd. in Yavne, Israel, offers the Mini-Micro Data Link System (M2DLS) digital data link system for micro size platforms like unmanned vehicles.

The device also is for other applications that are sensitive to size, weight, and power consumption (SWaP). The M2DLS is available as an airborne and ground data terminal.

The M2DLS It measures 6 by 5 by 2 centimeters and weighs 60 grams, making it suitable for small unmanned ground vehicles, small vertical-take-off unmanned aerial vehicles, sensors, and related applications. The M2DLS can download real-time video images, LAN, serial data, and information from most available sensors.

It supports as many as six antennas simultaneously for multi-coverage support. It offers power transmission varying from 0.25 to 1 Watt, and enables full duplex wideband with cyber security protection, digital link, error correction techniques, and high-rate communication in the uplink and downlink channels. ←

Mercury wins $29 million in DRFM-based electronic warfare (EW) work within a week

BY **John Keller**

LAKEHURST, N.J. — Electronic warfare (EW) experts at Mercury Systems will provide the U.S. Navy with 36 additional DRFM-based airborne radar-spoofing systems that can confuse enemy radar by projecting several different false radar images.

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.

Mercury Systems is providing a variety of electronic warfare systems to the U.S. Navy to spoof enemy radar.

Officials of the U.S. Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., announced a $20.5 million order to Mercury on Wednesday to provide the advanced digital radio frequency memories (DRFM) systems as part of a small business innovation research (SBIR) project.

One week ago, Mercury won a separate-but-related $8.4 million Navy order for SBIR phase III work to complete an effort in advanced techniques for DRFM.

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

Raytheon smart munitions experts to build GPS-controlled artillery shells

Smart munitions experts at the Raytheon Co. potentially will build additional M982 Excalibur satellite-guided heavy artillery shells for the U.S. Army under terms of a $93.7 million order. Officials of the Army Contracting Command at Picatinny Arsenal, N.J., are asking the Raytheon Missile Systems segment in Tucson, Ariz., to produce Excalibur 155-millimeter projectiles. Excalibur first was fielded in Iraq in 2007 for urban or complex-terrain engagements in which collateral damage must be kept to a minimum. Excalibur has a ruggedized Global Positioning System (GPS) satellite navigation receiver and uses satellite signals to help guide itself to its intended targets. The 155-millimeter artillery shell can hit targets as far away as 25 miles, or detect and attack moving targets in cities and other complex terrain after being fired at high angles and high altitudes. The M982 Excalibur precision-guided, extended-range artillery shell is a fire-and-forget smart munition with better accuracy than existing 155-millimeter artillery rounds. These shells are fin-stabilized, and are designed to glide to targets with base bleed technology, as well as with canards located at the front of the munition that create aerodynamic lift. For more information contact **Raytheon Missile Systems** online at www.raytheon.com, or the **Army Contracting Command-New Jersey** at www.slideshare.net/ArmyContracting/nj-22934540.

RF and microwave cable pairs for networking and supercomputing introduced by Fairview

RF and microwave specialist Fairview Microwave Inc. in Lewisville, Texas, is introducing a line of 40 GHz skew matched cable

pairs for semiconductor test, networking, and supercomputing applications where skew match is essential. These RF and microwave cables are designed for bit-error-rate testing, eye diagrams, and differential signals at data rates of 10 to 28 gigabits power second. Fairview's skew matched cables consist of three extremely flexible models that are 100 percent tested for skew match. Performance specs include an impressive voltage standing wave ratio (VSWR) of 1.4:1 and 1 picosecond delay match. These cable pairs cover two channels with 50 Ohms nominal impedance and a bandwidth of DC to 40 GHz. The skew matched cables are constructed with microporous PTFE cable dielectric and feature 2.92-millimeter male connectors, triple-shielded outer conductors, and finger-grip coupling nuts. They are come with polarity indicators and restraint bands to remain paired. For more information contact **Fairview Microwave** online at https://fairviewmicrowave.com.

Boeing pitches F-15 jet with modern radar, flight controls, cockpit displays

The Boeing Co. is quietly pitching the U.S. Air Force a new F-15 jet fighter jet using the same business strategy that convinced the Trump administration to buy more F/A-18E/F Super Hornet jet fighter-bombers for the U.S. Navy. Dubbed the F-15X, the new variant of the venerable F-15 jet offers modern flight controls, cockpit displays, and radar, say military and industry sources with knowledge of the plan. The plane also would pack a lot of firepower, carrying more than two dozen air-to-air missiles, the most of any U.S. Air Force aircraft. Boeing officials declined explicitly to confirm their efforts to sell the F-15X, except perhaps obliquely. The Air Force has not purchased new F-15s since

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 February 2020. ←

For more information contact ***Mercury Defense Systems*** *online at* www.mrcy.com, *or the* ***Naval Air Warfare Center Aircraft Division-Lakehurst*** *at* www.navair.navy.mil.

Secure cloud computing for forward-deployed military forces introduced by Thales

PARIS — Thales in Paris is introducing the secure Nexium Defence Cloud — a private cloud computing infrastructure to improve the operational efficiency and trusted computing capability of military forces.

With its Defence Cloud, Thales proposes secure end-to-end hosting of data and applications. Users ranging from commanders in the home country to units deployed in theaters of operation can access data in complete privacy in a dedicated environment that takes advantage of Thales cyber security expertise.

Thales is offering a tactical secure computing infrastructure for forward-deployed military forces.

Hyperconnectivity on the battlefield promises to create new capabilities to gather, share, and process large volumes of data in real time, Thales officials say. As threat environments evolve, armed forces units will be able to respond immediately, and sometimes simultaneously, to any situation that may arise in future conflicts.

In recent years, cloud services have changed the day-to-day lives of businesses and individuals, driving the development of a whole range of applications to address new use cases. Organizations with a real need to share content can now remain connected at all times from any type of terminal or device. The armed forces share the same requirements.

The cloud solutions in use today for civil applications are not appropriate for deployed forces. They require unlimited bandwidth that armed forces do not have in the field. The Thales Defence Cloud is a sovereign solution designed for constrained environments, enabling deployed forces to conduct their missions in total autonomy in the theater of operations.

The Nexium Defence Cloud solution is comprehensive and modular. A range of configurations is possible to accommodate very high-capacity, readily expandable infrastructure networks for headquarters all the way down to an all-in-one box that transforms forward operating bases into new cloud nodes in a matter of hours.

This ability to interconnect systems and devices quickly and easily within ad-hoc command structures and organizations boosts mission effectiveness with no trade-off in security. Equipment and applications can be deployed, configured, and updated remotely so that the armed forces can focus on their core missions. ←

*For more information contact **Thales** online at* www.thalesgroup.com.

placing a 2001 order for five F-15E Strike Eagles, a two-seat version that can bomb ground targets and shoot down other aircraft. The original F-15 first flew in 1972, and many of the Air Force's current air-to-air Eagles entered service in the 1980s. Many of them are older than the pilots who fly them.

GaN X-band front-end modules for radar and similar uses introduced by Qorvo

Qorvo Inc. in Greensboro, N.C., is introducing the QPM2637 and QPM1002 gallium nitride (GaN) X-band front-end modules (FEMs) for next-generation active electronically scanned array (AESA) radar and similar RF and microwave applications. These export-compliant GaN products also meet the need for high-power RF survivability, which is essential for mission-critical operations. The Qorvo FEMs are built on the company's GaN technology, which enables higher efficiency, reliability, power and survivability, as well as savings in size, weight and cost. The GaN FEMs provide four functions in one compact package, including an RF switch, power amplifier, low noise amplifier and limiter. They can withstand as much as 4 Watts of input power on the receive side without permanent damage, compared with a typical gallium arsenide (GaAs) low noise amplifier, which can be damaged by less than 100 milliwatts of input power. The market for RF GaN devices for defense applications such as radar, electronic warfare and communications is projected to grow at a 24-percent combined annual growth rate over the next five years, as the adoption rate of GaN significantly outpaces other technology choices. For more information contact **Qorvo** online at www.qorvo.com. ←

Navy developing revolutionary new propulsion for manned and unmanned undersea vehicles

BY **John Keller**

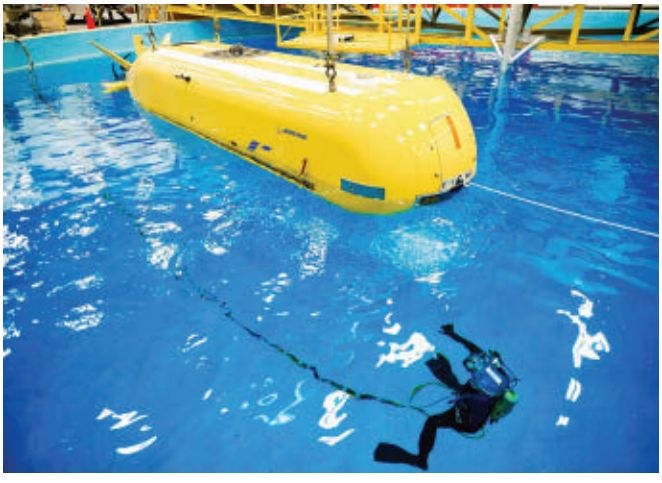
KEYPORT, Wash. — U.S. Navy researchers are moving on with a military research project to develop revolutionary propulsion and drag-reduction technologies to enable manned and unmanned undersea vehicles to move through the water faster and more energy-efficiently than ever before.

Officials of the Naval Undersea Warfare Center NUWC Division in Keyport, Wash., are considering awarding a sole-source contract to Applied Physical Sciences Corp. in Gorton, Conn., to continue the company's research in undersea vehicle propulsion and structures.

Applied Physical Sciences and several other defense companies are trying to develop and demonstrate integrated underwater vehicle prototypes able to operate at speed and range combinations previously unachievable in fixed-size platforms, while retaining traditional volume and weight fractions for payloads and electronics.

These efforts are part of the Blue Wolf program of the U.S. Defense Advanced Research Projects Agency in Arlington, Va. NUWC officials are asking for industry's help to help them decide whether to issue a formal solicitation for Applied Physical Sciences to continue its Blue Wolf research.

Applied Physical Sciences won a $3.1 million Blue Wolf contract in July 2015. Other contractors working on the Blue Wolf project are Boeing Defense, Space & Security segment in Huntington Beach, Calif.; the Lockheed Martin Mission Systems and Training segment in Riviera Beach, Fla.; and the Charles Stark Draper Laboratory in Cambridge, Mass.



Fast and efficient unmanned undersea vehicle propulsion is the aim of a research contract under consideration for Applied Physical Sciences.

The Blue Wolf project also involves developing alternative point designs for a fast, low-drag, and energy-efficient undersea vehicle, as well as revolutionary technologies for significant drag reduction, such as dynamic lift from winglets, body shaping, coatings, and drag-reduction technologies to improve system energy efficiency.

Undersea vehicle size, weight, and volume, traditionally are limited by handling, launch, and recovery systems, DARPA officials explain. Mission performance typically sets the range, endurance, speed, and depth requirements, and the range of underwater vehicles is limited by the amount of energy available for propulsion and the power required for a given underwater speed.

This means that for a given speed, range, and volume necessary for payloads and electronics, vehicle size is proportional to energy needed for the mission envelope.

While designers can modify this envelope by reducing hydrodynamic drag, improving lift-to-drag performance, or by improving the volumetric energy density of energy sources, the volume and weight needed for systems to reduce drag or improve lift-to-drag in a fixed-size vehicle also reduces the volume and weight available for energy.

The initial reference architecture consists of a 21-inch-diameter vehicle with volume and weight reserved for baseline guidance, control, electronic systems, and payload section. The vehicle will use a baseline electric drive and conventional fin control.

NUWC is gathering information from industry to help determine if Advanced Physical Sciences' work should continue. Email responses by 19 June 2018 to the Navy's Winston Dimagiba at winston.dimagiba@navy.mil. ←

More information is online at https://www.fbo.gov/spg/DON/NAVSEA/N00253/N00253-15-C-1001-P00017/listing.html.

Orbital to build 18 GQM-163A Coyote supersonic sea skimming target drones

BY **John Keller**

PATUXENT RIVER NAS, Md. — Aerial target experts at Orbital Sciences Corp. in Chandler, Ariz., are building additional supersonic Target drones for the U.S. Navy and allies to help surface warship crews practice how to detect and defeat incoming supersonic anti-ship missiles.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $52.9 million contract to Orbital to build 18 GQM-163A lot 12 full-rate-production Coyote supersonic sea skimming target base vehicles for the U.S. Navy and governments of Japan and Israel. The French navy also operates the GQM-163A.

The Orbital Sciences GQM-163 Coyote target drone is designed to simulate sea-skimming cruise missiles by maneuvering faster than twice the speed of sound as low as 12 feet off the surface of the ocean.

The contract includes D6AC long-lead steel for the GQM-163A for the Navy, Japan, and Israel.

The GQM-163A Coyote supersonic sea skimming target is designed to provide an affordable target to simulate supersonic sea-skimming and other emerging supersonic anti-ship cruise missiles. It also supports research in ship-defense systems and fleet training.

The supersonic target drone is designed to help Navy ship crews learn to defend themselves against modern anti-ship missiles like the French Exocet and the Russian-made SS-N-22 Sunburn and SS-NX-26 Oniks, which may be operational with military forces in Iran, Syria, and other countries in the Middle East for use against U.S. and allied naval forces in and around the Eastern Mediterranean, Persian Gulf, and other vital waterways.

The Sunburn anti-ship missile can fly at three times the speed of sound, giving targeted vessels little time to react. It carries a 705-pound explosive warhead — twice the destructive payload of the Exocet and three times as fast.

Orbital won a contract to develop the GQM-163A in 2000, and the target drone has been operational since 2005.

The GQM-163A drone is designed to simulate sea-skimming cruise missiles by flying faster than twice the speed of sound as low as 12 feet off the surface of the ocean. The target drone also can simulate high-altitude cruise missile attacks that plunge down at ships from higher than 30,000 feet.

On this contract Orbital Sciences will do the work in Chandler, Ariz.; Camden, Ark.; Vergennes, Vt.; Lancaster, Pa.; and Hollister, Calif.; and should be finished by May 2022. For more information contact **Orbital Sciences** www.orbital.com, or **Naval Air Systems Command** at www.navair.navy.mil. ←

Raytheon UAV acts as guided missile to attack and kill enemy drones

The U.S. Army plans to use Raytheon's Coyote unmanned aircraft and the KRFS radar against enemy drones on the battlefield, Raytheon officials said in July. The Coyote small unmanned aerial vehicle (UAV) is designed to be guided by the KRFS radar, and to explode next to enemy drones, effectively acting as a guided missile. The Coyote is a lightweight expendable UAV and is tube-launched, eliminating the need for a runway. It can be launched from ground, air or naval units, and can be networked to operate in swarm attacks to be used for surveillance in addition to strike attacks. The Coyote also is used for hurricane tracking by the National Oceanic and Atmospheric Administration, the agency responsible in the United States for severe weather monitoring.

Israel's Elbit unveils civilian UAV that can fly alongside commercial jets

The Israeli defense contractor Elbit has unveiled a civilian version of its Hermes 900 drone that can be flown alongside manned airplanes. The StarLiner, as the unmanned aerial vehicle (UAV) is known, is meant to enable governments and security agencies to collect intelligence in areas where drones are prohibited from flying alongside commercial passenger aircraft for safety reasons. Officials from the manufacturer, Elbit Systems Ltd. in Haifa, Israel, say the model was created in light of requests by countries around the world for drones that can help thwart domestic terror attacks, and not just for missions abroad. Most currently available UAVs lack the sensors to operate in these areas without interfering with other aircraft. As a result, many countries forbid such drones from flying in civilian airspaces. ←

Boeing Insitu to build six ScanEagle small unmanned aerial vehicles for Lebanon

BY **John Keller**

PATUXENT RIVER NAS, Md. — Unmanned aerial vehicle (UAV) designers at Insitu Inc. in Bingen, Wash., will build six ScanEagle small UAVs for the government of Lebanon under terms of a $8.2 million U.S. Navy order in late June.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking Insitu to provide six ScanEagle UAVs, support equipment, training, site activation, technical services, and data for Lebanon. Insitu is a subsidiary of the Boeing Co.

The ScanEagle UAV is 5.1 feet long with a 5.6-foot wingspan. It weighs as much as 48.5 pounds and can carry a 7.5-pound sensor payload. The UAV can fly for more than 24 hours at altitudes as high as 19.500 feet, and at speeds to 80 knots. The unmanned aircraft can fly on gasoline or heavy fuels like jet fuel, diesel, or kerosene.

The mission of ScanEagle is to provide persistent surveillance and reconnaissance imagery on land or at sea at lower costs than other surveillance methods for military and agriculture missions.

ScanEagle can carry a sensor payload consisting of visible-light camera, medium-wave infrared imager, or both integrated in one turret. The UAV also has an analog digitally encrypted video data link, as well as encrypted or unencrypted command-and-control data link.

Insitu is building six ScanEagle small UAVs for Lebanon for a variety of reconnaissance and surveillance uses.

The UAV can be launched autonomously and uses a no-nets recovery system that recovers with its wing tip on a rope that hangs from a boom.

On this contract Insitu will do the work in Bingen and White Salmon, Wash., and should be finished in June 2020. For more information contact **Insitu** online at www.insitu.com, or **Naval Air Systems Command** at www.navair.navy.mil.

BAE Systems to build additional APKWS laser-guided air-to-ground smart munitions

BY **John Keller**

PATUXENT RIVER NAS, Md. — The U.S. military is upgrading laser-guided rockets that enable fixed-wing aircraft, helicopters, and unmanned aerial vehicles (UAVs) to attack lightly armored vehicles, bunkers, field fortifications, cars, and trucks with electro-optical smart munitions.

Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $224.3 million order Wednesday to the BAE Systems Electronic Systems segment in Hudson, N.H., to build an additional 10,185 WGU-59/B Advanced Precision Kill Weapon Systems (APKWS) II under full-rate Production Lot 7.

APKWS is an add-on kit that turns a standard unguided 2.75-inch 70-millimeter rocket into a precision laser-guided munition to give warfighters a low-cost surgical strike capability, BAE Systems officials say. Typically the kit fits on the Hydra 70 fin-stabilized unguided air-to-ground rocket.

APKWS uses semi-active laser guidance technology to strike soft and lightly armored targets in confined areas, it has provided the U.S. Marine Corps with a 93 percent hit rate. It is smaller and less expensive than comparable laser-guided missiles like the AGM-114 Hellfire.

The APKWS laser-guided smart munition can fit aboard the U.S. Marine Corps UH-1Y, AH-1W, and AH-1Z helicopters, the experimental Bell 407GT helicopter, the U.S. Army AH-64 Apache attack helicopter, the Eurocopter Tiger, and the Navy MH-60 Seahawk helicopter.

The APKWS II smart munition uses optical guidance to attack lightly armored vehicles, bunkers, field fortifications, cars, and trucks.

The system also fits aboard fixed-wing aircraft such as the AV-8B Harrier II, OV-10 Bronco, F-16 jet fighter, and A-10 close-air-support jet.

In the future, the APKWS is under consideration for the Navy MQ-8 Fire Scout unmanned helicopter, OH-58 helicopter, V-22 tiltrotor, AH-6 Little Bird helicopter, the A-29 Super Tucano ground-attack aircraft, and the Navy F/A-18E/F fighter-bomber.

The APKWS-equipped rocket is slightly longer than six feet, 2.75 inches in diameter, has a wingspan of 9.55 inches, and weighs 32 pounds. It uses the Hydra 70 impact-detonating, airburst, or standoff warheads. The laser munition can hit targets as far away as three miles, flies at speeds of 2,200 miles per hour, and costs $30,000 apiece.

On this order BAE Systems will do the work in Hudson, N.H., and Austin, Texas, and should be finished by March 2019. ←

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

Israel deploys electronic eye to track fire kites and balloons from Gaza

Facing a wave of airborne incendiary attacks from the Gaza Strip, Israel has deployed a system that can spot fire-starting balloons and kites in the sky, track their progress, and then direct fire fighters to their landing spots, enabling them to more rapidly extinguish the flames and reduce damage. The Sky Spotter system, built by Rafael Advanced Defense Systems, has been in operation along the Gaza border. Originally developed to counter small drones, Sky Spotter can track the balloons or kites and pinpoint their location, where they are heading, and where they are likely to land. Sky Spotter also can direct defensive drones that collide in midair with the kites or balloons, bringing them down.

Processor board for next-gen embedded imaging introduced by Critical Link

Critical Link LLC in Syracuse, N.Y., is introducing the MitySOM-A10S-DSC embedded computing processor board for next-generation embedded imaging applications like machine vision, test and measurement, embedded instrumentation, industrial automation and control, and industrial and medical instrumentation. The board features dual-side connectors for stack-through configurations. It is a configurable system-on-module (SoM) featuring the Intel/Altera Arria 10 system on chip (SoC) with dual-core ARM microprocessor and 480KLE FPGA fabric. The module includes on-board power supplies, two DDR4 RAM memory subsystems, and a rich set of user interfaces. The A10 board supports OpenCL and high-level synthesis tools for accelerating design cycles and targeting C/C++ code to the FPGA. For more information contact **Critical Link** online at www.criticallink.com. ←

PRODUCT applications

POWER ELECTRONICS

Army eyes in power electronics, power generation, and energy storage

U.S. Army power electronics experts needed help in advanced research for power generation, energy storage, management, and distribution. They found their solution from General Technical Services LLC in Wall Township, N.J.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., announced a $13.4 million five-year contract to General Technical Services to manage research in soldier tactical and expeditionary power and energy generation Army devices.

General Technical Services will provide labor and materials necessary to develop advanced power and energy technologies for soldiers operating in squads, platoons, base camps, and tactical sites.

This contract will involve the company in several power electronics enabling technologies, including:

- energy storage extreme lightweight materials and components with advanced electrochemical technologies that can enable safe operation for longer than three days;
- state-of-the-art fuel cells;
- energy harvesting wearable and portable technologies for on-the-move and stationary power generation from alternative or renewable energy sources for longer than three days;
- high efficiency, lightweight, multipath, cableless power-distribution architectures, management algorithms and power network control;
- chemically stable non-fossil-fuel-based power generation to enable continuous power generation for longer than three days;
- fast and ultra-fast power charging using electronic circuit designs that enable safe battery charging of a depleted battery in one hour or less;
- electromechanical energy conversion that use advanced electronic controls to minimize energy loss and extend the operational life of expeditionary power systems;
- advanced power source analysis tools for modeling and simulation in technical decision making; and
- state-of-the-art test and evaluation equipment to help identify, examine, and forecast power and energy performance.

General Technical Services will do the work on this contract at Aberdeen Proving Ground, Md., and should be finished by June 2023. For more information contact **General Technical Services** online at *www.gtsllc.com*, the **Army Contracting Command at Aberdeen Proving Ground** at *http://acc.army.mil/contractingcenters/acc-apg*, or the **Command Power and Integration Directorate of the Army Communications-Electronics Research, Development and Engineering Center (CERDEC)** at *www.cerdec.army.mil/inside_cerdec/cpi*.

AVIONICS

Hindustan Aeronautics chooses L3 for helicopter flight data recorders

Aircraft designers at Hindustan Aeronautics Ltd. (HAL) in Bangalore, India, needed flight data recorders for civil and military helicopters. They found their solution from avionics supplier L3 Aviation Products in Grand Rapids, Mich.

Hindustan Aeronautics is choosing the FA2300 Modular Airborne Data Recorder/Acquisition System (MADRAS) for the HAL Advanced Light Helicopter and Light Combat Helicopter (LCH) production programs. The companies made the announcement in July at the Farnborough International Airshow in Farnborough, England.

The FA2300 MADRAS is a line-replaceable unit (LRU) produced in Bengaluru, India, that provides high-speed recording of flight data and audio that are crucial for post-flight analysis and accident investigation.

MADRAS records data as quickly as 256 words-per-second for a minimum of 25 hours and has the capability to record four channels of high-quality audio for as long as two hours.

The recorder's high reliability in the field and single-LRU design result in lower costs over the life of the system, L3 Aviation Products officials say.

L3 provides services and support on the MADRAS system at its facility in Bengaluru, India, which was approved in early 2018 as a CAR 145 repair station serving civil aviation and other non-military customers.

MADRAS is custom configured for data acquisition as a data recorder for helicopters, business aircraft, unique-mission, and military aircraft. It offers 20,000 hours mean time between failures; has a range of analog, digital, and discrete inputs; outputs to ARINC 747 for connection to a quick access recorder (QAR);

offers military options; has available control units, microphones, accelerometers, and installation accessories; and offers common ground support equipment with FA2100 cockpit voice recorder and flight data recorder.

The Hindustan Aeronautics Light Combat Helicopter is a multirole combat helicopter ordered for the Indian Air Force and the Indian Army. The aircraft is designed to operate at high altitudes. Full-rate production of this aircraft began in 2016.

The LCH has a glass cockpit with integrated avionics and display system and an onboard target acquisition and designation (TADS) system. The pilot wears a helmet mounted sight as his principal instrument for targeting and triggering the helicopter's weapons.

The combat helicopter has an electronic warfare (EW) suite from the South African division of Saab Group with a radar warning receiver, laser warning receiver, and a missile approach warning system.

The LCH has an integrated data link to participate in network-centric operations. Its onboard sensor suite, developed by HAL in cooperation with Israel has a CCD camera, a forward looking infrared (FLIR) imaging sensor, laser rangefinder, and a laser designator. The helicopter has an M621 cannon in a Nexter-built THL 20 turret and integrated into the helmet-mounted sight.

The helicopter can carry four 70-millimeter anti-tank guided missiles and MBDA Mistral 2 anti-air missile. Rockets also are available for attacking ground targets. For more information contact **L3 Aviation Products** online at *www.l3aviationproducts.com*, or **Hindustan Aeronautics Ltd.** at *https://hal-india.co.in*.

UBMARINE ELECTRONICS

General Dynamics to continue software upgrades on Navy AN/BYG-1 submarine combat system

Submarine electronics experts at the General Dynamics Corp. Mission Systems segment in Pittsfield, Mass., will upgrade software on the U.S. Navy AN/BYG-1 submarine combat system under terms of an $18.3 million order announced in late June.

Officials of the Naval Sea Systems Command in Washington are asking General Dynamics to upgrade computer software in the AN/BYG-1 Weapons Control System (WCS) as part of the system's technology insertion and advanced processing build software upgrade.

General Dynamics is upgrading the AN/BYG-1 submarine combat system with commercial off-the-shelf (COTS) computers. The company is replacing central processors with COTS computers, and is refreshing submarine combat system processors with new COTS technologies in periodic upgrades called technology insertions.

This contract calls for General Dynamics to continue AN/BYG-1 WCS technology insertion 16 (TI-16) advanced processing build (APB-15)

software for several different kinds of submarines. General Dynamics also will complete TI-14 APB-15, and maintain earlier baselines.

The AN/BYG-1 system is a counterpart to the Navy's Advanced Rapid COTS Insertion (A-RCI) program that uses COTS computers in submarine sonar signal processing systems.

Submarine crews equipped with the AN/BYG-1 combat control system are able to analyze submarine sensor contact information to track submarine and surface vessels in open-ocean and coastal waters; aim and fire heavyweight torpedoes against enemy submarines and surface ships; receive strike warfare orders, plan strike missions and employ Tomahawk land-attack cruise missiles; and receive and synthesize sensor data and external tactical intelligence to produce an integrated tactical picture for situational awareness.

These software upgrades are for the combat systems and computers aboard ballistic-missile submarines, cruise-missile submarines, and fast-attack submarines.

The AN/BYG-1 program includes combat control system for Virginia-class attack submarines, as well as upgraded combat control systems for Los Angeles- and Seawolf-class attack submarines and Ohio-class ballistic-missile and cruise-missile submarines. General Dynamics also is providing AN/BYG-1 system upgrades for Australian Collins-class attack submarines.

The AN/BYG-1 modernization program separates development of the tactical control system (TCS) and the weapons control system (WCS) to enable independent yet parallel development and certification of these computer systems, General Dynamics officials say. Each of these systems uses a variety of APB software algorithms developed by industry, government, and academia.

The TCS computer hardware portion of BYG-1 integrates sensor inputs to provide a secure common operational picture and improved situational awareness that blends information sonar, electronic support measures, radar, navigation, periscopes, and communications systems. The TCS system architecture allows for rapid COTS insertion to accommodate and integrate additional functionality and sensors.

One of the benefits of rapid COTS technology upgrades to submarine combat systems is the ability for the Navy to learn from real-world experience to make quick improvements. Recent Navy recommendations, for example, were to acquire automation technology to help the operator in areas of high contact density.

On this order, General Dynamics will do the work in Pittsfield, Mass., and should be finished by June 2019. For more information contact **General Dynamics Mission Systems** online at *https://gdmissionsystems.com*, or **Naval Sea Systems Command** at *www.navsea.navy.mil*. ←

new PRODUCTS

To submit new products for consideration, contact John Keller at jkeller@pennwell.com.

SIGNAL PROCESSING

FPGA boards for signal processing and data storage introduced by Annapolis and TE

TE Connectivity in Harrisburg, Pa., is collaborating with Annapolis Micro Systems Inc. in Annapolis, Md., to introduce three rugged high-performance field-programmable gate array (FPGA) embedded computing boards for

data acquisition, digital signal processing, and data storage applications. The FPGA boards are for advanced high-performance pomputing (HPC) and electronic warfare (EW) applications, including DRFM, beamforming, sensor processing, wireless communication, and radar signal processing. Each of the boards has TE's half-sized NanoRF module, which is designed to fit into the VITA 67.3 form factor and supports 70 GHz bandwidth, with more than double the RF contact density of existing VITA 67 solutions. The three OpenVPX FPGA processor boards from Annapolis Micro Systems include two 3U boards, the WILDSTAR 3XB0 and WILDSTAR 3XB1, as well as the 6U WILDSTAR 6XB2. Eliminating the need for front panel coaxial cables, the NanoRF design capitalizes on the alignment of optical VITA 66 modules. A floating insert on the backplane pre-aligns the RF contact array before the contacts start to engage. This rugged precision alignment is critical in blind-mate plug-in architecture, which requires high reliability under extreme conditions. For more information contact **Annapolis Micro Systems** online at *www.annapmicro.com*, or **TE Connectivity** at *www.te.com*.

SENSORS

Digital barometric pressure sensor for drones and weather forecasting offered by Mouser

Electronics parts distributor Mouser Electronics Inc. in Mansfield, Texas, is stocking the BMP388 digital barometric pressure sensor from Bosch Sensortec GmbH in Kusterdingen, Germany, for consumer drones, weather forecasting, augmented and virtual reality, enhanced GPS systems, and vertical velocity indication. The compact device is for altitude stabilization in consumer drones, Internet of Things applications, vertical velocity indication, weather forecasting, health care applications, augmented reality (AR) and virtual reality (VR) devices, and enhanced GPS accuracy. Featuring a tempera-

ture coefficient offset (TCO) between 20 and 65 degrees Celsius, the small, low-power, low-noise BMP388 sensor delivers accurate altitude measurement over a broad temperature range. The Bosch BMP388 digital barometric pressure sensor, available from Mouser Electronics, uses sensing principles to provide pressure and temperature measurements. The compact device also is for altitude stabilization in Internet of Things applications, vertical velocity indication, and health care applications. For more information contact **Mouser Electronics** online at *www.mouser.com*.

EMBEDDED POWER

PCI-104 power supply modules for military ground vehicles and aircraft introduced by Elma

Elma Electronic Inc. in Fremont, Calif., is introducing four PCI-104-based rugged power supply

modules for military ground vehicle and aircraft applications. The power supplies are for systems designers to use in PC/104, PC/104-Plus, PCI-104, PCIe/104 or PCI/104-Express embedded system stack arrangements. They can also provide power for other small form factor (SFF) embedded computing systems, such as COM Express. The rugged mechanical PCI-104 form factor is for demanding power conditions typically experienced in ground vehicles and aircraft applications. This enables the power supplies to function without active cooling in temperature ranges from -40 85 degrees Celsius per MIL-STD-810G, when attached to a base enclosure for heat dissipation.

Each module withstands high levels of shock and vibration for defense ground vehicles (MIL-STD-810G) and military aircraft (MIL-STD-704F) for reliable operation in harsh environments. For more information contact **Elma** online at *www.elma.com*.

RF SYNTHESIZERS

RF and microwave synthesizer for aerospace and defense introduced by Analog Devices

Analog Devices Inc. (ADI) in Norwood, Mass., is introducing the ADF4371 state-of-the-art synthesizer for RF and microwave systems in aerospace and defense applications, as well as test and measurement, communications infrastructure, and high-speed converter clocking. The ADF4371 consists of a phase-locked loop (PLL) with integrated voltage controlled oscillator (VCO) as well as integrated low dropout regulators (LDOs) and integrated tracking filter. Designed using ADI's 25 years of leading RF and microwave synthesizer expertise, the ADF4371 offers continuous RF output range of 62 MHz to 32 GHz, low PLL FOM (-234dBc/Hz), low spurious (-100dBc typ.), low VCO phase noise (-134dBc/Hz @1 MHz offset at 8 GHz), and built-in tracking filter technology. Its configurable architecture means that designers can choose one, compact, synthesizer solution to cover almost any LO/clock requirement within these frequency ranges, thereby reducing development costs, risk and time to market. For more information contact **Analog Devices** online at *www.analog.com.*

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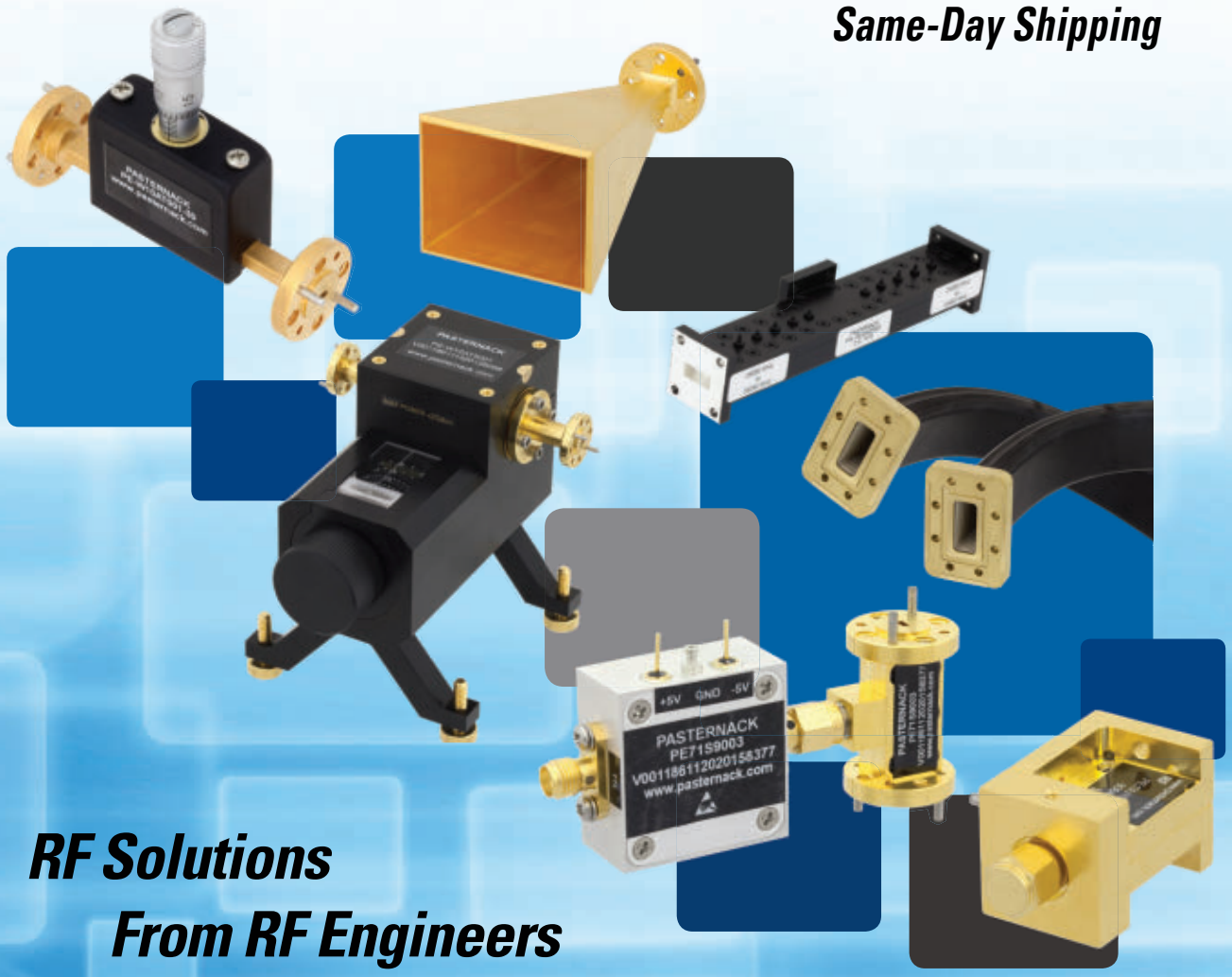

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