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COVER STORY

BY **JOHN KELLER**, EDITOR IN CHIEF

Navy looks to modified littoral combat ship as next-generation frigate

Naval surface warships like the frigate have filled a variety of diverse-yet-specific roles throughout history, such as projecting power, surface escort, command and control, and logistics support. Each has its place and serves as an integral cog in the machine of naval power.

Capital ships, the most powerful vessels in the fleet, are the instruments of projecting power. Today those are the aircraft carrier, amphibious assault ship, and to a more limited degree the guided missile cruiser.

Surface escort ships like destroyers and frigates traditionally protect the powerful capital ships, and provide escort protection to lightly armed naval surface warships, as well as to commercial or military merchant ships. Escort ships play a crucial role of keeping naval battle groups together, intact, and functioning in the face of the enemy. They screen ships from aircraft and submarine attack, and can act as advance scouts to determine what's beyond the battle group's horizon.

Today's ships are evolving away from their core escort missions. The U.S. Navy's Arleigh Burke-class destroyer, for example, has become a powerful vessel in its own right and increasingly operates independently in roles like seaborne ballistic missile defense. At the other end of the scale, the Navy's littoral combat ship (LCS) is taking on new roles of counter-mine warfare, ocean search-and-seizure, and reconnaissance of coastlines and harbors. The Navy's traditional frigate, meanwhile, has fallen by the wayside.

Today there are no frigates in the U.S. Navy, which has created a gap in the Navy's anti-air and anti-submarine escort capabilities. This hasn't gone unnoticed in the naval high command. Recognizing the need for frigates, Navy and U.S. Department of Defense (DOD) leaders have agreed to modify late-model littoral combat ships with more armor and more powerful anti-aircraft and anti-submarine capabilities and rename them frigates. Navy leaders plan to build a total of 40 LCS vessels, and at least 12 of them will be built as frigates.

The LCS was designed as a modular vessel to handle a variety of roles based on different equipment packages, including: counter-mine warfare, anti-aircraft warfare, anti-surface warfare, and anti-submarine warfare. There are two variants of the LCS: the Freedom class and Independence class. Navy leaders plan to base future frigates on just one type, but haven't decided yet which one.

The Freedom class, at 3,900 tons, is the larger of the two. Even if the Freedom-class LCS becomes the Navy's next frigate, the ship will be on the small side compared to other operating frigates. The De Zeven Provinciën-class frigate of the Royal Netherlands Navy displaces 6,000 tons. The United Kingdom Royal Navy's Duke-class Type 23 frigate displaces 5,400 tons.

Transforming the LCS design to a frigate has its drawbacks. The original LCS was designed for speed, and reportedly can approach speeds of 47 knots. The frigates will be heavier for enhanced survivability and more powerful weapons. The price of that extra protection and armament will be a reduction in speed. How much of a reduction remains unclear. Still, the redesigned frigate is likely to be fast compared to larger frigates in other navies. If the LCS-based frigates can steam at speeds faster than 35 knots, they'll be faster than the Duke-class and De Zeven Provinciën-class frigates, which top out at around 28 knots.

We can't know yet how well the Navy's plan of modifying the littoral combat ship into a frigate will work out. Navy officers eventually may regret their decision not to design a new frigate from the ground up. Still, that gap in naval surface escort capability will be narrowing soon. The first LCS-based frigates should go to sea sometime in the next decade.

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Military & Aerospace Electronics launches 2016 Innovators Awards

NASHUA, N.H. — *Military & Aerospace Electronics* is kicking off its first Innovators Awards program to recognize companies in the aerospace and defense electronics industry for technological innovations that solve design challenges with real solutions.

The *Military & Aerospace Electronics* Technology Innovation Awards will recognize developers of the most influential enabling technologies for aerospace and defense applications. Enabling technologies are those developed or discovered that actually solve design problems. Often these enabling technology solutions solve problems for which there was no known solution before, or which were particularly difficult.

Nominations for Innovation Awards can represent simple or complex solutions, or anything in-between. Nominations should state the design challenge, describe the innovative technology, and explain how the technology solved a design problem.

Technologies do not have to be new products. They can have been developed over the past several years, and are in contemporary designs no more than a couple of years old.

We understand that in the aerospace and defense business you can't always call out your customer by name, or by specific project. Instead, we can talk about technology challenges and technology solutions somewhat a generic sense, rather than challenges and solutions for specific programs.

Aerospace and defense electronics suppliers are urged to nominate their customers, and systems integrators are urged to nominate their suppliers. The awards process has no specific categories, as long as innovative technologies nominated represent true design solutions.

Defense electronics suppliers can nominate themselves, and we are encouraging customers of electronics suppliers at the prime contract and subcontractor levels to nominate their customers for recognition in the *Military & Aerospace Electronics* Technology Innovation Awards.

Award nominees can involve a wide range of military and aerospace electronics technologies, including command, control, communications, computers, intelligence, and surveillance (C4ISR); cyber security; electro-optics; embedded computing; high-reliability electronics; interconnect technology; power electronics, RF and microwave; test and measurement; and other technologies that apply to aerospace and defense applications on land, at sea, in the air, and in space.

Military & Aerospace Electronics 2016 Innovators Awards will go to organizations that demonstrate ex-

IN BRIEF

Army orders JLTV armored combat vehicles

Oshkosh Defense in Oshkosh, Wis., won its first major order for the Joint Light Tactical Vehicle (JLTV), the U.S. military's next-generation light battlefield vehicle to replace the venerable Humvee. The U.S. Army Contracting Command in Warren, Mich., announced a $243.8 million contract modification to Oshkosh for 657 JLTVs and 25 trailers. The Oshkosh JLTV is a version of the company's Light Combat Tactical All-Terrain Vehicle. The JLTV program was delayed after Oshkosh rival Lockheed Martin protested the initial contract awarded last August. The program resumed last month after the protest was dismissed.

Air Force orders Raytheon air-to-air missiles

Officials of the Air Force Life Cycle Manager Center at Eglin Air Force Base, Fla., are awarding a $573 million contract modification to Raytheon Missile Systems in Tucson, Ariz., for Lot 30 production of the AIM-120 Advanced Medium Range Air to Air Missile (AMRAAM) for the U.S. Air Force and Navy. AMRAAM is an advanced all-weather, all-environment, medium-range air-to-air missile with inherent electronic protection capabilities.

cellence in the use of a product or system. Designers, integrators, and users of military and aerospace electronic systems may nominate their own projects or applications, or integrators or distributors that supply products or systems can nominate exceptional projects for consideration.

Awards will be presented in November 2016, and the deadline for nominations is July 2016.

To make nominations, download and fill out the submission form, which is in .pdf format, at www.militaryaerospace.com/content/dam/mae/site-images/MAE16-Awards-Agreement.pdf. Upload the completed form to *Military & Aerospace Electronics* at www.militaryaerospace.com/innovators-awards/innovation-awards-form.html. Return the forms by 1 July 2016.

Documentation for submitting entries is online at www.militaryaerospace.com/content/dam/mae/site-images/MAE16-Application-Form.pdf.

High-scoring companies will be recognized as leaders and innovators within the aerospace and defense electronics at a live event as well as in the pages and on the website of *Military & Aerospace Electronics*.

For questions or concerns, contact *Military & Aerospace Electronics* Chief Editor John Keller by phone at 603-891-9117 or by e-mail at jkeller@pennwell.com.

MORE INFORMATION ABOUT the *Military & Aerospace Electronics* 2016 Innovators Awards is online at *www.militaryaerospace.com/innovators-awards.html*.

Army goes on $1.5 billion helicopter shopping spree in March

BY JOHN KELLER

REDSTONE ARSENAL, Ala. — U.S. Army aviation experts went on a military helicopter-buying spree in March, culminating with a $184.9 million order for an undisclosed number of AH-64E Guardian attack helicopters from the Boeing Co.

Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking the Boeing Defense, Space & Security segment in Mesa, Ariz., for Apache helicopter full-rate production lot 7. One Apache helicopter production lot consists of about 24 helicopters.

A U.S. Army helicopter-buying spree last month culminated in a $184.9 million order for an undisclosed number of AH-64E Guardian attack helicopters from the Boeing Co.

Army helicopter shopping started on 8 March with a $387.2 million order to Sikorsky, a Lockheed Martin company, in Stratford, Conn., to build 35 UH-60M Black Hawk military utility helicopters.

Rotorcraft buying continued again on 15 March when the Army ordered 12 new and 27 rebuilt Boeing CH-47F Chinook twin-rotor multimission, heavy-lift transport helicopters in an $896.9 million

contract as part of Chinook production lot 14.

The AH-64E Apache Guardian attack helicopter contract brought the Army helicopter buying total for March to about $1.5 billion in a span of just two weeks.

The twin-engine UH-60M Black Hawk can serve in the most extreme conditions on Earth, Sikorsky officials say. The newest model of the Black Hawk helicopter integrates the Army's Future Combat Systems and automated aircraft health monitoring. Lockheed Martin Corp. completed its acquisition of Sikorsky Aircraft Corp. last fall.

The UH-60M is designed to replace the older UH-60A Black Hawk and is the centerpiece of the Army's long-term effort to modernize the service's medium-lift helicopter fleet. Sikorsky Aircraft has manufactured the Army Black Hawk since 1978.

The CH-47F is an advanced multimission helicopter for the U.S. Army and international defense forces. It contains an integrated, digital cockpit management system, common aviation architecture cockpit, and advanced cargo-handling capabilities.

The Chinook's primary mission is to move troops, artillery, ammunition, fuel, water, barrier materials, supplies, and equipment on the battlefield. Its secondary missions include medical evacuation, disaster relief, search and rescue, aircraft recovery, firefighting, parachute drops, heavy construction, and civil development. Under the U.S. Army Modernization Program, new-build CH-47F began deliveries in 2006. Under the same program, CH-47Ds are being upgraded to remanufactured CH-47F helicopters.

The AH-64 Apache is a multirole combat helicopter with integrated avionics and weapons, as well as advanced digital communications to enable real-time, secure transfer of battlefield information to air and ground forces.

The E-model Apache Guardian features enhanced performance, joint digital operability, improved survivability and cognitive decision aiding, and reduced operating and support costs, Boeing officials describe.

The AH-64E Apache is being delivered to the U.S. Army and has been selected by several international defense forces.

Draper Lab to enhance accuracy of submarine-launched nuclear missiles

BY JOHN KELLER

WASHINGTON — U.S. Navy strategic weapons experts continue to make U.S. submarine-launched atomic missiles even more accurate and deadly with a program to fine-tune the accuracy of the Navy's Trident II D5 nuclear missiles aboard Ohio-class ballistic missile submarines.

Officials of the Navy Strategic Systems Program office in Washington announced a potential $163.6 million contract in March to the Charles Stark Draper Laboratory Inc. in Cambridge, Mass., to build, test, verify, and recertify Trident missile inertial measurement units, electronic assemblies, and electronic modules.

The Trident II is the primary weapon aboard Navy Ohio-class ballistic missile submarines. The missile has a range of more than 7,000 miles and carries four independently targeted 475-kiloton nuclear warheads.

The Trident missile's MK 6 guidance system consists of an electronics assembly with the system's flight computers, and an IMU with the system's inertial sensors. The electronics assembly interfaces with the submarine's fire-control system and the missile's flight-control electronics assembly. The IMU, meanwhile,

Navigation and guidance experts from Draper Lab are upgrading U.S. submarine-launched ballistic missiles to be more accurate than ever before.

senses the motion of missile and provides navigation information to the mission computer.

Trident missiles are aboard 14 Navy Ohio-class submarines and four British Royal Navy Vanguard-class submarines. Each Ohio-class submarine can carry as many as 24 Trident atomic missiles. These vessels together carry about half of all U.S. strategic thermonuclear warheads.

The Draper Lab contract is part of a Navy effort begun in 2002 to extend the life of the D5 missiles to the year 2040 by replacing obsolete components with commercial off-the-shelf (COTS) hardware. Upgrades involved the missile reentry systems and guidance systems.

The first flight test of a D5 extended-life subsystem, the MK 6 Mod 1 guidance system, was in early 2012 aboard the Ohio-class ballistic missile submarine USS Tennessee (SSBN 734).

The Trident nuclear missile has a maximum speed of 13,000 miles per hour, and has precision guidance from inertial sensors with star sighting. No GPS-guided Trident D5 missiles have been deployed.

The Trident II missile warhead discharges the energy of 475,000 tons of TNT, and is roughly 30 times the size of the U.S. nuclear bomb dropped on Hiroshima, Japan, in 1945.

On this contract Draper Lab will do the work in Minneapolis; Clearwater, Fla.; and Cambridge and Pittsfield, Mass.; and should be finished by January 2020.

FOR MORE INFORMATION visit **Draper Lab** online at *www.draper.com*, or the **Navy Strategic Systems Programs Office** at *www.ssp.navy.mil*.

U.S. intelligence analysts approach industry for computer 3D models based on satellite imagery

BY JOHN KELLER

WASHINGTON — U.S. intelligence researchers are asking industry to develop core libraries of computer 3D models that represent manmade objects like buildings, roads, walls, bridges, towers, and dams to help with military mission planning based on satellite imagery.

The IARPA CORE3D program is asking industry for libraries of computer 3D models to help with military mission planning based on satellite imagery.

Officials of the U.S. Intelligence Advanced Research Projects Agency (IARPA) in Washington briefed industry on 30 March 2016 concerning details of this program, called CORE3D. IARPA is the research arm of the U.S. Director of National Intelligence.

U.S. intelligence experts need global situational awareness as well as military, intelligence, and humanitarian mission planning that involves timely access to geospatially accurate 3D object data, IARPA officials say.

The CORE3D program has two aims: automated ways to create timely 3D models that capitalize on spectral, textural, and dimensional information from satellite data; and automated ways to recognize and understand objects in satellite reconnaissance data.

The manmade objects that the CORE3D program will model are invariant and relatively large, such as buildings, roads, walls, bridges, towers, dams, or other static structures.

The program will use simplified 3D representation such as constructive solid geometry (CSG), where 3D shapes are built from Boolean operations on simple shape primitives, such as cubes, cylinders, or spheres to fit and store the geometry of 3D models. IARPA experts will provide a core library of 3D shape primitives to all performers.

The CORE3D program focuses on wide-area manmade object recognition and scene understanding. Proposed methods shall demonstrate that they can automatically recognize, tag, and update predefined object categories from satellite imagery.

Similar to the targets of the physical models, the object categories for functional modeling shall consist of static structures such as communication towers, airfields, power plants, water towers, lighthouses, schools, and hospitals.

IARPA researchers want industry to develop customized learning frameworks optimized for satellite imagery and multi-modal data fusion. Researchers particularly are interested in hybrid approaches that do not rely on just one computer vision or learning modality.

Researchers are interested in satellite panchromatic, multispectral, point clouds, and maps; multi-level fusion to include data-level, feature-level, and decision-level fusion; object-level segmentation and classification; point cloud generation from multiview satellite images; representations of complex scene geometry; accurate 3D model fitting and statistical inferencing; a deep learning framework optimized for satellite imagery scene recognition; and hybrid image understanding module using deep learning, traditional, and new image-understanding algorithms.

E-mail questions or concerns to dni-iarpa-baa-16-06@iarpa.gov.

MORE INFORMATION IS online at *https://www.fbo.gov/notices/d84464082e32a0567bde08ea38d5042a*.

Raytheon to help Army develop new long-range artillery rocket

BY JOHN KELLER

REDSTONE ARSENAL, Ala. — U.S. Army fire-support experts are choosing Raytheon Co. as one of two or more companies to begin developing a new long-range artillery rocket with a maximum range of 300 miles to replace the Army Tactical Missile System (ATACMS).

The Raytheon Missile Systems segment in Huntsville, Ala., will offer a new missile design for the Army's Long-Range Precision Fires (LRPF) program, Raytheon officials say. The Army terminated ATACMS production in 2007.

Raytheon will be one of two or more companies to begin developing an LRPF system that is compatible with launchers for the Army's M270A1 Multiple Launch Rocket System (MLRS) and M142 High Mobility Artillery Rocket System (HIMARS).

Army leaders plan to downselect the LRPF program to one contractor in late 2018 or 2019 for full-scale development, and begin producing the new system by late 2021 or 2022. Lockheed Martin Corp., the ATACMS contractor, and the Boeing Co. reportedly also are interested in the LRPF program.

The LRPF program is intended to provide battlefield commanders with around-the-clock, all-weather, long-range fire support without placing aircraft and crews at risk.

Raytheon and any future LRPF contractors will conduct competitive subsystem risk reduction activities to mature the rocket motor and warhead technology. Two or more contractors will build competitive LRPF prototypes through the program's technology maturation and risk reduction phase.

Raytheon will compete with other U.S. defense contractors to develop a new long-range artillery rocket with a maximum range of 300 miles to replace the Army Tactical Missile System (ATACMS), shown above.

Army officials are trying to keep their options open on whether to perform a service life extension of the Lockheed Martin ATACMS program, restart the ATACMS production line, develop a new missile to replace ATACMS, or consider systems built by U.S. allies.

The amount of the contract to Raytheon was not released. The Army Contracting Command at Redstone Arsenal, Ala., awarded the contract to Raytheon on behalf of the Precision Fires Rocket and Missile Systems Project Office of the Army Aviation & Missile Command's Program Executive Office for Missiles and Space.

FOR MORE INFORMATION visit **Raytheon Missile Systems** online at *www.raytheon.com*.

UUVs hit their stride

New designs in autonomous submersibles for military applications are setting new standards for long-endurance power storage and stealthy propulsion for surveillance, mine warfare, and anti-submarine warfare operations.

BY **J.R. Wilson**

The Echo Voyager large UUV from Boeing is helping develop power storage and propulsion technologies for future long-endurance UUV operations.

Unmanned underwater vehicles (UUVs) have been compared to cats' whiskers as extended sensors, although they could more accurately be compared to catfish barbels, whisker-like feelers loaded with tiny taste buds and olfactory sensors to help the fish survive in dark, murky waters.

UUVs are the undersea cousins of unmanned aerial vehicles (UAVs), but are running two decades or more behind UAVs in development and military implementation — a situation U.S. Navy officials say is about to change.

"The key technologies for UUVs in general really can be categorized in autonomy and power, which have had the most focus in the last few

years," says Dan Tubbs, deputy director of sea & land at Boeing Phantom Works in Huntington Beach, Calif. "Battery power is one of the keys, but other things are being looked at by ONR [Office of Naval Research] and other companies, such as fuel cells, aluminum power capability, air-independent power, etc.

"You see a lot of AUVs [autonomous undersea vessels] in oil and gas today, where a commercial surface ship will launch a UUV to traverse the sea floor and bring data back," Tubbs continues. "In the military world, work is going on with Knifefish [General Dynamics], which would use UUVs to do mine reconnaissance on the sea floor. That and other programs are really doing recon, but other work is being done to keep people out of dangerous locations, such as disabling [underwater] mines."

A key difference between military UAVs and UUVs is communications, Tubbs adds: "UAVs have evolved rapidly in direct communication with people on the ground while flying. For UUVs, there is no real high-bandwidth communications path for that kind of direct link. So while AUVs will follow, to a large degree, the path forged by UAVs, there still needs to be significant work on how to talk to those vehicles, especially in terms of weaponized UUVs. ISR [intelligence, surveillance, and reconnaissance], whether below water or on the surface, is absolutely viable for UUVs today, although they still have to overcome communications limitations."

The counter-UUV challenge

A small business innovation research solicitation last year gave a detailed Navy description of the requirements for advancing and deploying next-generation UUV technologies to counter emerging threats, including enemy UUVs:

"New or improved sensing concepts and technologies are needed to better recognize the presence of UUVs operating in ports and harbors, particularly in the proximity of U.S. Navy ships and submarines," the solicitation stated. "The maturity and proliferation of UUVs throughout the world is presenting an emerging

challenge for force protection in harbor environments. It is important to counter sensor-laden units that do not present a direct threat, but an armed UUV presents a particularly compelling challenge. The mobility of UUVs limits the effectiveness of traditional mine countermeasures, like change detection."

Ships tied up in harbors are stationary and inviting targets for UUV sensors or weapons. "The stationary nature of the assets that are being protected in harbors allows for slow and deliberate approaches by enemy platforms," the solicitation states. "Current strategies for detecting and classifying UUVs employ systems that were originally designed to detect combat swimmers and scuba divers. A number of these systems have demonstrated some capability against UUV targets that were presented in a controlled research environment, but the typical warning ranges do not provide a completely satisfactory response window. It is envisioned that a multimodal layered approach has the potential to significantly increase the average response window available to counter UUV approaches to U.S. Navy assets."

Given the ubiquity of and nearly universal reliance on UAVs after 15 years of constant combat development, it may be hard to remember the scant military interest in unmanned aircraft decades ago. Military interest in UAVs did not start rising until scientists at the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., noted Israeli efforts to remove human pilots from dangerous reconnaissance missions. As a result, DARPA began a series of small research programs.

It has been a similar challenge for UUVs and their proponents, especially given many years of predominantly land warfare and air-dominance operations. UUV interest revived, however, in the wake of a deadly small boat terrorist attack on the destroyer USS Cole in the Yemen harbor at Aden in 2000.

The GhostSwimmer UUV from Boston Engineering is designed to mimic the behavior and movement of a fish to preserve stealth for military missions like surveillance, mine countermeasures, port security, and similar defense and homeland security applications.

Growing interest in UUVs

UUV interest later increased with feigned Iranian attacks on U.S. ships in the Persian Gulf, constant threats against naval and commercial shipping by North Korea, the growing U.S. face-off with China in the Western Pacific, pirates off the coast of Africa, and even the use of relatively primitive semisubmersibles by drug smugglers off U.S. coasts in the Atlantic, Pacific, Caribbean, and Gulf of Mexico.

"Unmanned capabilities have a high value in removing the risk to humans, but the success of these technologies in UAVs has made it a much more mainstream option for UUVs," notes Aaron Heisler, mechanical engineering manager at embedded computing specialist Extreme Engineering Solutions (X-ES) in Middleton, Wis. "Regardless of the mission — SIGINT, offensive, communications — once we have the capabilities to perform those without putting humans at risk, our regional influence will not be restricted by very expensive manned platforms.

"There has been a very significant interest in the latest processors for prepackaged small-form-factor solutions, the goal being to improve the prime's capability, cost- and schedule-wise," Heisler continues. "Expectations following creation of N99 [Unmanned Warfare Systems Directorate] to push these technologies in this application space is for significant advancement and more military and government interest in UUVs. I think we're approaching the threshold where UAV success and widespread acceptance are opening the door for UUVs. The creation of the new office should ensure those technologies will see significant investments in the future."

DARPA continues to lead military research of future technologies and missions for unmanned marine vehicles that operate on the surface or under the water. One of DARPA's high-profile research programs is the Anti-Submarine Warfare [ASW] Continuous Trail Unmanned Vessel (ACTUV) program to develop an unmanned surface vessel (USV) optimized to track quiet diesel-electric submarines

persistent to limit the submarine's tactical capacity for surprise.

"We're looking for test-ready, multi-sensor approaches that push the boundaries of today's automated sensing systems for unmanned surface vessels," DARPA Program Manager Scott Littlefield says. "Enhancing the ability of these kinds of vessels to sense their environment in all weather and traffic conditions, day or night, would significantly advance our ability to conduct a range of military missions."

Next is the DARPA Blue Wolf to develop UUVs with inherent operational and tactical advantages like stealth and surprise. Blue Wolf also is an attempt to introduce fundamentally new UUV designs.

Overcoming size and weight

Today UUV size, weight, and volume are constrained by their launch and recovery systems. UUV range, moreover, is limited by the amount of energy available for propulsion and the power necessary to maintain underwater speeds. Current state-of-the-art energy sources are limited by safety and certification requirements for host platforms.

In September 2015, the Naval Undersea Warfare Center (NUWC) in Keyport, Wash., awarded $2.5 million Blue Wolf contracts on behalf of DARPA to Boeing Defense, Space & Security in Huntington Beach, Calif., and to Lockheed Martin Mission Systems and Training in Riviera Beach, Fla. They joined the Charles Stark Draper Laboratory in Cambridge, Mass., which won a $3.7 million Blue Wolf contract, and Applied Physical Sciences (APS) Corp. in Groton, Conn., which won a $3.1 million Blue Wolf contract.

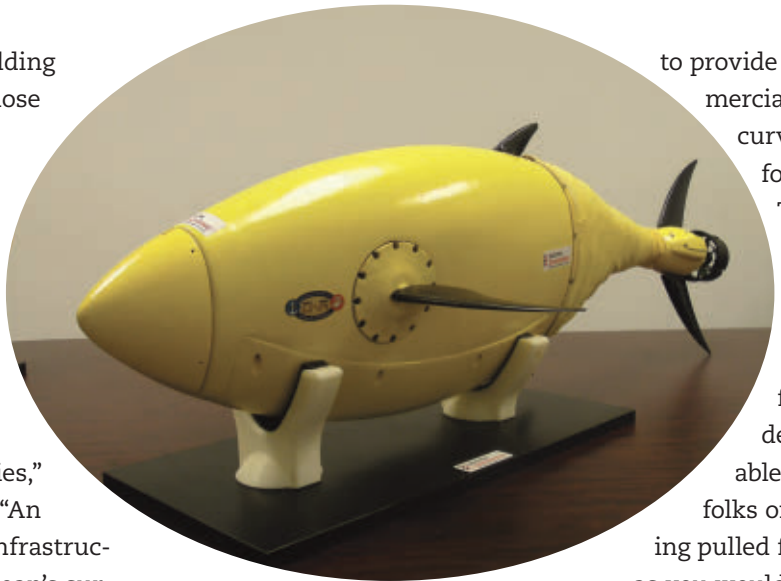
DARPA also is working on the Hydra Distributed Undersea Network to create a force multiplier that enables rapid, scalable, and cost-effective deployment of capabilities much faster and more cost-effectively. U.S. Navy assets must cover vast regions of interest around the globe even as force reductions and fiscal constraints continue to shrink fleet sizes. To maintain an advantage over adversaries, the Navy must project key capabilities in multiple locations at once, without the

time and expense of building new vessels to deliver those capabilities.

"The climate of budget austerity runs up against an uncertain security environment that includes natural disasters, piracy, ungoverned states, and the proliferation of sophisticated defense technologies," DARPA's Littlefield says. "An unmanned technology infrastructure staged below the ocean's surface could relieve some of that resource strain and expand military capabilities in this increasingly challenging space."

Rear Adm. Mathias Winter, chief of the Office of Naval Research (ONR) in Arlington, Va., and Navy Secretary Ray Mabus also have touted development of a UUV that can operate underwater for long periods without refueling.

The program-of-record in that regard is the Large-Displacement UUV (LDUUV), a naval prototype that would use new energy technologies to enable months of operations in the littorals without returning to port or being directed from a mothership. According to ONR documents, "new energy sources for UUVs will increase the current energy density significantly, allow for quick recharge or refueling, operate at an acceptable cost level, and enable pier-to-pier operation with months of endurance."



The BIOSwimmer UUV from Boston Engineering, a biologically inspired UUV built to resemble a tuna fish, is designed for inspecting ships, securing ports, and marine maintenance.

UUV mothership

While Boeing has been one of the contractors bidding to be prime on the LDUUV, the company's Phantom Works in Huntington Beach, Calif., has moved ahead using company money to develop just such a vessel: the Echo Voyager, which rolled out on 10 March 2016 and is scheduled to begin sea trials off the California coast this summer.

"The Navy is changing its acquisition approach and we're waiting to see how that plays out," says Boeing's Tubbs about LDUUV, but adds Boeing is moving forward with its in-house-funded program. "Around 2010, we embarked on developing a concept for something that could change the paradigm on how UUVs operate in terms of increasing their legs so they could be out for weeks or months at a time instead of only two or three days. And removing UUVs from the tyranny of the host platform, which limits UUV size as well as redundancies and fault tolerance onboard.

"With invested Boeing money to change the UUV paradigm, how UUVs are utilized in commercial, military, and science markets, to provide a change to the commercial off-the-shelf (COTS) curve on how to use UUVs for important missions," Tubbs says. "We believe we have taken a large step. We've also done work on how to support the UUV in the field; Echo Voyager is designed so it is supportable and maintainable by folks on the pier without being pulled from the water, much as you would a manned submarine, which makes it much more economical to utilize."

With its hybrid rechargeable power system and modular payload bay, the 51-foot Echo Voyager follows earlier Boeing UUV designs, such as the 32-foot Echo Seeker and 18-foot Echo Ranger, but is the company's first to offer fully autonomous, long-duration capability with sufficient payload space for a wide range of missions.

While it is too early for customer contracts on the Echo Voyager, Tubbs says if they received an order today, they could deliver the first vessel in 24 months or less and, without significant additions to the facility, produce at least two a year at Huntington Beach.

Master plan for UUVs

While the current version of "The Navy Unmanned Undersea Vehicle Master Plan" is classified, the publicly released 2004 version listed 11 mission categories for UUV operations: intelligence, surveillance, and reconnaissance; mine countermeasures; anti-submarine warfare; inspection/identification; oceanography; communications/navigation

network node; payload delivery; information operations; time-critical strike; barrier patrol for homeland defense and force protection; and sea base support.

Accomplishing so wide a variety of missions will require the same kind of developmental work that has gone into UAVs since the terrorist attacks of 9/11, with many of those able to transfer directly or with only minor modifications to UUVs.

One potential use for the UUVs would be to act as an undersea warning and control system — a submersible version of the U.S. Air Force Airborne Warning and Control System (AWACS) surveillance and air traffic and control system jet. "A UUV with an AWACS capability for subs to surface ships is a possibility, as is expanding communications, where multiple services engaged simultaneously may not always work," says Joe Eicher, business development manager at embedded computing specialist Kontron in Poway, Calif.

Eicher also cites the Northrop Grumman Battlefield Airborne Communications Node (BACN) as a future candidate for UUVs. The BACN, he says, "can serve as a translator between communications technologies. You can see a UUV designed to bridge gaps in hardware and feature interoperability in a similar manner. Battery power will be a very important part of the future of UUVs. If the battery runs out before it gets home, it might sink and become a target for enemy recovery. So intelligent power management would have to be employed in a UUV, including knowing when to return to base."

One issue with UUVs continues to be size. "These vehicles have been around for some time on the commercial and research sides, but are a relatively recent endeavor on the military side to develop on a scale large enough to be of use to the Navy," Kontron's Eicher says.

"It seems like a natural evolution from all the work that has been done on UAVs, but developing underwater capability for military use is relatively new," Eicher adds. "There have been proof-of-concept efforts, such as Echo Ranger, but I think we're now moving beyond the point where we showed

something to the Pentagon, only to see it mothballed, to actually moving forward with development and deployment."

Open-systems electronics

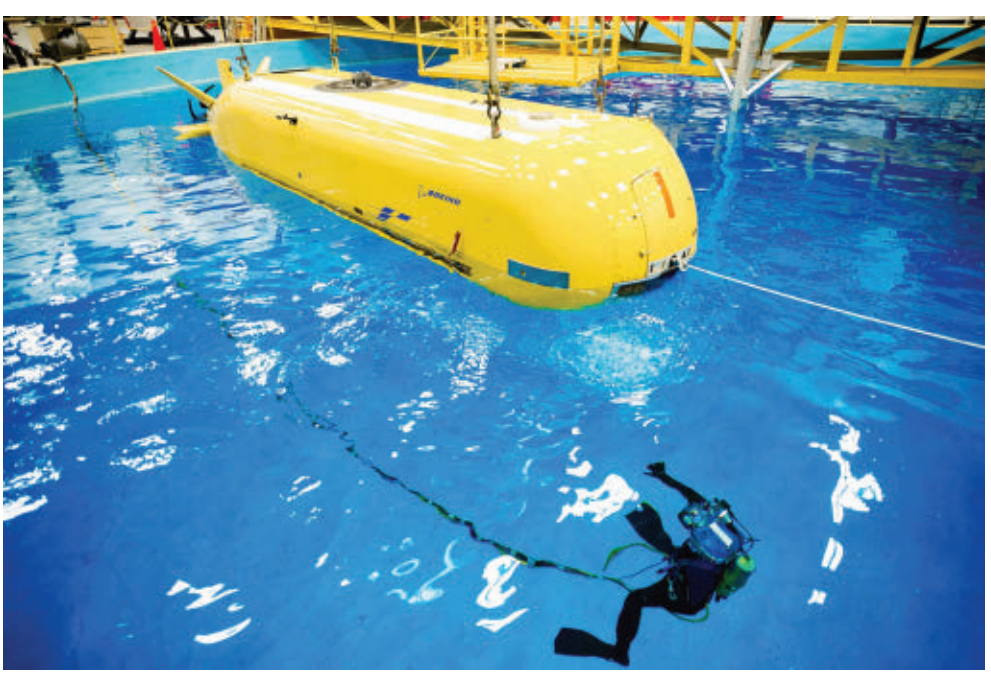
A new entrant into the UUV market is North Atlantic Industries (NAI) in Bohemia, N.Y. For the past year NAI engineers have been adapting their company's boxes, boards, and I/O for a classified mine-hunting UUV program. Their overall UUV efforts include onboard equipment to analyze sensor data, gauge strain, and measure water temperature, says Lino Massafra, NAI's vice president of sales and marketing. While most of that data is used on and by the UUV, NAI also can provide Ethernet communications back to a manned vessel.

"The entire architecture we're offering for the UUV market is the same as we offer for custom-on-standard-architecture [COSA] for all our customers," Massafra explains. "That fits in nicely with the integrated modular architecture some U.S. Department of Defense people have been resisting but now are beginning to understand the threats are changing, almost monthly, and if it takes five to 10 years to bring a new program out, we don't have that kind of time anymore."

NAI engineers capitalize on the company's expertise in modular electronics architectures to adapt components and subsystems to UAV applications. "A modular architecture helps us pick and choose how to configure a system and, with very little if any non-recurring engineering, we can turn things around and populate systems with specific I/O functions and processing to meet specific requirements as part of our accelerated time-to-market," Massafra says. "That's our COSA approach. Customers can do everything in-house, which is very expensive, or go full COTS, which makes you dependent on others. We bring together the best of both worlds, with a custom solution using COTS products under COSA."

Component companies such as NAI and Kontron must maintain a constant vigil on the emergence of new chips with higher efficiency, higher channel count, better resolution, and higher speed that can be used in future products.

"The key thing is there are only a limited number of configurations in a fixed-box design as opposed to our COSA approach," Massafra notes, adding a warning that the federal government may be making it easier for other nations to close the technology gap, including UUVs. "What's preventing the U.S. from moving forward is budget cuts and so many rules and regulations being put in place that limit the innovative aspects of small businesses such as ours," he asks. "They may only want to buy five pieces from us off-the-shelf, but then when they want more they are asking us to justify earned value management and a lot of other paperwork."



Medium- to large-sized UUVs designed by Boeing are demonstrating enabling technologies for a future UUV mothership that could deploy smaller UUVs or even unmanned aircraft for wide-area surveillance.

Homeland security concerns

ONR and the U.S. Department of Homeland Security Science & Technology Directorate (DHS S&T) are supporting the advancement of two related products at the Boston Engineering Corp. Advanced Systems Group in Waltham, Mass.

The first is GhostSwimmer, a stealthy biomimetic UUV for military missions like surveillance, mine countermeasures, port security, and similar defense

and homeland security initiatives. The other is BIOSwimmer, a biologically inspired UUV built to resemble a tuna fish. It has broad commercial and homeland security applications like inspecting ships, securing ports, and marine maintenance.

"Unmanned systems directly support our sailors, making their jobs easier, more efficient, and, ultimately, a more effective combat team," says Navy Rear Adm. Robert Girrier, director of the Navy's N99 office of unmanned weapon systems.

"As unmanned systems continue to come online and mature, we're changing how we think and how we operate, so we're not just reacting to the challenges we face today, but focusing creativity and initiative to ensure we prevail in the future," Girrier says. "I remain committed to developing and integrating unmanned systems into our broader warfare areas."

The Boeing Echo Voyager is one of the largest UUVs ever developed and is expected to be a prototype for future generations of UUV motherships and long-range submersible surveillance craft.

A wide range of companies are looking to get a piece of what is

seen as a major growth market in the coming decade, not only vessel manufacturers, but sensor, power, communications, and other mission-support technologies and components. German-based Kontron AG, for example, offers control, guidance, sonar, and other components to UUV primes.

"The common thread of interest on anything unmanned is safety critical," says Kontron's Eicher. "If you have a zone where you don't want to risk collisions, you want the UUV to operate in a safety-critical mode. Anytime you have any kind of unmanned vehicle making decisions as it moves along, you want to be very, very sure it won't damage anything or risk lives. That has to be a mechanism that not only detects a problem, but has a fallback position, such as shutting down and floating to the surface.

"There also are questions about throughput — how many cores can we provide, what is our thermal efficiency — so it meets their envelope for environmental operability," Eicher continues. "Can it withstand the pressures in which it operates? What is the total load of the processor? How do we feed that out? The Navy also will want to maintain very tight-loop security on UUVs so the enemy cannot employ any countermeasures to usurp functionality or spoof us with erroneous data.

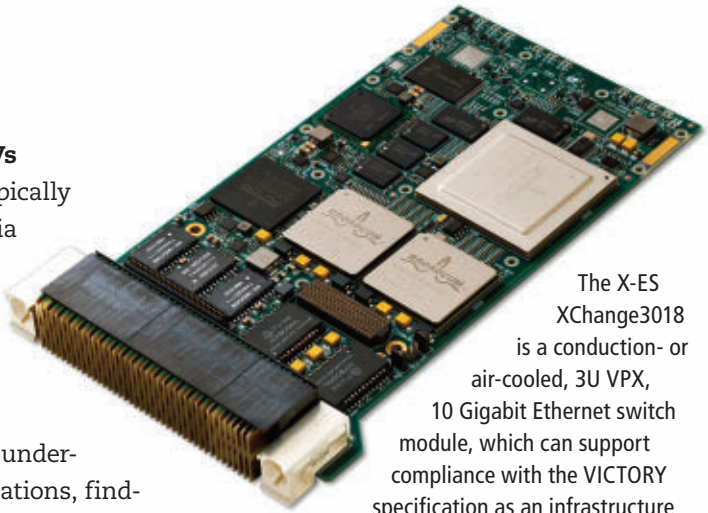
"UAVs have been around a long time now and more effort has been applied to making future generations stealthy," Eicher says. "That also seems a logical step for UUVs, applying sister technologies similar to UAVs."

Networking UUVs

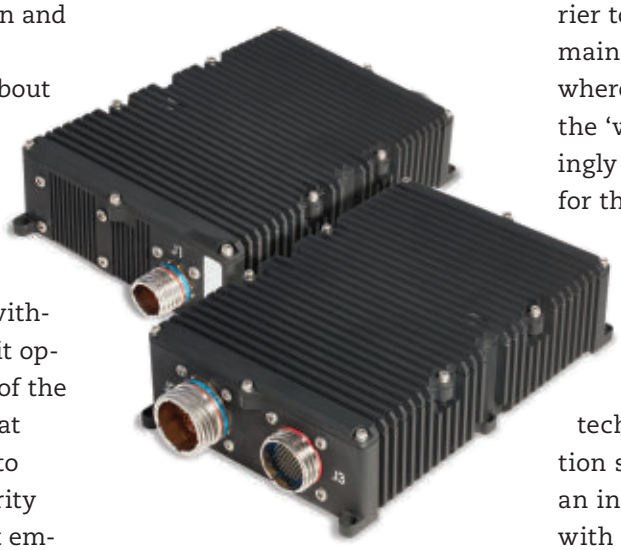
Today's UUVs typically receive control via data link from a manned surface ship or submarine. Due to the relatively short range of underwater communications, finding a UUV could make it easier to backtrack it to that vessel, no matter how stealthy it might be.

That is one benefit of long-endurance autonomous undersea vessels (AUVs), such as the proposed LDUUV or Boeing's Echo Voyager, which operate independent of and far from their controllers.

At a 29 January 2016 event cohosted by the U.S. Naval Institute and the Center for Strategic and International Studies, Girrier described how his new office fits into the Navy's other staff centers — Amphibious Warfare Directorate (N95), focused on ship-to-objective maneuver; Surface Warfare Directorate (N96), implementing a distributed lethality concept; Undersea Warfare Directorate (N97), working to achieve undersea dominance; and Air Warfare Directorate (N98), which will build the airwing of the future.



The X-ES XChange3018 is a conduction- or air-cooled, 3U VPX, 10 Gigabit Ethernet switch module, which can support compliance with the VICTORY specification as an infrastructure switch and router in UUV applications.



The XPand6000 series networked embedded computing product from X-ES can be deployed quickly into a wide variety of manned and unmanned applications.

"It is the future. It is not at the expense of, it is not in replacement of — it is a complement to [the other warfare directorates]," Girrier told the conference. "The domain is the enabler; the domain is where the vehicle [operates], where the 'what' plays out. It's increasingly about 'how' and 'how fast' for that larger end-state. So I think there's a greater realization of cross-boundaries.

"We are living in a world that is connected more than ever with the surge of technology and rapid information sharing. We are also living in an increasingly dangerous world with contested regions on the sea, in the air, under the sea, and in cyberspace. My job, drawing on fleet experience, is to see how unmanned systems and technology can help solve problems we face in contested regions around the world. How can unmanned systems help leverage the capabilities of our ships, submarines and aircraft?"

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Beating the heat in high-performance embedded computing

Today's high-performance processors are generating more heat than ever before, which forces embedded computing designers to take a systems approach that makes thermal management just as important as processors, circuit cards, and chassis.

BY **John Keller**

Designers of high-performance embedded computing (HPEC) systems are up against a wall of heat that comes from a cascade effect of customer demands for ever-smaller size and higher performance. Typically these two factors — small size and high performance — conspire to create unprecedented amounts of heat in HPEC systems, which if not managed properly can slow down systems, reduce product life cycles, or risk catastrophic failures in military mission- and life-critical systems.

As a result, systems designers have to take much more of a high-level engineering approach than they had to 10 or 15 years ago. Electronics thermal management isn't just about blowing air or conducting heat anymore. Systems designers must consider using exotic and proprietary cooling techniques, a widening variety of standardized cooling approaches, and sometimes blending several different cooling techniques in the same system to achieve size and performance goals. At a minimum, designers no longer can consider thermal management as an afterthought.

"I've been doing thermal management for the last 20 years, and thermal engineers need to be more multidisciplinary now; know size, weight, power, and cost (SWaP-C) approaches; and work more closely with the processor designers," says Ivan Straznicky, technical fellow in the strategic planning office of the Curtiss-Wright Corp. Defense Solutions Division in Ashburn, Va.

When it comes to thermal management, there is a world of difference for embedded computing designers today than there was even a few years ago, experts say. "Today we have about 50 percent more heat to get out of the system than just five years ago," says Brian Hoden, principal mechanical engineer at Abaco Systems Inc. (formerly GE Intelligent Platforms) in Huntsville, Ala.

This 3D-printed, air-flow-through cooled chassis from Curtiss-Wright is lightweight enough for fixed-wing aircraft and helicopters that require high-performance embedded computing.

"Ten years ago we had to remove about 20 watts of heat from 3U-type cards, and five years ago it was 50 watts per card," Hoden says. "Now we are looking at close to 80 watts

per 3U VPX card." Embedded systems generate about 1 watt of heat for each watt of power the system consumes, Hoden explains. "Power consumption on a board gets transferred to a heat load," he says. "It is about a one-to-one ratio; if a card draws 60 watts of power, you have to dissipate 60 watts of heat."

As difficult as the thermal-management challenges are for embedded systems designers, it just looks like things will get tougher in the future. "The Intel processors are getting smaller and hotter, and offer a lot more functionality; that's the trend," Hoden says. "If you can put a lot more on a board, you have to remove more heat."

With today's systems complexities, designers must consider thermal management as part of the overall system, rather than something that they can take care of near the end of the process. "Everything we do in thermal management is a systems approach," says Mike Shorey, director of mechanical engineering at Mercury Systems in Chelmsford, Mass. "The densities at the chip level have increased, the power has increased, and the size of the system has decreased. Cooling now is system level, where it used to be board level."

Getting the heat out

Removing heat from embedded computing cards and chassis, at least in theory, is limited only to the designer's imagination. Embedded systems designers can use forced air, heat conduction, a variety of liquid cooling approaches, and even refrigerated air conditioning to get heat off the cards and out of the box. Sometimes a combination of all or several of these alternatives can meet the challenge.

Practical considerations, however, quickly narrow down the designer's options. The customers who specify embedded systems have stringent requirements for small size and weight, low power consumption,

and competitive pricing. This can make for a tricky balancing act.

Making the wrong choices could be disastrous. Design something that runs too hot, and processors start to throttle-back, which compromises performance. Overheated embedded systems also can cause maintenance headaches when heat-stressed components wear out more quickly than anticipated. Worse, heat can cause system failures at the worst possible times.

The bottom line is removing heat from electronics today is just as important, and just as challenging, as deciding on circuit board form factors, processors, and stiffening approaches to ruggedize boards and chassis.

"Managing the heat load is difficult, and we are having to re-evaluate how we do thermal designs to be more strategic about it," says Abaco's Hoden. "A gap pad that we used in the past won't suffice now. We are looking at heat pipes, vapor chambers, pyrolytic graphite layers, and enhanced wedge locks."

Electronics cooling for systems thermal management essentially comes down to three approaches: convection cooling, or removing heat with air; conduction cooling, or removing heat to ambient outside air; and liquid cooling, or removing heat to flowing inert fluids like 3M Fluorinert.

While these three thermal-management approaches may sound simple, the real challenges lie in the details of how engineers implement them. Creative systems designers also find that sometimes the best approaches involve blending more than one approach to electronics cooling.

Convection cooling

For many embedded computing systems managing heat with blowing air — or convection cooling — is the simplest and least expensive way to cool hot components like microprocessors. There are problems with blowing air, however — particularly when operating in environments with dirt, dust, contaminants, explosive vapors, humidity, or salt spray are present; no one wants to channel damaging elements into an embedded computer. In addition, blowing air requires moving parts like fans, which are subject to wear-out at the worst possible times.

As a result, many mission- and life-critical, convection-cooled systems require the use of redundant fans and system monitoring not only to determine if a fan has gone out, but also to track environmental conditions and predict when fans might be under heavy stress or are nearing the end of their lives. This can add to system size, complexity, and price.

There are rugged fans available, for example, from several companies like AMETEK Rotron Inc. in Woodstock, N.Y., which offers a high-output version of the company's MIL-XTM fan that is optimized for heat sink and heat exchanger thermal management applications in harsh military, aerospace, and industrial environments.

Abaco has worked together with the General Electric Research Center in Schenectady, N.Y., to invent an unorthodox, small, rugged solid-state fan called Dual Cool Jet that is a piezoelectric cooling device that moves two parallel surfaces in a kind of bellows effect to blow a small puff of air at very high velocities.

"We're looking at close to two times thermal improvement," says Abaco's Hoden. "If you could do 50 watts convection at 71 degrees Celsius, then you could increase that from 50 watts to 100 watts heat load in the chassis and still maintain 71 degrees C ambient." Dual Cool Jet technology has no spinning parts like a conventional fan, so it's very reliable, and very lightweight, Hoden says.

The piezoelectric fan measures 1.5-millimeters thick, and today is manufactured under license to GE by Aavid Thermalloy LLC in Laconia, N.H.

One convection-cooling approach for high-performance embedded computing involves the VITA 48.1 VPX standard from the VITA Open Standards, Open Markets trade association in Oklahoma City. VITA 48.1 defines embedded computing architectures using 3U and 6U VPX air-cooled circuit cards. It uses cooling air that flows directly over the components and circuit boards.

Blowing air directly over circuit cards in an embedded computing system also can require use of conformal coatings to protect sensitive electronic components from contaminants, which can add cost and complicate future systems upgrades.

A second convection-cooling approach for military HPEC systems is VITA 48.5, which defines a mechanical standard for electronic plug-in units using air-flow-through cooling. It uses a compact core heat exchanger inside the central heat sink of the unit, rather than air blown directly over the boards like VITA 48.1 does.

"A VITA 48.5 system is where you

have a fan that moves air down individual card heat sinks, so you cool the center of the cards in a chassis," explains Abaco's Hoden. "The main benefit is getting the air down a heat frame so you get the air close to the hot items like processors." Abaco has delivered a full-up VITA 48.5 system "with very hot cards" to an aerospace and defense customer, Hoden says. The system has eight 6U VPX cards that generate upwards of 100 watts each.

Blended cooling

Many of today's high-performance embedded computing systems blend convection and conduction cooling. Systems designers sometimes use conduction cooling inside the chassis, move heat to the chassis wall, and then go to convection cooling by blowing air over the hot chassis walls to cool the system.

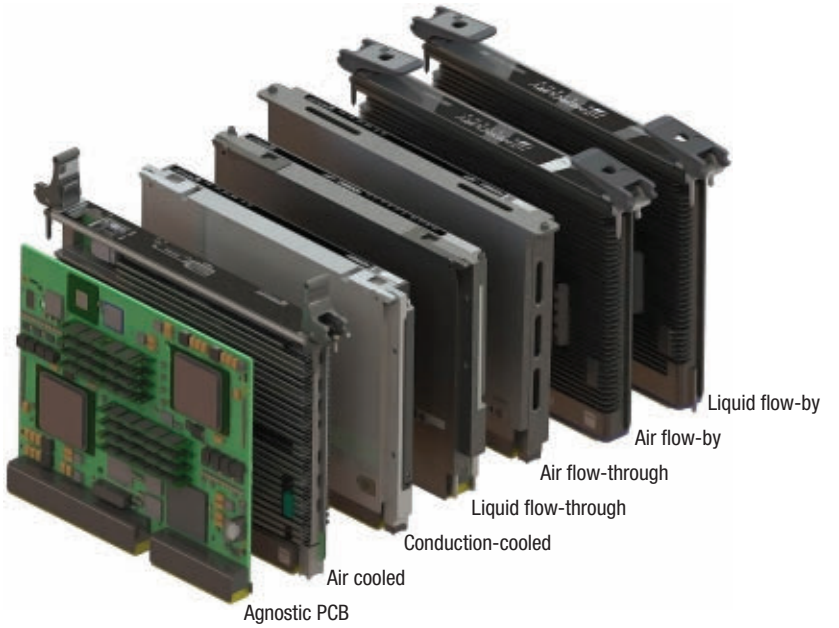
Two design guidelines with growing popularity that take this hybrid approach that blends conduction and convection cooling are the VITA 48.7 air-flow-by (AFB) cooling standard and the VITA 48.8 air-flow-through (AFT) standard.

VITA 48.7 applies to 6U and 3U VPX embedded computing boards, and uses convection heat transfer to cool plug-in modules while shielding circuit boards and backplanes from the cooling air by using plates with apertures for backplane connectors over the backplane.

VITA 48.8 AFT technology, meanwhile, applies to 3U and 6U VPX circuit cards and eliminates the use of wedge locks and ejector-injector handles, does not use module-to-chassis conduction cooling, and promotes use of new lightweight plastic or composite chassis to reduce system weight.

"Air-flow-by uses an air high-pressure differential to create high-velocity turbulent air between modules. Thermal management is built into the covers so it is a clamshell approach," explains Mercury's Shorey. Mercury is the primary developer of the technology that VITA 47 covers.

"All modules are segregated, and we have to look at the whole system to squeeze out every last bit of performance," Shorey says. "It adapts



Mercury Systems is developing a standard architecture that can mix and match convection-, conduction-, and liquid-cooled embedded computing technologies, or come up with several different combinations.

and modifies itself. Higher-performance processors get more air than the lower-power components, so it basically self-balances."

Air-flow-by technology also can enable systems designers to adapt to operating environments with low air flow, such as high altitudes, or high air flow, such as ground-level applications. "We can manage about 200 watts per slot with air flow by, and we believe we could manage over 300 watts per slot with this technology," Shorey says. "It comes down to the amount of air you have," he says, adding that limiting factors for this technology primarily are altitude and maximum ambient temperature.

A similar electronics cooling approach that blends conduction and convection cooling is VITA 48.8 air-flow-through technology. This approach also uses blown air to cool protected circuit cards, and can blend air-cooled and conduction-cooled modules in the same chassis, explains Curtiss-Wright's Straznicky.

"The air-flow-through alternative allows you to design and deploy a combination of chassis that have conduction and air-flow-through modules in the same chassis," Straznicky says. "Where you don't need the most efficient thermal management, you can use the conduction, and on the hotter boards you could use air flow through. Your DSP [digital signal processing] cards will be the high-power modules, and are perfect candidates for air flow through, while general-purpose processors, I/O cards, or switch modules could use conduction cooling."

Curtiss-Wright has demonstrated a VITA 48.8 3D-printed electronics chassis for 3U and 6U computer boards with AFT cooling. The company's 3D-printed plastic chassis is integrated with Curtiss-Wright's VPX3-1258 single-board computer and VPX3-716 graphics modules, both outfitted with AFT frames.

Curtiss-Wright designers plan to demonstrate a functional 3U AFT chassis sometime this spring that is able to run applications while cooling two VPX modules. Curtiss-Wright has delivered commercial off-the-shelf (COTS) 3U AFT embedded computing cards to its lead customer.

The advantages of a lightweight 3D-printed chassis are reduced weight for size, weight, power, and cost (SWaP-C)-constrained platforms, such as helicopters and unmanned vehicles.

VITA 48.8 also supports alternative air-flow arrangements, allowing air inlet at both card edges. Because VITA 48.8 does not use module-to-chassis conduction cooling, it also promises to help drive innovative use of new lightweight plastic or composite material-based chassis.

Conduction cooling

With all the hybrid thermal-management technologies available today, like VITA 48.7 and VITA 48.8, conduction cooling still has its place in aerospace and defense high-performance embedded computing. The implementations are changing, but the principle is the same: conduct heat away from sensitive components out to the ambient air.

One of the innovators in conduction cooling is Thermacore in Lancaster, Pa., which specializes in heat pipes, vapor chambers, and graphite, a solid material that can improve

the heat-spreading properties of metal, yet is extremely light weight.

Heat pipes are sealed copper cylinders containing a small amount of water that help channel heat from hot components inside the chassis out to the edge of the chassis walls. As components heat up, the water inside the sealed heat pipe goes through evaporation and condensation cycles to move the heat, explains Greg Baldassarre, Thermacore's vice president of sales and marketing.

Another conduction-cooling alternative from Thermacore is a variant of the heat pipe called a vapor chamber, Baldassarre says. The vapor chamber is a double-walled, sealed surface with water inside that works on the same evaporation-condensation principle as the heat pipe, but is larger and more efficient at lateral spreading of heat than the heat pipe.

"The vapor chamber is one continuous chamber, rather than discrete heat pipes, which is more efficient," Baldassarre says. "It uses a top and bottom lid, but is the same principle of a sealed chamber, yet with a different geometric shape."

Vapor chambers can measure as small as a couple of inches rectangular, or could be 20 by 20 inches, Baldassarre says. In addition to its thermal characteristics, vapor chambers also can be designed rugged to resist the effects of shock and vibration in military systems. Vapor chambers and heat pipes also lend themselves to future systems upgrades because they can act as drop-in replacements for aluminum heat spreaders.

Graphite heat-spreading material, like heat pipes and vapor chambers, also can improve the heat-spreading properties of metal, yet is more lightweight than chambers or pipes.

Rugged fans like this MIL-XTM from AMETEK Rotron Inc. in Woodstock, N.Y., are available for use in harsh military, aerospace, and industrial environments.

"The biggest advantage of graphite is low mass," Baldassarre says. "Gravitational forces are not factors in graphite. It acts like metal, and is very popular in space applications because it is lightweight. It also is popular in fighter aircraft because it is impervious to G forces." The F-35 joint strike fighter uses graphite for cooling, he says.

When and where to use heat pipes, vapor chambers, and graphite depends on the system at hand. "The design tradeoffs are how far you have to distribute the heat, versus how much mass your system can tolerate. Heat pipes carry heat the farthest, vapor chambers are a little shorter, and graphite is a little shorter than that," Baldassarre says. "The lowest cost is heat pipes, then moves through vapor chambers, and then to graphite as the most expensive."

Custom solutions

Sometimes the demands for high performance in embedded computing call for custom conduction-cooling solutions for the highest-performing systems. General Micro Systems Inc. (GMS) in Rancho Cucamonga, Calif., has designed a solution called RuggedCool for use in extreme cases where standard VPX cooling simply does not work, says GMS President and CEO Ben Sharfi.

For extremely hot components like the Intel Xeon server-class chip, the GMS RuggedCool technology, which relies on liquid silver not only to move heat away from the processor, but also to cushion the processor from the effects of shock and vibration.

Essentially the RuggedCool approach uses one surface of copper, one surface of aluminum, and sandwiched in-between is a layer of silver. "We transfer heat through one side copper, and one side aluminum," Sharfi explains. "The space between the aluminum and copper we fill with liquid silver, which next to copper is the best thing to remove heat, but is not electrically conductive. Silver melts at 40 degrees Celsius, and as soon as it melts it gives you one to one-half thousandths of an inch thickness perfectly controlled. Now the heat goes from the processor to the heat spreader that connects to the silver. That transfers the heat to the aluminum, and we transfer it outward."

Using materials like liquid silver makes it clear that the RuggedCool technology is expensive, but is intended for applications for which nothing else will suffice.

Navy orders backpack electronic warfare jammers to counter IEDs

U.S. military explosives-disposal experts are ordering additional electronic warfare (EW) jammers for deployed infantry warfighters to counter improvised explosive devices (IEDs) in dangerous parts of the world. Officials of the Naval Surface Warfare Center (NSWC) in Indian Head, Md., have announced a $29.5 million contract modification to Sierra Nevada Corp. in Sparks, Nev., for an undetermined number of the AN/PLT-5 IED electronic jammer to support explosive ordnance-disposal personnel. The order from the NSWC Explosive Ordnance Disposal Technology Division is a modification to an original $14.1 million contract awarded to Sierra Nevada in 2009 for AN/PLT-5 IED jammers. This contract modification is to extend the ordering period and exercise option year five for the procurement and support of the transmitting set. The AN/PLT-5 is a man-portable system designed to assist experts from the U.S. Joint Service Explosive Ordnance Disposal (JSEOD) Counter Radio Controlled Improvised Explosive Device Electronic Warfare (CREW) program.

Air Force eyes interoperable data links for new and legacy jet fighters

BY **John Keller**

HANSCOM AFB, Mass. — U.S. Air Force researchers are reaching out to industry to find companies able to design an advanced version of the 5th to 4th Gen Gateway that enables jet fighters of different generations to share a common picture over different tactical data links.

Officials of the Air Force Life Cycle Management Center at Hanscom Air Force Base, Mass., issued a sources-sought notice for Increment II of the 5th to 4th Gen Gateway.

The second-increment system must enable fifth-generation fighters like the F-22 and F-35 to share a common battlespace picture over different tactical data link as the first increment does, but also must have an infrared search and track (IRST) sensor as a stealthy alternative to radar to scan the skies for enemy aircraft.

The second-increment system also must have a means for maintaining satellite communications (SATCOM) during air combat, as well as the ability to create a secure common tactical picture that blends information from the F-22's inflight data link (IFDL), the F-35's multifunction advanced data link (MADL), IRST sensors, National Technical Means (NTM), and legacy Link 16 that is accessible to aircraft using Link 16.

IFDL, MADL, and Link 16 refer to airborne information-distribution data links that enable combat aircraft to share sensor information in a common tactical picture.

The Air Force is looking for digital data links that will connect legacy aircraft like the F-15 fighter shown above with next-generation aircraft like the F-35 Joint Strike Fighter.

The legacy Link 16 is a U.S. and NATO military tactical data exchange network for aircraft, ships, ground forces, and smart munitions. In addition to creating a common tactical picture, Link 16 enables military forces working together to share text messages, imagery, and digital voice communications. Aircraft that use Link 16 include the F-15, F-16, Eurofighter, F/A-18, and Mirage 2000 jet fighters. One problem with Link 16, however, is its RF signature, which the enemy can use to detect and track Link 16-equipped aircraft.

The Air Force F-22 Raptor jet fighter uses IFDL, which provides a low-probability-of-detection and low-probability-of-intercept inflight data link. The F-35 uses MADL, a fast switching narrow directional communications data link. The problem is that Link-16, IFDL, and MADL are not compatible.

Air Force experts have tried to bridge the compatibility gap between the three data links with the first increment of the 5th to 4th Gen Gateway, which has been demonstrated by

several contractors, including Boeing, Lockheed Martin, and Northrop Grumman.

Air Force experts also want the second-increment 5th to 4th Gen Gateway to have beyond-line-of-sight access to national data service providers, and a multi-level security track correlation and data fusion processor, connected to several different data domains.

The new system should be able to provide a radio solution guaranteeing interoperability with F-22 over the IFDL data link, and F-35 over the MADL data link, as well as support for IFDL Block 3.1, Block 3.2A, Block 3.2B, and Widenet Reuse; current and future MADL releases; radio interoperability between F-22 and F-35 aircraft; configuration management of the IFDL and MADL waveforms; and DD Form 254 requirements.

Air Force officials would like to demonstrate the next-generation 5th to 4th Gen Gateway aboard an F-15C jet fighter.

Companies interested should e-mail white papers and questions to the Air Force's Lori-Ann Dionne (lori-ann.dionne@us.af.mil) and Gregory Bailey (gregory.bailey.9@us.af.mil). ←

MORE INFORMATION IS online at *https://www.fbo.gov/spg/USAF/AFMC/ESC/TBD0001/listing.html.*

Navy orders 48 sophisticated electronic warfare jammers for Navy combat jets

BY **John Keller**

Exelis continues to produce the latest version of the AN/ALQ-214 airborne electronic jammer for the U.S. Navy F/A-18 jet fighter-bomber.

PATUXENT RIVER NAS, Md. — Electronic warfare (EW) experts at Exelis Inc. in Clifton, N.J., will provide the U.S. Navy with 48 sophisticated EW systems designed to protect Navy combat aircraft from incoming radar-guided missiles.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $88.3 million contract option to Exelis to build 48 full-rate production lot 13 AN/ALQ-214(V)4/5 integrated defensive electronic countermeasures jammer systems for the Navy's F/A-18C/D and F/A-18E/F Hornet and Super Hornet carrier-based strike fighters.

The AN/ALQ-214(V)4/5 is an electronic jammer component of the integrated defensive electronic countermeasures system (IDECM), which comes to the Navy from a joint venture of Exelis and BAE Systems. It protects Navy fighter-bombers from radar-guided surface-to-air and air-to-air missiles by jamming the enemy missile guidance systems. Exelis is a wholly owned subsidiary of Harris Corp. in Melbourne, Fla.

Last July, Exelis won a $97.3 million contract to build 46 AN/ALQ-214(V)4/5 IDECM jammers for Navy combat jets. This latest order brings the value of the contract to $185.6 million for a total of 94 AN/ALQ-214(V)4/5 systems.

The ALQ-214 component of the IDECM EW system has been delivered to the Navy as well as to the Royal Australian Air Force for contemporary versions of the Boeing F/A-18 fighter-bomber. The system blends sensitive receivers and active countermeasures to form an electronic shield around the aircraft, Exelis officials say.

The RF countermeasure system engages incoming missiles autonomously with a series of measures designed to protect the aircraft from detection.

The AN/ALQ-214(V)4 is a smaller and lighter version of its predecessors, and has an open-architecture design that is ready for integration on several different kinds of aircraft.

The system is designed to counter radar-guided anti-aircraft missiles with electronic countermeasures (ECM) techniques that deny, disrupt, delay, and degrade the enemy missile launch and engagement sequence. The system identifies, ranks, and counters incoming missiles, and displays engagements to the flight crew for situational awareness.

Exelis will do the work in Clifton, N.J.; San Jose, Calif.; San Diego; Rancho Cordova, Calif.; Mountain View, Calif.; Hudson, N.H.; and other U.S. locations, and should be finished by December 2018. ←

FOR MORE INFORMATION visit **Exelis** online at *www.exelisinc.com.*

Kratos target drones put advanced air-to-air missiles through their paces

Unmanned target drone designers at Kratos Defense & Security Solutions Inc. in Sacramento, Calif., will provide the U.S. Air Force with 21 BQM-167A Air Force Subscale Aerial Target (AFSAT) drones under terms of an $18.7 million contract modification. Officials of the Air Force Life Cycle Management Center at Eglin Air Force Base, Fla., are asking Composite Engineering for AFSAT Lots 11-13 production. The BQM-167A AFSAT is a high-performance, remotely controlled subscale aerial target drone that helps prove the value of advanced air-to-air weapons. Air Force weapons experts use the AFSAT target drone to support the Air-to-Air Weapon System Evaluation Program and other Air Force and U.S. Department of Defense air-to-air test and evaluation programs. Composite Engineering builds the BQM-167A of carbon fiber and epoxy-based materials that help increase performance and endurance compared to previous targets, which were built mainly of aluminum, Air Force officials say. The BQM-167A can reach speeds from 230 to 600 knots true airspeed at sea level with a maximum speed of 0.92 Mach. The drone can fly at altitudes from 50 feet above ground level to 50,000 feet mean sea level. Maneuvers include G-turns to 9Gs, and other aerial acrobatic turns that emulate high-performance jet fighter aircraft. ←

DARPA eyes bistatic sonar with UUV-based pingers to preserve submarine stealth

BY **John Keller**

ARLINGTON, Va. — U.S. military researchers are asking for industry's help in developing a bistatic sonar system for anti-submarine warfare (ASW) that capitalizes on the benefits of active sonar without compromising the stealth of U.S. attack submarines.

Officials of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va., released a solicitation (DARPA-BAA-16-10) for the Mobile Offboard Command and Control and Approach (MOCCA) program.

DARPA's MOCCA program seeks to enable manned Navy submarines to use active sonar pings from nearby unmanned underwater vehicles (UUVs) to detect and track enemy submarines at long ranges without giving away their presence to potentially hostile vessels.

Traditional active sonar bounces sound waves off of submarines, surface warships, and other objects for detection and tracking. The problem with active sonar, however, is it's like shining a flashlight in a darkened room: it can find objects effectively, but gives away its presence and forfeits any pretense of stealth.

Passive sonar, on the other hand, simply listens for sounds from enemy submarines or surface ships. It's not as effective or as efficient as active sonar, but it preserves stealth and can keep the submarine's presence secret from the enemy.

Bistatic sonar using sonar transmitters aboard a UUV and sonar receivers aboard nearby attack submarines, however, has the potential to gain the best of both worlds.

As long as attack submarine crews have precise knowledge of the position of the pinging UUV, then they can detect the presence of enemy submarines based on sonar sound returns, and track its movements with accuracy. Moreover, attack submarines can keep their locations secret.

The DARPA MOCCA program seeks active sonar solutions that will mitigate the limits of passive submarine sonar sensors, researchers say. The objective is to achieve significant standoff detection and tracking range by using an active sonar projector deployed offboard a submarine and onboard a UUV.

The submarine will need the ability to coordinate the operational functions of the supporting UUV. Thus, the program also must demonstrate reliable clandestine communications between the host submarine and support-

ing UUV without sacrificing submarine stealth.

The program is looking for companies to develop compact active sonar sources, signal processing, and secure undersea communications technologies for an offboard UUV in direct support of submarine ASW operations.

DARPA researchers expect to spend as much as $12 million on the first phase of the MOCCA program, and award several different contracts. Ultimately the program could have three phases over more than four years, depending on how successful the first phase is.

The first phase will last for 15 months and will involve preliminary designs for innovative sonar and communications concepts, as well as subsystem prototype demonstrations to validate design approaches.

The MOCCA program has two key technical challenges: an active sonar pinger small enough for UUVs, as well as signal processing; and a secure communications link to enable the host submarine to control the UUV at significant distances.

DARPA researchers want an active sonar with an active sonar projector small enough for UUV operations; and bistatic active sonar processing. This will involve developing high-output transducer materials, and a sonar projector that is as energy-efficient as possible.

Researchers want the ability to focus the projected acoustic signal in a direction of interest. The goal is to produce practical and flexible designs for the projector that can scale for several different UUVs and deployment options.

Military researchers are trying to enable unmanned submersibles like the REMUS 6000, shown above, to use active sonar while preserving the stealth qualities of manned submarines.

In addition to a small and power-efficient sonar projector, or pinger, researchers are looking for bistatic sonar processing advancements in reverberation and clutter rejection, as well as precision localization capability.

The host UUV will be no larger than 21 inches in diameter.

The system will be operated in bottom-limited acoustic environments, so projected sound will scatter and produce reverberation and signal loss. Scattered sound inadvertently may illuminate the host submarine and possibly compromise stealth, so researchers want detailed and accurate predictions of the acoustic environment to manage the sonar and potential exposures.

Researchers also need a secure and reliable communications link to provide positive control of a UUV and its sonar payload operating at a significant distance from its host submarine. The communications link also must be able to communicate information generated on the UUV back to the host platform.

An ideal link would have a low probability of intercept and of exploitation and provide high link reliability. The MOCCA communications link cannot degrade submarine stealth.

Companies interested were to have submitted proposals by 15 March 2016. E-mail questions or concerns to DARPA at DARPA-BAA-16-10@darpa.mil.

MORE INFORMATION IS online at *https://www.fbo.gov/spg/ODA/DARPA/CMO/DARPA-BAA-16-10/listing.html*.

Navy orders 16 additional electro-optical submarine masts for U.S. submarine fleet

U.S. Navy undersea warfare experts are ordering 16 non-penetrating electro-optical sensor submarine masts from L-3 KEO in Northampton, Mass., for Virginia-class, fast-attack submarines, and for other kinds of modern submarines without traditional periscope wells. The Naval Sea Systems Command in Washington announced a $12 million contract to L-3 KEO to provide 16 Universal Modular Mast (UMM) systems for Navy submarines. The Virginia-class is one of the first submarines without a traditional optical periscope that penetrates the vessel's pressure hull and extends upward to enable commanders of submerged submarines to view the scene on the surface. Rather than raising a large periscope from a well inside the submarine's pressure hull, the UMM uses fiber-optic connections between sensors and the submarine. The UMM serves as a lifting mechanism for five different sensors including the photonics mast program, high-data-rate mast, multifunctional mast, multifunctional modular mast, and integrated electronics support measures mast. Users control the UMM with a computer game-like joystick and channel its imagery to digital displays in the submarine's control room as well as to other displays distributed throughout the vessel.

Optical warfare takes big step forward with Navy CESARS contracts

BY **John Keller**

VIEWPOINT — We've been talking about the notion of optical warfare now for nearly 20 years, yet while most topics on optical warfare largely have been theoretical, a couple of new programs are making this emerging discipline a lot more real.

The latest developments revolve around a U.S. Navy research program called Combined EO/IR Surveillance and Response System — or CESARS for short. This initiative seeks to develop an electro-optical shipboard defense system to protect surface warships from missiles, fast attack boats, unmanned aerial vehicles (UAVs), and other optically guided threats.

The CESARS program has two parts, and research contractors are lined up for both of them. We'll know by the end of this decade how promising the enabling technologies those contractors are developing will be.

The first part of the CESARS program is the Shipboard Panoramic EO/IR Cueing and Surveillance System — better-known as SPECSS — while the other part is the Multispectral EO/IR Countermeasures for Advanced Threats project, or MEIRCAT.

L-3 Cincinnati Electronics in Mason, Ohio, won a $9 million contract in early February to develop the SPECSS portion of the CESARS program, while the Lockheed Martin Laser and Sensor Systems segment (formerly Aculight) in Bothell, Wash., won a $10.6 million contract earlier this month to develop MEIRCAT.

Together, SPECSS and MEIRCAT are expected to develop core enabling technologies for comprehensive shipboard defenses against optically guided threats.

For SPECSS, L-3 Cincinnati Electronics engineers are developing an enhanced electro-optical and infrared (EO/IR) countermeasure and situational awareness capability that performs wide field-of-view target detection and tracking and then cues MEIRCAT high-resolution sensors.

For MEIRCAT, meanwhile, Lockheed Martin is developing capabilities for target re-acquisition, tracking, classification, identification, 3D ranging, threat assessment, countermeasures execution, and countermeasures effectiveness monitoring (CMEM). MEIRCAT also will offer multi-band capability against many different fast incoming targets during the same engagement.

Shipboard defenses that work at the speed of light: perhaps those will come in handy as U.S. adversaries develop hypersonic anti-ship missiles that streak through the air at speeds approaching eight times the speed of sound.

Even more intriguing than the quantum leap in shipboard defenses

Shipboard defenses like the Rolling Airframe Missile, shown above, could become much more effective with new ship electro-optical defense systems.

that SPECSS and MEIRCAT might offer is the prospect of how these and other optical warfare technologies might evolve in the future. More to the point, I'm thinking about how the mature principles of electronic warfare (EW) might apply to the emerging principles of optical warfare.

Electronic warfare pertains to the radio-frequency (RF) spectrum, and involves offensive and defensive military operations that emit or receive RF energy. It seeks to enable the use of RF sensors like radar and RF communications like radios, while denying any enemy the use of RF systems through electronic jamming, eavesdropping, or special missiles that home-in on radar and communications signals.

Now let's apply that to optical warfare. It would follow that optical warfare pertains to the optical spectrum, and involves offensive and defensive military operations that emit or receive optical energy. Optical warfare seeks to enable the use of optical sensors like visible-light and infrared cameras, infrared guidance systems, and laser range finders, while denying the enemy use of optical systems through optical jamming, eavesdropping on laser and other optical communications, or special missiles that home-in on visible-light or infrared guidance systems.

Now look at the CESARS programs and its components. SPECSS is developing an EO/IR countermeasure (jammer), as well as target detection, tracking, and sensor cueing. MEIRCAT is developing EO/IR target tracking and ranging, countermeasures execution (jammers or anti-optical weapons), and countermeasures effectiveness monitoring (weapons damage assessment). Sounds an awful lot like what we expect from EW, except in the optical spectrum.

We have electronic warfare systems today — the HARM missile comes to mind — that are designed to detect, locate, and attack RF emitters. How long will it take to develop optical warfare systems that detect, locate, and attack optical sensors and emitters? From the sound of it, this won't take long.

It's likely that very soon the notion of optical warfare won't simply be a matter of conjecture. ←

Honeywell to replace ring laser gyros to keep Navy AN/WSN-7 functioning

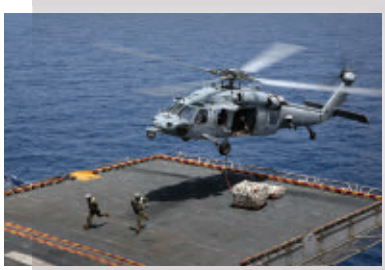
Navigation and guidance specialists at Honeywell International's Aerospace segment in Minneapolis are building three configurations of ring laser gyros for the U.S. Navy's AN/WSN-7(V) maritime navigation system. Officials of the Land and Maritime segment of the U.S. Defense Logistics Agency in Mechanicsburg, Pa., announced a 3-year $38.9 million contract to Honeywell Aerospace to produce the gyros, which will be spares for navigation systems aboard Navy surface warships and submarines. The AN/WSN-7 is a self-contained, ring laser gyro inertial navigation system that senses ship motions; computes the ship's precise position, velocity, attitude, heading, and rates in digital and analog formats; and forwards the data to other vital ship systems. It has been designed as a replacement for spinning-mass gyro navigation equipment aboard Navy warships. The AN/WSN-7 passive shipboard navigation system calculates and indicates ship's position, attitude, heading, and velocity in relation to the Earth's rotation. It senses motion, gravity, and Earth rotation, and receives externally supplied GPS updates and ship's speed through the water. The standard shipboard configuration consists of two independent cabinets for redundancy and survivability. It is not be susceptible to jamming or detection by enemy forces. ←

PRODUCT applications

AVIONICS

Lockheed Martin to provide avionics cockpits for Saudi Arabian MH-60R military helicopters

Helicopter avionics experts at Lockheed Martin Corp. will provide cockpit avionics for 10 MH-60R Seahawk multimission military helicopters under terms of a $117.2 million contract modification.



Officials of the U.S. Naval Air Systems Command at Patuxent River Naval Air Station, Md., are asking the Lockheed Martin Mission Systems and Training segment in Owego, N.Y., to build and deliver 10 MH-60R mission avionics systems and common cockpits for the government of Saudi Arabia under the Foreign Military Sales (FMS) program.

The MH-60R, also operated by the U.S. Navy, is the latest version of the Sikorsky Seahawk. It is based on the U.S. Army Sikorsky UH-60 Black Hawk utility helicopter, as well as on a member of the Sikorsky S-70 family. The multimission helicopter has sophisticated sensors, and is designed for anti-submarine and anti-surface warfare, operating from frigates, destroyers, cruisers, and aircraft carriers.

Its avionics include the Enhanced Advanced Flight Control System with naval modules and coupled hover capability, as well as four our 8-by-10-inch color multifunction mission displays that are sunlight readable and night-vision device capable. The MH-60R cockpit has secure VHF/UHF communications; an inertial navigation system; satellite communications; data link; and accommodation for forward-looking infrared sensors and night-vision goggles. The MH-60R uses many sensors, including the ASE package, MTS-FLIR, the AN/APS-147 multi-mode radar/IFF interrogator, an advanced airborne fleet data link, and an airborne active sonar. The helicopter includes instrumentation based on the MH-60S glass cockpit, and uses digital monitors instead of an array of gauges and dials.

Lockheed Martin will do the work in multiple U.S. locations and Ciudad Real, Spain, and should be finished by April 2019.

FOR MORE INFORMATION visit **Lockheed Martin Mission Systems and Training** online at *www.lockheedmartin.com/us/mst*.

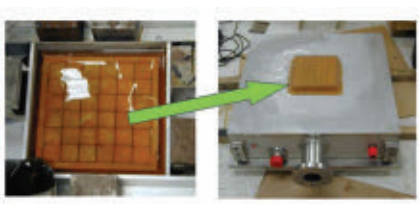
ADHESIVES AND ENCAPSULANTS

Navy chooses adhesive from Alfa for underwater transducers and hydrophones

U.S. Navy undersea warfare experts needed an acoustically transparent adhesive encapsulant for underwater transducers and hydrophones. They found their solution from Alfa International in Woonsocket, R.I.

Officials of Naval Undersea Warfare Center (NUWC) Newport in Middletown, R.I., are working with Alfa to commercialize the company's NUWC XP-1 high-performance polyurethane to protect marine acoustic and optical equipment.

Almost all acoustic projectors and hydrophones are encapsulated in polymeric materials to protect them from water while allowing acoustic energy to pass without significant reflection, loss, or distortion. To do this, these undersea devices need materials for acoustical performance with properties like density and sound speeds close to those of seawater; low mechanical loss tangent; medium to high shear loss tangent; low shear storage modulus; Poisson's ratio near 0.50; and no major polymeric transitions in or near the frequency and temperature ranges of interest.



Alfa's NUWC XP-1 offers these properties, officials say. The adhesive uses a toluene diisocyanate/polyether polyol base (molecular

weight about 1500) and dimethylthiotoluenediamine as the cross-linking and curing agent.

The two-part polyurethane exhibits good hydrolytic stability and exceptional acoustic properties while also being optically clear, NUWC officials say. Unlike other encapsulates, NUWC XP-1 can be cured at room or elevated temperatures in less than 24 hours.

"Navy chemists and material scientists first developed the polyurethane known as NUWC XP-1 in the 1990s," says NUWC Commander Capt. Howard Goldman. "NUWC Newport has continued investment to optimize the formulation for protection of equipment such as sonar transducers from damage caused by water seepage in the undersea environment."

Alfa International will manufacture and offer the product for sale to government and commercial customers.

NUWC XP-1 cures overnight at room temperature to 75 Shore A hardness. Its sound speed is very close to that of seawater at room temperature, and at 25/spl deg/C, its acoustic impedance is 1.71/spl times/10/sup 6/ metric Rayls.

NUWC XP-1 exhibits a sub-ambient glass transition temperature (-31/spl deg/C) and its dynamic mechanical properties are almost ideal for underwater transducer/hydrophone encapsulants, experts say.

A distinct benefit to the industry is that the chemical formula of NUWC XP-1 is controlled by the U.S. Navy. The material is made from basic raw materials, thus its future availability is more assured than many other commercial products.

FOR MORE INFORMATION visit **Alfa International Corp**. online at *www.alfaadhesives.com*.

RUGGED COMPUTERS

OSI to provide rugged laptop computers for Navy mission planning

Experts at OSI Federal Technologies in Aldie, Va., will provide the U.S. Navy with commercially available rugged laptop computers under terms of a $7.9 million contract.

Officials of the Naval Air Warfare Center Aircraft Division in Lakehurst, N.J., are asking OSI Federal to provide 759 laptop computers, with options for as many as 2,605, to serve as mission planning systems for Navy aircraft pilots.

The contract also calls for OSI Federal to provide 100 to 248 spare hard drives, as many as 88 docking stations, and 450 carrying cases. OSI Federal competed for this contract with eight other companies, officials say.

OSI Federal specializes in providing technology products and services to federal government customers including major systems integrators that support federal agencies. The company provides custom configuration of computer systems, software, and peripherals, with an emphasis in rugged and secure computing.

The Naval Air Warfare Center Aircraft Division-Lakehurst at Joint Base McGuire-Dix-Lakehurst is responsible for Navy aircraft launch and recovery equipment and support equipment. The division's mission, the Aircraft Platform Interface (API), assures that fixed-wing aircraft and helicopters operate safely and effectively from aircraft carriers, air-capable ships, and expeditionary airfields worldwide.

Among suppliers to OSI Federal are Cisco Systems Inc. in San Jose, Calif.; Belkin International Inc. in Playa Vista, Calif.; CIS Secure Computing Inc. in Dulles, Va.; Getac USA in Irvine, Calif.; Advanced Design Corp. in Lorton, Va.; Panasonic in Secaucus, N.J.; Thuraya Telecommunications Co. in Dubai, United Arab Emirates; Tresys Technology LLC in Columbia, Md.; Citrix Systems Inc. in Fort Lauderdale, Fla.; SYNNEX Corp. in Fremont, Calif.; Crystal Group in Hiawatha, Iowa; and Lexmark International Inc. in Lexington, Ky.

FOR MORE INFORMATION visit **OSI Federal Technologies** online at *www.osifederal.com*.

CHEMICAL DETECTION

Army orders handheld chemical warfare detectors from Smiths Detection

U.S. Army chemical defense experts needed additional chemical warfare detectors to help protect warfighters and emergency responders from chemical and industrial toxic agents. They found their solution at Smiths Detection in Edgewood, Md.

Officials of the Army Contracting Command, Aberdeen Proving Ground, Md., announced a $17.1 million contract modification to Smiths Detection for 2,092 M4A1 joint chemical agent detectors.

The contract also calls for Smiths Detection to provide 2,088

communication adapter kits and 10 platform interface kits. Smiths Detection is a Part of Smiths Group plc.

The M4A1 JCAD is based on the Smiths Detection LCD 3.3 detect-to-warn device that protects troops or emergency responders by sampling the air for chemical warfare agents and toxic industrial chemicals.

The device is a pocket-size, rugged, handheld detector that automatically detects, identifies, and alarms to chemical warfare agents and toxic industrial chemical vapors.

The unit weighs less than two pounds, and can be worn or carried by troops without obstructing their primary duties. Members of the U.S. military services can use the system on vehicles, at fixed sites, and on individuals designated to operate in chemical threat areas. The system can operate in a general chemical warfare environment, and can undergo conventional decontamination procedures.

The unit offers instant feedback of hazards and real-time detection of nerve, blister, and blood agents. It is network-ready with the common chemical, biological, radiological, and nuclear standard interface.

Procurement of the JCAD began in 2008, and procurements of the relatively new unit based on the Smiths Detection LCD 3.3 began in 2011.

FOR MORE INFORMATION visit **Smiths Detection** online at *www.smithsdetection.com*, or the **Army Contracting Command** at *www.army.mil/acc*.

DATA STORAGE

Air Force chooses Gatekeeper video recorders for AC-130 gunship

U.S. Air Force reconnaissance and surveillance experts needed high-definition (HD) digital airborne video recorders for use with an electro-optical sensor payload on the Air Force AC-130 gunship. They found their solution from Gatekeeper Systems Inc. in Abbotsford, British Columbia.

U.S. Air Force officials, through Sterling Computers in Dakota Dunes, S.D., is buying 25 Gatekeeper Viperfish SDI-1 HD airborne digital video recorders for roughly $350,000 for use with the MX-15Di digital multi-sensor, multi-spectral airborne imaging system from L-3 Wescam in Burlington, Ontario.

The Air Force chose the Viperfish HD video recorder to capture 720-pixel or greater resolution video over an HD SDI interface from L3 Wescam's MX-15Di sensor, Gatekeeper officials say.

Other requirements included synchronized audio, carry-on/carry-off external storage media and various military standards, including MIL-STD-461F electromagnetic interference/conductance (EMI-EMC) and MIL-STD-810G environmental including explosive atmosphere.

The Viperfish HD video recorder, from Gatekeeper's Deep Development Corp. division in Abbotsford, British Columbia, records 720-by-486-pixel video at 30 frames per second with zero latency, company officials say.

It combines a 1 GHz processor, the Linux real-time operating system, and wavelet compression, and enables users to view and record video simultaneously. It has a minimum of a 100-gigabyte hard drive and USB 2.0 removable drive. It has 10/100 megabit Ethernet and operates in temperatures from -20 to 70 degrees Celsius.

The L3 Wescam MX-15Di electro-optical sensor pod is for medium-altitude covert intelligence, surveillance, and reconnaissance and search-and-rescue missions and homeland security applications aboard aerostats, fixed-wing aircraft, helicopters, and unmanned aerial vehicles (UAVs).

The airborne sensor pod has visible-light and infrared cameras; multispectral imaging that blends matched images from several sensors to uncover detail in each frame; enhanced local area processing (ELAP); real-time image enhancement to enhance contrast during the day, at night, and in low light; high-performance haze penetration; solid-state inertial measurement unit (IMU); and works in several digital and analog output formats. ←

FOR MORE INFORMATION visit Gatekeeper Systems online at *www.gatekeeper-systems.com*, **Deep Development Corp.** at *www.deepdevelopmentcorp.com*, or **L-3 Wescam** at *www.wescam.com*.

new PRODUCTS

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

ADHESIVES

Electronics tape for military wire and cable repairs introduced by TE

TE Connectivity in Harrisburg, Pa., is introducing Raychem S1260 Hot-Melt tape electronics adhesive for high-temperature wire and cable repairs for ground-defense and aero-

space applications. The S1260 tape uses an environmentally resistant modified fluoropolymer for sealing high-temperature, heat-shrink components to backshells, and is suited for power cables with fluoropolymer and fluoroelastomer insulations and jackets. The fluid-resistant tape adheres to polytetrafluoroethylene (PTFE) insulation and may be used to repair high-temperature power cables. The tape, which measures three-fourths of an inch wide, cures with a heat gun, and is for wrapping, while minimizing the amount of wasted material.

FOR MORE INFORMATION visit **TE Connectivity** online at *www.te.com/adhesives*.

RUGGED COMPUTERS

Rugged tablet computer for harsh environments introduced by Getac

Getac Inc. in Irvine, Calif., is introducing the RX10 portable, lightweight rugged tablet computer for field service in harsh environments. The Getac RX10 combines an Intel Core M processor with a 10.1-inch liquid crystal display, which operates in wet environments while using a stylus, digitizer, or gloves. The rugged tablet measures 0.74 inches thick and weighs 2.65 pounds. It offers the Getac LifeSupport hot-swappable battery, which lasts as long as eight hours on a charge, and users can swap the main battery and replace it with a fresh battery without shutting the computer down. The rugged tablet includes an optional front-facing HD camera, 1D/2D barcode reader, USB 3.0/2.0 ports, micro HDMI port, and headphone/microphone combo. On the tablet's backside are an 8-megapixel camera and

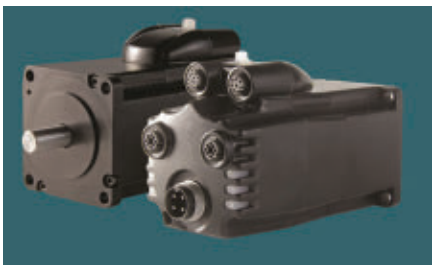
POGO-style dock connector pins. The computer operates in temperatures from -5.8 to 131 degrees Fahrenheit, and is certified to MIL-STD 810G and IP65 to survive drops, vibration, water, dust, and extreme temperatures.

FOR MORE INFORMATION visit **Getac** online at *www.getac.com*.

MOTION CONTROL

Smart motor for motion control in test equipment offered by Moog

Motion-control experts at Moog Animatics in Milpitas, Calif., are introducing the standard Class 6 SmartMotor for material handling, testing equipment, packaging machinery, manufacturing equipment, and spooling and winding machinery. The Class 6 Ethernet/IP SmartMotor is available in standard servo and hybrid smart motor versions, and includes PROFINET and EtherCAT versions, and extends the industrial Ethernet SmartMotor with Ethernet/IP position controller capability. The Class 6 Ethernet/IP SmartMotor integrates as a position controller device for access to SmartMotor commands and parameters; improved uptime and optional redundant cabling through device level ring (DLR); optimal performance ensured through quality of service (QoS); and simplified, modular programming through add on instructions (AOI).



FOR MORE INFORMATION visit **Moog Animatics** online at *www.animatics.com*.

RUGGED DATA STORAGE

Self-encrypting drive for rugged data storage introduced by Phoenix

Phoenix International Systems Inc. in Orange, Calif., is introducing self-encrypting drive (SED) technology support for its RPC24 4004 series drive magazine-based, rugged data storage solution. The Phoenix International RPC24 4004 series supports TCG-compliant and FIPS 140-2 certified AES 256 encryption as well as instant secure

erase when configured with solid-state disks and hard disk drives with these capabilities. The Phoenix International RPC 4004 series is available in configurations for 2.5-inch SSDs and 2.5-inch HDDs. Each RPC24 converged interface storage array includes two four-port controllers and can be configured in the field with eight 16-gigabit Fiber Channel ports, eight 10-gigabit iSCSI ports, or a combination of four 16-gigabit Fiber Channel and four 10-gigabit iSCSI ports. These storage arrays are backward-compatible with 8-gigabit/4-gigabit Fiber Channel and 1-gigabit iSCSI networking, such as switches and host bus adapters. The RPC24 4004 12-gigabit SAS models are backward-compatible with 6-gigabit SAS investments. All 4004 models are meta-data compatible with previous generation RPC24 arrays, so that customers can accomplish data-in-place migration by simply upgrading to 4004 generation controllers.

FOR MORE INFORMATION visit **Phoenix International** online at *www.phenxint.com*.

RUGGED COMPUTERS

Fanless mini PC rugged computer introduced by Stealth

Stealth.com, a Sparton company in Woodbridge, Ontario, is introducing the LPC-720F Fanless Mini PC rugged computer with built-in dual expansion slot capability for demanding military applications. The LPC-720F can be configured with two PCI slots or two PCI Express x1 expansion slots for data acquisition, specialized graphics cards, and expanded I/O cards. Optionally, dual solid-state drives (SSD) also can be configured to give expanded internal storage capacity. Stealth's LPC-720F minicomputer operates without cooling fans that could draw in dirt and dust. Stealth's fanless com-

puters are encapsulated in a rugged extruded-aluminum chassis performing as a heat sink to dissipate heat build-up and provide noise-free operation.

FOR MORE INFORMATION visit **Stealth** online at *www.stealth.com*.

CHASSIS AND ENCLOSURES

ATCA chassis with 400 watts per slot cooling introduced by Pixus

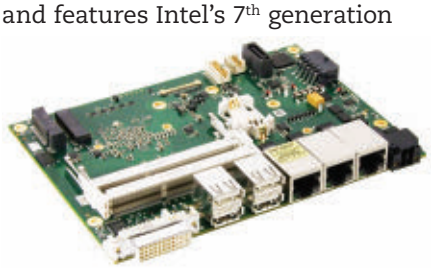
Pixus Technologies in Waterloo, Ontario, is introducing a 15U AdvancedTCA (ATCA) embedded computing chassis that exceeds 400 watts per slot cooling capability and meets Network Equipment-Building System (NEBS) requirements. The embedded computing chassis has the ability to cool the chassis with a fan tray removed for two minutes and remaining within FCC acoustic requirements for Db levels. The Pixus chassis is designed to provide at least 400 watts per slot while meeting compliance criteria and recommended practices. The Pixus chassis leverages the original Kaparel design, and provides more air evacuation using the next generation of reverse impeller hot-plug cartridges. The RiCool III blowers feature 185 cubic feet per minute of airflow per fan with 71-millimeter H20 of static pressure.

FOR MORE INFORMATION visit **Pixus Technologies** online at *www.pixustechnologies.com*.

EMBEDDED COMPUTING

Single-board computer for rugged, extended-temperature use introduced by ADL

ADL Embedded Solutions Inc. in San Diego is introducing a 3.5-inch single-board computer for rugged, extended-temperature embedded computing applications. The ADLE3800HDC is based on Intel's first System-on-Chip (SoC) E3800-series Atom processors, which use Intel's 22-nanometer 3D Tri-gate process, and features Intel's 7th generation



graphics engine for graphics performance. Improved power management capabilities result in standby power measured in milliwatts with days of standby time.

FOR MORE INFORMATION visit **ADL Embedded Solutions** online at *www.adl-usa.com*.

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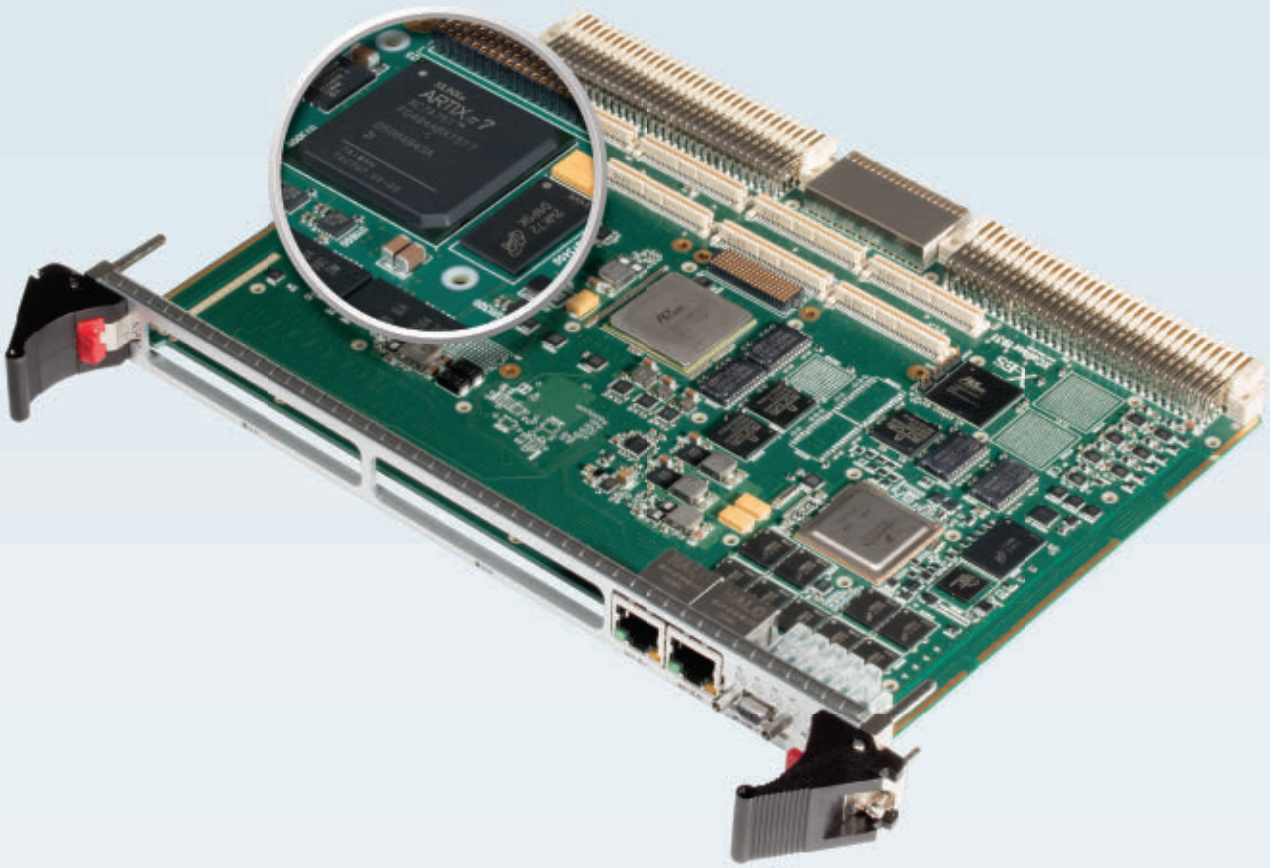

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