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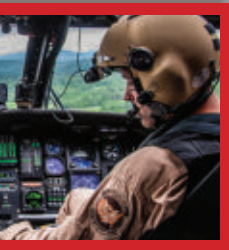

COVER STORY

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BY **JOHN KELLER**, EDITOR IN CHIEF

Near-peer conflict bringing back the heavy armor, and more vetronics upgrades

The last decade of the 20th Century brought waves of change to the U.S. military after the Berlin Wall came down in 1989, when Pentagon leaders adjusted to a post-Soviet world and the presumed end of the Cold War. One of the big changes involved U.S. heavy armored combat vehicles.

Rather than continuing their dependence on heavy iron like the M1 Abrams main battle tank, the M2 Bradley Fighting Vehicle, and the M109 Paladin self-propelled howitzer, the U.S. Army and Marine Corps moved toward lighter armor with tires instead of treads, like the M1126 Stryker interim combat vehicle, the Mine Resistant Ambush Protected (MRAP) vehicle, the LAV-25 light armored vehicle, and the M1128 Mobile Gun System.

It made sense at the time. Those lighter wheeled combat vehicles are easier to transport quickly by aircraft than their heavier, tougher tracked brethren like the Abrams and the Bradley. They were less expensive, and the lighter vehicles were better suited for the emerging global war on terror. The Cold War was over, and retooling of U.S. mechanized land forces retired the notion of U.S. and Western military forces going toe-to-toe with Soviet armored forces in Central Europe.

At the time, moreover, U.S. military planners were eager to reap the economic benefits of ending the Cold War — just as they were after World War II, Korea, and Vietnam.

As the new light wheeled combat vehicles started entering the force two decades ago, I couldn't help wondering if the era of the heavy tank was over. Yes, the Soviet Union had transformed into Russia, but was there no more need for the Abrams tank if some conflict unexpectedly flared up? The name of that country changed, but there were still plenty of Russian-made T-72 tanks left in the world.

I remember shuddering then at the thought of a battle between Russian T-72s and U.S. Strykers. The ignominious U.S. defeat in the 1943 Battle of Kasserine Pass in North Africa comes to mind. The German Tiger tanks had 88-millimeter high-velocity guns that made quick and gruesome work of the U.S. M3 light tanks with 37-millimeter main guns, and allied forces were pushed back for 50 miles. A force-on-force engagement of Strykers and T-72s wouldn't be much different.

Today, however, it's a different era, as U.S. military planners tighten their focus on the possibility of peer and near-peer conflicts with military powers like Russia and China, and with this new day we are seeing the return of heavy armor.

The 1st Brigade Combat Team of the Army's 1st Armored Division at Fort Bliss, Texas, next spring is trading-in their Stryker light armored vehicles for upgraded Abrams tanks. The 2nd Brigade Combat Team of the Army's 4th Armored Division at Fort Carson, Colo., are transforming their unit from an infantry brigade to a Stryker brigade in spring 2020, adding hundreds of Strykers.

Last year the 2nd Brigade Combat Team of the 3rd Infantry Division at Fort Stewart, Ga., switched from an infantry brigade combat team to an armored brigade combat team, adding 18 Paladin self-propelled howitzers, 138 Bradley fighting vehicles, and 87 Abrams tanks.

Sounds like the era of heavy armor is far from over. Depending on whom you talk to, a new era of heavy armor might be just getting started.

What are the technological ramifications of such a trend? Combat vehicles aren't just collections of firepower anymore; they're nodes on tactical battlefield networks. A renewed emphasis on heavy armor will mean upgrades in communications, networking, sensors, displays, digital signal processing, and more.

The new emphasis on peer and near-peer conflict, and with it the return of heavy armored combat vehicles, will continue vast opportunities for the defense electronics industry, and combat vehicle upgrades with the latest generations of electronics technologies. ←

Army briefs industry on combat vehicle vetronics and electrification

U.S. Army vetronics and armored combat vehicles experts have briefed industry on technology initiatives in open-architecture vehicle power; vehicular cyber security; high-voltage and battery safety; and electronic recharging; and hydrogen refueling. Officials of the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) in Warren, Mich., are trying to advance electrification of Army combat and tactical systems by enabling industry to invest and innovate on combat vehicle products that meet Army needs. The forum enables industry to contribute to TARDEC's vehicle electrification strategy. Army combat vehicles include main battle tanks, armored personnel carriers, self-propelled artillery, and utility vehicles like the JLTV.

Army asks Lockheed Martin to build JAGM air-to-ground missiles with multi-mode guidance

Missile experts at Lockheed Martin Corp. will build next-generation air-to-ground missiles under terms of a $49.6 million contract. Officials of the Army Contracting Command at Redstone Arsenal, Ala., are asking the Lockheed Martin Missiles and Fire Control segment in Orlando, Fla., to build a new batch of the Joint-Air-to-Ground Missile (JAGM). Lockheed Martin is developing the JAGM for launch from the Army AH-64 Apache attack helicopter, the Army MQ-1C Gray Eagle unmanned aerial vehicle (UAV), the Navy MH-60R helicopter, and the Marine Corps AH-1Z Viper attack helicopter. JAGM is to replace U.S. inventories of Airborne TOW, Maverick, and Hellfire air-to-ground missiles. ←

Northrop Grumman will upgrade the mission computers aboard U.S. Marine Corps helicopters

BY **John Keller**

CHINA LAKE NAVAL AIR WEAPONS STATION, Calif. — Avionics and flight computer experts at Northrop Grumman Corp. will upgrade VME-based FlightPro Gen III scalable mission computers aboard the U.S. Marine Corps AH-1Z Viper attack helicopters and UH-1Y Venom utility helicopters.

Officials of the U.S. Naval Air Warfare Center Weapons Division at China Lake Naval Air Weapons Station, Calif., have announced an $89 million contract increase to the Northrop Grumman Mission Systems segment in Woodland Hills, Calif., to upgrade existing mission computers on Viper and Venom helicopters.

Northrop Grumman is upgrading mission computers aboard U.S. Marine Corps AH-1Z Viper attack helicopters and UH-1Y Venom utility helicopters.

The contract increase involves research and development of AH-1Z and UH-1Y system configurations for Viper and Venom mission computers. Northrop Grumman engineers will upgrade existing mission computer software and hardware for improved performance, as well as to mitigate obsolescence issues.

The company also will handle block upgrades to the integrated avionics systems aboard the AH-1Z and UH-1Y helicopters, including prototypes, simulations, and weapons models. Northrop Grumman engineers also will look into future avionics improvements.

The Northrop Grumman Gen III mission computers are the heart of the integrated avionics system that powers the glass cockpit avionics of the UH-1Y and AH-1Z helicopters.

The conduction-cooled Gen III mission computer has a ruggedized 6U VME PowerPC-based single board computer. Interfaces include Fast Ethernet, four serial ports, parallel I/O, and built-in-test. FlightPro has a standard partitioned real-time operating system called INTEGRITY-178 tuMP for multicore architectures from Green Hills Software in Santa Barbara, Calif., with ARINC 653 and POSIX support.

The mission computer's standard configuration also includes a quad-channel 1553 mezzanine card, high-speed serial card, digital I/O module with eight channels of opto-coupled discrete inputs, eight channels of opto-coupled discrete outputs, and 16 channels of general-purpose bi-directional discretes that can be programmed individually as embedded computing outputs or inputs.

The flight computers use 28-volt DC or 115-volt AC three-phase 400 Hz input power, measure 13.61 by 11.5 by 7.55 inches, and weigh 30.4 pounds.

The computers have rated 3,200 hours mean time between failures.

The flight computer software is RTCA DO-178C compliant, has ARINC-653 partitioning for safety and security, and complies with the Modular Open Systems Architecture (MOSA) standard. The software is aligned with the Future Airborne Capability Environment (FACE) technical standard, has hardware-independent application software developed to MIL-STD-498, under MIL-STD-882C safety program environmental qualification.

Flight computer hardware is designed to MIL-STD-461D for electro-magnetic compatibility, and is tested to MIL-STD-462 and MIL-STD 810E. FlightPro is conduction cooled, and represents "Quiet Cockpit Technology," Northrop Grumman officials say.

Dual mission computers are part of Northrop Grumman's integrated avionics aboard the AH-1Z and UH-1Y. The mission computers provide centralized control of the helicopter avionics, displays, situational awareness, and health monitoring.

Additionally, the helicopter avionics and mission computers can accommodate future system upgrades; rapid insertion of new technologies; and integration of other avionics, communications, and survivability equipment. Northrop Grumman also provides the operational flight program software.

The H-1 Upgrade program is replacing aging AH-1W and UH-1N helicopters with upgraded UH-1Y and AH-1Z aircraft to enhance commonality, reliability, and maintainability. ←

For more information contact ***Northrop Grumman Mission Systems*** *online at* www.northropgrumman.com, *or the* ***Naval Air Warfare Center Weapons Division-China Lake*** *at* www.navair.navy.mil/nawcwd/command/Navy.aspx.

Navy needs enabling technologies for new sonobuoy to detect quiet enemy submarines

BY **John Keller**

ARLINGTON, Va.—U.S. Navy researchers are asking industry for enabling technologies for a new advanced air-deployed passive sonobuoy that can detect, identify, and track new generations of extremely quiet enemy submarines.

Officials of the Office of Naval Research in Arlington, Va., issued a solicitation (N00014-18-R-S008) for additional sonobuoy research as part of the organization's Long Range Broad Agency Announcement (BAA) for Navy and Marine Corps Science and Technology.

Officials of the ONR Naval Research Ocean Battlespace Sensing Department are seeking new technologies to develop an advanced passive sonobuoy called the Extended Range Directional Frequency Analysis and Recording (ER-DIFAR) to address new quiet threat submarine targets.

They are looking for a new A-size sonobuoy that measures 36 inches long, 5.25 inches in diameter, and weighs 39 pounds. This new sonobuoy should offer passive detection at tactically significant ranges against extremely quiet targets.

A government conceptual hydrophone array design will serve as the basis for maturing the sonobuoy design, as well as for developing and demonstrating a prototype.

Goals are to deploy the prototype from an A-size package; automatic precise localization of hydrophone elements on the hydrophone array; and in-buoy signal processing for beam-forming and communicating data to a receiving system.

Included will be upper float, communications and GPS receiver, and surface suspension for motion isolation of the upper assembly from the array. A lower electronics section will have power for the sonar hydrophone array, telemetry, beamforming, and signal processing hardware with sufficient processing power to run software developed and provided by the Navy.

The Navy is surveying industry for enabling technologies for next-generation sonobuoys able to detect and track quiet enemy submarines

The winning contractor will integrate components into an A-size sonobuoy and demonstrate the ability to achieve air launch certification, water entry, and array deployment in an at-sea demonstration.

The cost of manufacturing the sonobuoy in small numbers is a key objective. A-size sonobuoy packaging imposes severe restrictions on the size of hydrophone, which must be non-developmental.

Companies interested should email four-page white papers to the Office of Naval Research's David Johnson at dave.h.johnson@navy.mil. Full proposals will be due no later than 1 Feb. 2019. ←

More information is online at https://www.fbo.gov/spg/DON/ONR/ONR/N00014-18-R-S008/listing.html.

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Lockheed Martin eyes submarine system-of-systems for integrated fighting forces

BY **John Keller**

WASHINGTON — The Lockheed Martin Corp. Rotary and Mission Systems segment in Manassas, Va., is moving ahead with a U.S. Navy program to create common, open-architecture system-of-systems electronic designs aboard most Navy submarines to promote interoperability during joint operations with integrated fighting forces.

Officials of the U.S. Naval Sea Systems Command in Washington have announced a $13.5 million order to Lockheed Martin to provide additional engineering, integration, and testing for the Submarine Warfare Federated Tactical Systems (SWFTS) program, which seeks to enable submarines to join integrated fighting forces in coastal areas and harbors, as well as in the open ocean.

SWFTS is composed of all submarine combat systems and subsystems, mainly consultation, command, control, communications, computers, and intelligence to provide for the overall integration of submarine subsystems into one combat system for naval battle group interconnectivity.

The program is composed of tactical and support subsystems, each of which is developed under an independent business model. SWFTS is the engineering umbrella to integrate and deliver these subsystems as one system.

Lockheed Martin is creating common, open-architecture system-of-systems electronic designs to promote system interoperability aboard Navy submarines.

SWFTS has become common to four of the Navy's five classes of submarines, enabling a cost reduction in maintaining independent systems and an increase in efficiency. It allocates and tests warfare requirements across subsystems, and is not a traditional acquisition program.

Integration results when independent systems are integrated into a larger submarine system that delivers capabilities greater than the sum of its parts. Separate systems retain individual program management.

The goal is to enable submarines to support network-centric warfare and join integrated fighting forces for battle group operations; strike warfare; intelligence collection and surveillance; indication and warning; electronic warfare; special warfare; mine warfare; anti-submarine warfare; and anti-ship warfare.

Previously, the Navy had five different combat systems on five different submarine classes — the Los Angeles-class fast-attack submarine (SSN 688), the improved SSN 688, the Seawolf-class fast attack submarine (SSN 21), the Ohio-class cruise-missile submarine (SSGN 726), and the Virginia-class fast attack submarine (SSN 774).

The SWFTS program developed a common architecture for these five ubmarine classes based on open architectures and commercial off-the-shelf (COTS) components and subsystems. This not only transformed submarines from stand-alone vessels to nodes in combat networks, but also saved hundreds of millions of dollars, Navy officials say. The SWFTS programs approach focuses on open systems interface standards and widely available commercial computer products.

All Navy submarines except the Ohio-class ballistic missile boats (SSBN 726) contain the same basic set of subsystems and information architecture with some variations to accommodate different sensors and mission capabilities.

The SWFTS program has installed external Internet protocol (IP) communications capability aboard Navy attack and cruise-missile submarines to enable network-centric strike, anti-submarine warfare, intelligence and reconnaissance, special operations, and anti-ship missions.

IP capability also enables chat, e-mail, and Web services to exchange information among submarine crew members and mission stations with several different security levels, based on the sensitivity of the missions at hand the subsystems being used.

SWFTS enhances interoperability by sharing of authenticated, trusted, and verified information among authorized users, applications, and weapons.

THE ROLE OF TECHNOLOGY IN securing the nation's borders

The U.S. Department of Homeland Security relies on a variety of electro-optical cameras, lasers, chemical detectors, X-rays, and other sensors to limit entry of illegal immigrants, drugs, and other contraband. BY **J.R. Wilson**

U.S. border security and immigration control is one of the hottest — and most divisive — political topics in America today. Yet technology, not politics, is one of the most important topics for those tasked with securing the borders, countering the influx of illegal drugs and other contraband, and containing a flood of people from all over the world. Autorities must defend the long and largely isolated northern and southern land borders, thousands of miles of coastline, and the nation's vast airspace.

The days of monitoring these areas by human eyes alone, attempting to use sometimes-out-of-date paper to identify repeat offenders and known criminals, are over (although still a vital part of the effort). Today, the nation's

Customs and Border Patrol agents use the Sikorsky UH-60 Black Hawk helicopter, developed originally for the U.S. military, for border surveillance and interdiction.

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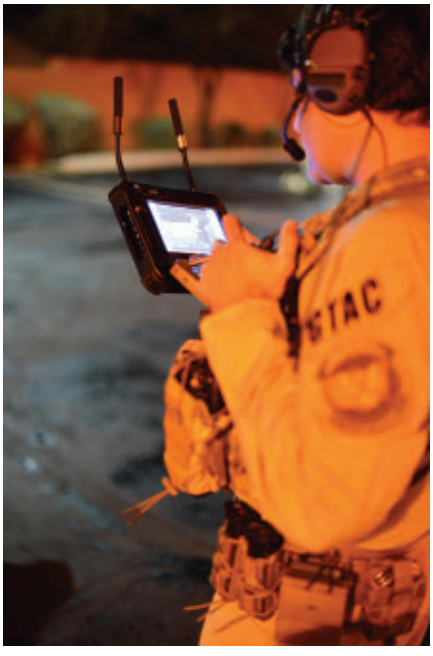
borders and coastlines are under constant surveillance from satellites and sensor-packed unmanned aerial vehicles (UAVs), aerostats, manned aircraft, boats, and ground vehicles.

The fast-growing need for interdiction, the large variety of sensors and platforms now being used or planned for in the future, and the dozens of local, state, and federal agencies involved also has increased the need for shared



Border patrol agents are adopting a variety of wearable and handheld computers and sensors to help secure U.S. borders.

intelligence at all levels through real-time networks, advanced communications systems, and artificial intelligence (AI). The technologies employed and being developed vary from agency to agency, depending on the task for which each is responsible.

The U.S. Coast Guard research center in New London, Conn., is one of the smallest of the armed services labs, focusing its limited budget on adapting existing sensor technologies, non- and less-than-lethal technologies, unmanned and autonomous systems, and operations research modeling and simulation — all to develop and support better patrol tactics to deploy to the field.

"As part of the intel community, we aren't just focused on the ops side — interdicting and countering contraband — but tying things together with intel," explains Bert Macesker, executive director of the Coast Guard research center. "That's a lot of the guiding principal for some of the smuggling technologies we're investigating. Combating networks, securing borders, and safeguarding commerce are three pillars that guide a lot of the tech we're looking at, focusing more on the higher-end technologies and introducing that to the Coast Guard.

Laser technology

Laser technology is one Coast Guard focus when it comes to border security. "We're looking in the field at the Coast Guard-Hailing Acoustic Laser-Light Tactical," Macesker says. "CG-HALLTS sits on a tripod, but will be integrated onto the top of the bridge on smaller cutters. It includes a long-range acoustic device, with very focused acoustic capabilities, so you can talk to someone from long distances and issue commands to suspect vessels. It also has a laser system to get attention, somewhat like an eye-safe laser dazzler, so we can use it in a port environment, which was part of the challenge to get approval for it. Those can be operated separately or together, from a small boat, or remote-controlled from the bridge of a fast response cutter."

Originally developed for the U.S. Navy, the Coast Guard's unique missions require some significant modifications to HALLTS, such as the long-range acoustic device directional speaker, capable of projecting a warning tone for nearly two miles; a Maxa Beam searchlight with a 12 million-candlepower peak beam, and an eye-safe Class 2 Glare Helios dazzling laser.

The Coast Guard has the widest area of responsibility for border security of any U.S. agency, starting with 100,000 miles of coastline and inland waterways. It also safeguards an Exclusive Economic Zone (EEZ) encompassing 4.5 million square miles, stretching from north of the Arctic Circle to south of the Equator, from Puerto Rico to Guam, encompassing nine time zones — the largest EEZ in the world. In addition, Coast Guard District 14 alone covers more than 12 million square miles in the remote Pacific, including the maritime boundaries of four independent Pacific island countries that lie within their area of responsibility.

As the smallest of the uniformed services — fewer personnel than the New York City Police Department — the Coast Guard has come to see the rapid evolution of technology as essential to keeping up with, if not ahead of, drug cartels, terrorist organizations, and other elements of organized crime that sometimes have more money and more advanced technologies.

A cornerstone of U.S. border security technology involves electro-optical devices like visible-light cameras and infrared sensors to detect illegal border crossings.

They are not, however, the only guardians of America's borders. That task is shared with Customs and Border Protection (CBP), Immigration & Customs Enforcement (ICE), Border Patrol Air & Marine Operations (AMO) — all, including the Coast Guard, part of the Department of Homeland Security.

Homeland security programs

Even a partial list of technology programs within DHS, the nation's largest cabinet-level department, is extensive and indicative of how far-reaching the search for technological advantage has grown. The search includes:

- air-based technologies;
- apex border situational awareness;
- Arctic communications and technologies;
- biometric technology engine;
- Canada-U.S. Enhanced Resiliency Experiment (CAUSE);
- countering violent extremism — actionable indicators and countermeasures project;
- data analytics engine;
- eye-dentify;
- Future Attribute Screening Technology (FAST);
- ground-based technologies;
- identity and access management engine;
- low-light internet protocol camera;
- Pat-Down Accuracy Training Tool (PATT);
- Polar Scout;
- space-based sensors;
- port of entry-based technology;
- port and waterway resiliency;
- port of entry people screening;
- port and coastal surveillance;
- port of entry forensics and investigations;
- Post Tracking System (PTS);
- small dark aircraft, or the hunt for drug-smuggling aircraft at the borders;
- tunnel detection and surveillance;
- video-based training for border patrol trackers; and
- virtual shooter

For the Coast Guard, whose boats, aircraft, and personnel are lightly armed, the goal is to get a suspect or platform to stop, using technologies such as CG-HALLTS to do that at some distance.

"Our small-boat operators don't have a lot of time to escalate force. We're trying not to use lethal capabilities, so we have researched and developed various entanglement systems that can be

Border surveillance experts use some of the latest commercial-off-the-shelf computers and communications devices in border patrol and search-and-rescue operations.

shot from a helicopter or from special guns on our patrol boats. We also use pepper balls shot from a paint gun. But the bad guys are always coming up with ways to combat those things, so we have to keep working on what's next," Macesker explains.

Nonlethal technology

"We've been looking at less-than-lethal RF technology, which DOD is investing a lot of money in; the technology isn't quite ready for the Coast Guard, so we're waiting to see how it develops with the Navy," Macesker says. "We're looking at technology for improved communications and to improve or strengthen our ability to intercept non-compliant vessels. Some future game-changers, which are already taking place in some cases, include machine learning to make good use of intel. But the challenge is to get things out rapidly into the hands of operators in the field."

AMO covers much of the same territory as the Coast Guard, but by air rather than the predominantly water-based Coast Guard. Their fleet of 240 aircraft and nearly 600 pilots flies an average of more than 200 hours a day in air-to-air, air-to-water and air-to-ground border interdiction missions, patrolling oceans, lakes, and rivers to prevent the illegal entry of undocumented aliens, weapons of terror, and illegal narcotics.

AMO's recently released Vision 2025, the first official documentation of the organization's role in securing the homeland, established its approach to meeting the challenges of securing a 21st Century border using advanced aeronautical and maritime technologies. One of those is the Customs and Border Protection Air and Marine Operations Surveillance System (CBP AMOSS), which provides real-time air and maritime surveillance of U.S. borders and portions of the Western Hemisphere.

Another is the Coastal Interceptor Vessel SAFE Boat, a 41-foot, 10-ton boat equipped with four 350-horsepower Mercury outboard engines that provide a cruising speed of 58 knots across its 350-nautical-mile range. Using the new vessel's radar and electro-optical infrared sensors, the three-man crew will work with AMO aircraft and other federal, state, and local law-enforcement agencies.

AMO also has issued a request for information (RFI) for a new Riverine Surface Patrol Platform (RSPP), to expand the capabilities of Border Patrol agents operating in the Rio Grande Valley. The current airboats operate in shallow to moderately deep waters and from soft river bed to rocky substrate; the RSPP would extend that to areas of river covered with weeds, grass and mud. It will have seating for five Border Patrol agents, other law enforcement officers, cargo, equipment, detainees or other individuals, and will be able to tow law enforcement or detained boats.

U.S. Customs and Border Protection uses the Bell UH-1 helicopter, among other aircraft, to maintain surveillance on U.S. borders.

Biometrics

The rapidly advancing technologies of biometrics already are finding new applications in border security and

immigration control missions. For example, facial recognition software led to the arrest of two imposters in separate incidents at Washington Dulles International Airport in Northern Virginia this summer, alerting federal agents that the two were using false passports to enter the country illegally. The software, also being tested at 14 other airports around the nation, compares a picture of a traveler with a database of passport and visa pictures belonging to people flying that day and flags those that do not match.

Federal officials recently announced plans to expand their biometric-based entry and exit system to include vehicles at land ports of entry. Customs and Border Protection, which is testing and evaluating several technological and operational changes to improve the accuracy and speed of biometric collection, will handle the new system. Officials say this should decrease ports of entry and exit wait times by improving the information resources available to immigration and border management personnel.

Small tactical UAVs like the RQ-7B Shadow are in use by border security authorities.

"These biometrics may include digital fingerprint scans, facial images, iris images or other biometrics," according to a Customs and Border Protection statement. "Biometrics may be collected from travelers entering or exiting the United States. Customs and Border Protection will store and use biometric data from those aliens specified in 8 CFR 215.8 and 8 CFR 235.1 to verify identity, determine admissibility of those seeking entry into the United States, confirm exit from the United States, track aliens who have overstayed their visas or are otherwise illegally present in the United States, prevent visa fraud, and identify known or suspected criminals or terrorists."

Federal officials already have dozens of such screening terminals at detention centers to collect biometric data — fingerprints, iris scans, identifying features like scars and tattoos — from thousands of immigrants, mostly Central Americans arrested in Mexico. The department plans to expand the program in Mexico later this year and is negotiating similar efforts with the nations of Central America.

Meanwhile, scientists at the U.S. Army Research Laboratory have developed a method, using machine learning and artificial intelligence, to compare a thermal image of a person's face with existing visual images. That would enable facial recognition in low-light environments or at night.

The U.S. Department of Homeland Security's Bureau of Customs and Border Protection is capitalizing on military technology like the MQ-9 Reaper unmanned aircraft, shown above.

Small boat threat

New technologies also are being researched and applied by AMO and the Coast Guard, to deal with small boat threats. Small vessels include

commercial fishing vessels, recreational boats and yachts, towing vessels, uninspected passenger vessels, or any other small commercial vessels involved in foreign or U.S. voyages.

According to DHS, security risks for small vessels can be broken down into four general categories:

- weapons smuggling;
- boat bombs;
- terrorist smuggling; and
- missile launchers.

AMO, Customs and Border Protection, and the Coast Guard also are expanding their use of UAVs to help manned helicopters and fixed-wing aircraft. The UAVs offer several advantages over manned platforms. Most don't need to operate from airfields; some have greater endurance; they are less expensive; and they are more difficult for smugglers to see and avoid.

UAVs also can reach remote areas more quickly than boats and ground vehicles, and provide persistent, tactical airborne intelligence, surveillance and reconnaissance (ISR) capabilities to increase the effectiveness of patrol boats, national security cutters, and agents in the field.

Customs and Border Protection UAVs now provide aerial ISR along the entire Southwestern border, significantly enhancing the ground efforts of some 18,500 Border Patrol agents — more than twice the number working the area in 2001. To the north, UAVs patrol some 950 miles of remote border with Canada between Washington and Minnesota and another 200 miles across New York and Lake Ontario. Since 9/11, the number of Border Patrol agents on the Northern border has increased by

The long borders between the U.S., Canada, and Mexico require automated border surveillance with a variety of electro-optical equipment.

U.S. border agents use sophisticated airborne sensor platforms like the P-3 Orion aircraft to keep tabs on border and maritime areas. This plane is based on a legacy U.S. Navy anti-submarine warfare aircraft.

500 percent, to 2,200, while another 3,700 Customs and Border Protection officers manage the flow of people and goods. The actual security those agents provide is further multiplied by the application of various new and evolving technologies.

"We've been doing a lot with small UAV packages, which will be a game-changer in the future. Sensors are getting smaller and smaller; we have a test facility at Cape Cod looking at a direction-finding mini-SAR [synthetic aperture radar] for Pumas, for example. The Coast Guard has mid-size UAVs on the National Security Cutters, which are catapult-launched and have a lot of endurance, but there is opportunity for even smaller UAVs," Macesker says.

"That also applies to unmanned surface vessels [USVs]. There is a lot of potential there. We recently used an unmanned rigid-hull inflatable boat the Navy is using for counter-mine detection, evaluating it against several counter-drug vignettes. All those things are coming, but a lot of it is a challenge in overcoming policies and regulations within the government."

The United States is one of the most vulnerable nations on Earth in terms of securing its borders against all forms of smuggling and ensuring those entering the country do so legally and are fully vetted as to identity, criminal history and ties to terrorist groups. The DHS Science and Technology Directorate (S&T) works closely with industry, Pentagon labs, and individual agency research centers to develop or adapt technology and knowledge products to detect, interdict, and prosecute illegal activities along borders and ports of entry.

Border security initiatives

The scope and diversity of challenges of border security and immigration control can be seen in some of the programs DHS science and technology currently is pursuing or has deployed:

- the Border Research in Instrumented Construction Project identifies cameras, sensors, and other technology that can be applied on or near a smart wall via ground, surface, air, subsurface, and water to enhance border security and agent safety;
- the Apex Border Situational Awareness program helps Customs and Border Protection access data sources,

develop decision support tools, and share information with partner law enforcement agencies to improve situational awareness;

- Integrated Maritime Domain Enterprise a platform bridging disparate data systems to make it easier for DHS components to share information and collaborate;
- the Adaptive Sensor Analytics Project (ASAP) provides automated data analytics to process satellite imagery, identify patterns of criminal activity and alert DHS officials;
- Ground-Based Technologies Program — improves the ability to detect illegal activity at the border through stronger situational awareness, automated detection and alerts, target classification, and tools to promote agent safety;
- Air-Based Technologies Program — identifies, tests and evaluates unmanned and manned aircraft and sensors for law enforcement, search-and-rescue, and disaster response in land and maritime environments;
- Expert Tracker training program — helps Border Patrol agents improve their ability to track movement in rough terrain along the nation's borders;
- Port of Entry-Based Technology Program — a multi-year effort to improve illicit cargo detection and legitimate cargo throughput by upgrading legacy scanning systems, linking them to new analysis and information sharing tools that make the most of personnel resources and state-of-the-art technology to enhance the detection performance of cargo scanning systems and extend their service life;

A wide variety of car-scanning sensors are in use on the U.S. border crossing at San Ysidro, Calif., to detect illegal drugs, explosives, and other kinds of contraband.

- Port of Entry People Screening Program — identifies, evaluates and implements combinations of process and technology improvements to facilitate the movement of people through the nation's air, land and sea ports of entry;
- Autopsy is an open-source digital forensics platform that helps law enforcement determine how electronic devices were used in a crime and recover evidence;
- Child Exploitation Image Analytics (CHEXIA) — reduces the amount of time it takes to identify and rescue children from exploitation, as well as identify perpetrators, through automated face recognition algorithms and forensic tools;
- Tunnel Detection and Surveillance Program — helps border officials detect and locate clandestine tunnels, as well as gather forensic data to support investigation and prosecution of drug smuggling activities;
- Port of Entry Forensics and Investigations Program — helps combat transnational crime and investigate child exploitation and human trafficking through open-source data and forensic analysis of material collected from suspicious packages and cargo;

- Common Viewer Workstation — develops a common scanning workstation with a common graphical user interface with stationary and mobile non-intrusive inspection systems; develops a wireless communications infrastructure to support data-sharing, workload-sharing, and rapid information exchange; and develops threat-detection algorithms for contraband;
- Improve Performance of NII Detectors and/or Sources — improves the performance of non-intrusive inspection systems to increase Customs and Border Protection's ability to interdict contraband without slowing commerce through advanced data analytics and system architecture, automated threat recognition, advanced imaging systems and standardized NII metrics;
- Integrated Fixed Tower (IFT) systems — provide Border Patrol with long-range, persistent surveillance along the Arizona/Mexico border, automatically using radars to identify and classify items of interest with day/night cameras and tracking items of interest at the Command and Control Center using a COP that integrates data, video and geospatial locations;
- Remote Video Surveillance Systems (RVSS) — a fixed technology used by Border Patrol in select areas along the Southwest and Northern borders, providing short-, medium- and long-range persistent surveillance from towers or other structures. RVSS uses cameras, radio and microwave transmitters to send video to a control room operator to remotely detect, identify, classify and track targets.

Border Patrol agents must deal with tunnels crossing the U.S. border, which makes development of underground sensors and communications a top priority.

This Customs and Border Patrol P-3 surveillance aircraft can detect and track several different targets simultaneously to enable accompanying aircraft and boats to interdict illegal border traffic.

- Unattended Ground Sensors (UGS) — seismic, passive infrared, acoustic, contact closure, and magnetic sensors providing short-range persistent surveillance to support detection and, to a limited extent, track and identify subjects;
- Mobile Surveillance Capability (MSC) systems — Border Patrol vehicle-mounted radars and camera sensors for long-range mobile surveillance, automatic detection and and tracking of items of interest while providing the agent/operator with data and video of the observed subject;
- Mobile Vehicle Surveillance Systems (MVSS) — short- and medium-range mobile surveillance cameras on telescoping masts mounted on Border Patrol vehicles to detect, track, identify, and classify items of interest and assist agents responding to any intrusions;
- Agent Portable Surveillance System (APSS) — a tripod-mounted medium-range mobile surveillance system used by teams of two or three Border Patrol agents to automatically detect, track and record items of interest;
- Customs and Border Protection's Tactical Aerostats and Re-locatable Towers program — a mix of aerostats, towers, cameras, and radars providing agents with increased wide-area situational awareness. Since initial deployment in 2012, they have detected more than 180,000 illegal border incursions of aliens and smugglers, leading to the seizure of approximately 180 tons of narcotics and related contraband; and
- AMO's Tethered Aerostat Radar System (TARS) — monitors low-altitude aerial approaches to the United States

from eight sites — six along the Southwest border, one in the Florida Keys, and one in Puerto Rico. The elevated TARS sensor provides over-the-horizon coverage. From 2014 through 2016, TARS was responsible for detecting 86 percent of all suspected air smuggling flights approaching the Southwest border from Mexico.

Customs and Border Protection agents use X-ray scanners to screen vehicles for people and contraband crossing U.S. borders.

Underwater imaging

"We've been evaluating an underwater imaging system to track parasitic attachments to vessels seeking entry to ports using high-definition, high-resolution underwater acoustic capability," Macesker says. "To counter contraband smuggling on the Northern borders and Great Lakes, we are looking at unmanned systems, including tethered balloons that could carry small infrared sensors. The smaller sensor payloads get, the more accessible they become and you will see more of these systems out there, especially as the price point comes down.

"We're also trying to take advantage of the new generation of small pico-sats. We're getting ready for a SpaceX launch of a couple of cubesats with programmable radios on board, sometime in October. They will go into a polar orbit and we'll evaluate their capability to monitor distress beacons, so it will have a search and-rescue] focus. We built a ground control station in Fairbanks and will build another with a dome and tracking radar at the Coast Guard Academy. That will be our first real foray into the space environment with our own cubesats, which are much more affordable. We do have other assets for SAR and so forth, but this is our first look at really low-cost micro-sats, which also can be communications relays or have other applications. as border security]."

Thermal management for high-performance embedded computing

Liquid cooling is becoming more efficient and affordable, while hybrid approaches that blend air, liquid, and conduction cooling are coming into their own to give systems designers a leg-up in the battle against electronics heat.

BY **John Keller**

It's long been a given in the electronics industry that computing power doubles roughly every two years — sometimes even faster. Although this maxim, referred to as Moore's Law, still holds true today, some industry experts worry that an inability to remove heat from electronics eventually could bring Moore's Law to an abrupt halt.

Integrated circuits in high-performance embedded computing (HPEC) systems are shrinking; that's also part of Moore's Law, which says the number of transistors in a dense integrated circuit doubles about every two years. Increasing numbers of transistors in relatively small and cramped spaces means waste heat, and lots of it. If Moore's Law is to continue further into the 21st Century, then it's up to engineers who specialize in a variety of disciplines to safeguard the ability to remove heat from embedded systems, while keeping pace with ever-more-powerful computer processors.

On the face of it, removing waste heat from high-performance embedded computers is a straightforward process; it involves transferring heat from processors and other hot components inside an enclosure to a cold wall nearby using conduction, blown air, liquid, or a combination of these approaches.

Curtiss-Wright Defense Solutions specializes in Air Flow-Through (AFT) technology for high-performance 3U VPX embedded computing systems.

Agnostic OpenVPX embedded computing cooling technology from Mercury Systems can be packaged as circuit board-only, Air Flow-By and Liquid Flow-By, conduction cooled and Liquid Flow-Through, Air Flow-Through, and convection cooled.

Electronics cooling only is straightforward, however, in the abstract; the real engineering challenges are in the details, where factors like shock and vibration, high altitudes, dust and dirt, salt spray, humidity, and many others come into play. Thermal-management techniques that work at sea level might not at 40,000 feet. Blown air might be insufficient in the desert heat or on an airport tarmac. The list goes on.

Despite many aerospace and defense applications with pressing thermal-management issues, and a growing number of approaches for removing heat, there's still one constant: a growing amount of waste heat and the imperative to get rid of it.

"In HPEC it's really the same old story it has been in the past 15 to 20 years: power is going up, and power density is going up," says Ivan Straznicky, chief technology officer of advanced packaging at the Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va. More power in tighter spaces means the thermal-management problem is here to stay.

On a hopeful note, embedded computing architectures themselves do not pose the dire heat threat today that they did only a few years ago, Straznicky points out. Central processing units (CPUs), graphics processing units (GPUs), and field-programmable gate arrays (FPGAs) — all crucial technologies in today's HPEC architectures

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— simply may not be generating heat at the rates they used to. "It's not as much of a problem because there are more and more CPU, GPU, and FPGA cores, so the heat load is spread over more cores. It is one glimmer of hope in thermal management."

Approaches to thermal management

Perhaps the most common way to cool military embedded computing systems is conduction cooling, where designers package electronics components in sealed enclosures. Waste heat moves from hot components on circuit boards to the sides of boards, through the enclosures, and out to large metal surfaces like the armor of a main battle tank, where the heat disperses to the ambient air.

Conduction cooling is handy in military environments where dust, dirt, and other contaminants make it impossible to use blown air to cool hot components.

Embedded systems designers are hard-pressed to deal with rising amounts of heat in ever-smaller packages with conventional thermal-management techniques. Still, companies like General Micro Systems (GMS) Inc. in Rancho Cucamonga, Calif., are pushing the bounds of conduction cooling with new, and often-patented ways of removing heat in this traditional manner.

Air Flow-By cooling technology surrounds circuit boards in metallic clam shells that can be exposed to air and liquid cooling.

"We can use things on the edges of the board, which are the VME chassis clamps, or wedge locks," explains Chris Ciufo the GMS chief technology officer and vice president of product marketing. Conventional wisdom has it that these clamps can handle roughly 25 Watts of waste heat. Two clamps per board, and this offers capacity to cool 50 Watts of heat per processor board. This approach only goes so far, and "people really do need to cool more than that," Ciufo says.

For reference, the Intel Xeon E5 22-core processor, which is becoming popular for HPEC military and aerospace applications, can generate as much heat as 145 Watts, while the same processor with 14 cores generates as much as 120 Watts. It's just too much heat for conventional VME wedge locks. "Clearly, people are finding other ways to do this," Ciufo says.

GMS has patented a version of the VME card-edge clamp that doubles the conventional VME clamp's capacity to from 50 Watts to 100 Watts per card. "We contact both sides of our 6U VME board, so instead of just one side of the board, we can increase the heat the clamp pushes out to the chassis," Ciufo says. "This clamp is broken into multiple segments, which move toward each other as the screw tightens. We feed heat from more surface area on both sides of the board to the clamp."

There are other ways of squeezing more performance out of conduction cooling. GMS has patented a socket that fastens the Xeon E5 processor to an 3U or 6U VPX computer board that creates an efficient heat path from the processor to the cold plate, Ciufo says. "It allows us to get a maximum amount of heat off the processor with less than 10 degrees of heat rise to the cold plate of the system."

Reducing the processor's heat rise can enable GMS systems designers to run the Xeon E5 processor and other high-performance chips at their maximum clock speeds. While some designers deal with thermal management by throttling-back processor clock speeds, at GMS "we can run processors at their maximum speed and heat with no compromise in reliability," Ciufo says.

Convection cooling

Another typical way to cool embedded computing components is with fan-blown air, also called convection cooling. This approach places heat sinks with fins on hot components, and blows air over the heat sinks to remove excess heat to the ambient air.

This approach can be a problem for aerospace and defense applications because shock, vibration, and air contaminants can cause system failures in convection-cooled systems. Plus, fans are notorious single-points-of-failure, so military systems designers use them only when they must.

There's a second kind of convection cooling, however, that doesn't use fans. It's called natural convection cooling, which moves air by creating currents based on the temperature difference between the cooling fins and the surrounding air. Yet while at least partially solving the problems of fan reliability, natural convection cooling is limited in the amount heat it can remove. "You would not use natural

convection cooling for HPEC," says Curtiss-Wright's Straznicky. "It's mostly for the lower-end stuff."

Liquid cooling

In today's high-power HPEC applications, sometimes liquid cooling is one of only a few viable options for removing large amounts of heat. Systems designers can use a variety of liquids, ranging from jet fuel to inert liquids. "We are seeing a lot more liquid cooling these days than we did in the past," says Shaun McQuaid, director of product management at the Mercury Systems Sensor and Mission Processing (SMP) segment in Andover, Mass. "The processing and performance requirements are pushing in that direction."

General Micro Systems uses a proprietary thermal-management technology called RuggedCool for HPEC applications to cool 300-Watt Intel Xeon processors.

Liquid cooling for high-performance embedded systems can involve channeling liquid through small pipes that snake their way throughout processing boards or through card clamps to move heat away from card edges. Systems designers adapt their liquid cooling techniques to match the demands of their applications.

Liquid cooling historically has been one of the most-expensive and least-reliable electronics cooling techniques available, but depending on the application, the added expense can be worth it — not only to make the most of system performance, but also for long-term system, card, and processor reliability. The longer a processor is subject to high temperatures near the top of its specifications, the more likely it is to fail at a critical moment. "To get the longest life and best efficiency in power-hungry systems, you go with liquid," McQuaid says.

Liquid cooling in the recent past has taken a bad rap for systems reliability. Leaky connectors once threatened system performance and longevity. That's not the case today, says Curtiss-Wright's Straznicky. "A lot of the reliability issues of liquid cooling have been solved," he says. "The leaks often used to be associated with quick disconnects. Leaks were an issue, but what we have seen is, if you know which vendors to use, the leaks should not be an issue."

Mercury's McQuaid says the cooling necessary for extreme applications of 300 to 400 Watts at the board level typically requires liquid cooling. "It's become a lot more of an available thing," he says. "It's not as exotic as it used to be. Technology has advanced in quick disconnects and leak-proofing to put liquid cooling in the realm of deployment."

Despite its advantages and growing availability, however, liquid cooling still isn't for everybody. "We don't use liquid cooling or spray cooling because it adds the kind of complexity that doesn't fit with small form factors," says GMS's Ciufo.

Hybrid cooling techniques

Some of the most intriguing new developments in electronics cooling involve blends of conduction, convection, and liquid cooling. Often these hybrid approaches offer to keep costs down, as well as to capitalize on the existing electronics infrastructure available on military systems and platforms.

Liquid cooling is becoming a viable option for many high-performance embedded computing systems for demanding applications like radar, electronic warfare, and signals intelligence.

Two notable industry-standard hybrid cooling approaches are ANSI/VITA 48.8 Air Flow Through (AFT) cooling, and ANSI/VITA 48.7 Air Flow-By cooling. Both approaches are for 3U and 6U VPX plug-in embedded computing boards. AFT cooling was pioneered by Curtiss-Wright Defense Solutions and Northrop Grumman Corp., while Air Flow-By cooling started at Mercury Systems.

AFT offers cooling capacity of as much as 200 Watts per card slot to support high-power embedded computing applications like sensor processing; it's environmentally sealed to accommodate harsh military operating conditions. AFT passes air through the chassis heat frame, preventing the ambient air from contacting the

electronics, but decreasing the thermal path to the cooling air dramatically, Curtiss-Wright officials say.

A gasket mounted inside the chassis seals the card's internal air passage to the chassis side walls, and shields the internal electronics from the blown air. Each card has an isolated thermal path, rather than sharing cooling air among several cards.

Air Flow-By cooling, meanwhile, encapsulates circuit boards in heat-exchanger shells that cool both sides of the board by flowing air across both sides. The heat exchanger shell protects against airborne contaminants, electromagnetic interference (EMI), electrostatic discharge (ESD), and provides an extra layer of physical security.

General Micro Systems has adapted several thermal-management approaches to handle high-power embedded computing based on the Intel Xeon microprocessor.

Air Flow-By maintains the card's standard 1-inch pitch, and offers a 25-percent reduction in processor temperature for dual Intel Xeon processors; a 33-percent increase in processor frequency at that reduced temperature; five times increase in mean times between failures (MTBF); and a 25-percent reduction in weight of the processor module, according to Mercury.

The AFT and Air Flow-By techniques can offer the next logical step when conventional conduction cooling no longer can meet system requirements. "If the limits of air cooling and conduction cooling are reached, the next step is Air Flow-Through," says Curtiss-Wright's Straznicky. In addition, the AFT and Air Flow-By cooling approaches also can offer options for liquid cooling if systems designers need it.

Cost tradeoffs

It's true that up-front costs increase when systems designers look beyond conventional conduction and convection cooling for high-performance embedded computing. "Cost is a big concern," admits Mercury's McQuaid. "People always are looking for the most cost-efficient method of meeting these challenges."

Still, relatively high initial costs often can be justified when systems integrators consider costs over the lifetimes of these technologies. "Total cost of ownership is coming into play," McQuaid says. "It's not how much the board costs today, but it involves calculating reliability figures into the system." It's accepted that running high-performance processors at relatively cool temperatures can increase their life cycles substantially.

"Standard cooling technologies like Liquid Flow-Through have not only caught-up with embedded computing, but they also have given us significant head-room with the new computing devices," says Curtiss-Wright's Straznicky. "Air Flow-Through, for example, is still very feasible for modern and future designs.". ←

COMPANY LIST

Aavid Thermacore Inc.
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https://www.thermacore.com/default.aspx

Abaco Systems
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Advanced Thermal Solutions Inc.
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http://www.ddc-web.com

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https://www.elma.com

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

General Micro Systems Inc.
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https://www.gms4sbc.com

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Parker Hannifin Corp. Aerospace Group
Alexandria, Va.
https://www.parker.com

Vicor Corp.
Andover, Mass.
http://www.vicorpower.com

DISA looks for ways of using artificial intelligence (AI) to detect malware

BY **John Keller**

SCOTT AIR FORCE BASE, Ill. — U.S. military trusted computing researchers are asking industry for news ways of applying artificial intelligence (AI) and machine learning to cyber security to detect malware and prevent it from infecting military computers and data networks.

Officials of the Defense Information Systems Agency (DISA) at Scott Air Force Base, Ill., have issued a sources-sought notice (PL84110001) for the Signatureless Endpoint Protection (SEP) Prototype Pilot-Test program.

DISA wants a SEP solution that detects and prevents malware by applying AI, algorithmic science, and machine learning for analyzing the potential existence of computer files and file executions for malware.

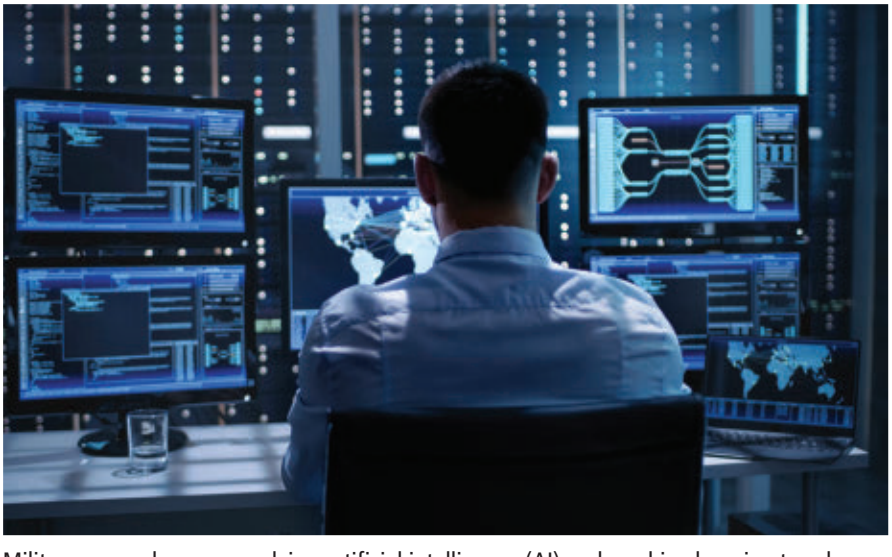
The solution should rely on AI and machine learning to analyze malware at the DNA-level, require minimal updates, work on air-gapped networks, predict cyber malware threats, and prevent malware from exploiting system vulnerabilities.

Sponsoring this project are officials of the DISA Development and Business Center Cyber Development Directorate Innovation Office.

Computer systems today typically guard against malware by comparing signature files for known malware exploits. Instead, DISA intends to audit signatureless endpoint solutions to compare and contrast with existing cyber security tools.

DISA is looking for a solution to eliminate zero-day attacks where the AI/machine learning engine does not depend on signature file repositories in trusted computing attempts to identify and remove malware. Target client systems include Microsoft Windows server/desktop, Linux, and MAC.

The solution should be able to detect and block unknown malware on



Military researchers are applying artificial intelligence (AI) and machine learning to cyber security to detect malware.

MIT scientists envision a way to enable submerged submarines to communicate with airplanes

Researchers from the Massachusetts Institute of Technology (MIT) in Cambridge, Mass. are helping find ways for military aircraft to communicate with submerged submarines. They have created an underwater-to-air communications system called translational acoustic-RF communication (TARF) that seamlessly can convert sonar into radar. The TARF technology turns the water surface from an obstacle into a communication interface by combining sound and radio in an innovative way. It uses an underwater speaker to send data as sound, which vibrates the surface. Sensitive radar aboard overhead aircraft then could pick up these vibrations, and decode them to recover the sound data. The technology still is in its infancy. The team has tested it at depths of 11.5 feet in swimming pools and with circulation currents to mimic some ocean conditions.

Military has microphones on back teeth for invisible, hands-free radio secure communications

The future of battlefield communications is resting comfortably on the warfighter's back teeth. Next time you pass someone on the street who appears to be talking to themselves, he literally may have voices inside his head ... and be a highly trained warfighter on a dangerous mission. The Pentagon has inked a roughly $10 million contract with a California company to provide secure communications gear that's essentially invisible. Dubbed the Molar Mic, it's a small device that clips to a person's back teeth. The device is microphone and speaker to enable the wearer to transmit without any conspicuous external microphone and receive with no visible headset or earpiece. ←

or off the DISA Network (DISANet) with an accurate AI-derived local detection engine.

The solution should not require continuous cloud connectivity or signature updates, and work in open and isolated networks with an on-premise option. It should be able to run alongside any existing standard anti-virus products without interference.

The solution should have a central management component able to deploy, manage, and centrally report client components and events. The cyber security management interface should be able to establish central configuration of policies of each client, and be intuitive and easy to use with minimal training.

The solution should provide other detection and prevention features including fileless malware, exploit prevention, script control, device control, and application control. It should be able explicitly to block powershell and activescript interpreters while still allowing specific scripts to execute.

The solution should be able to integrate with any standard security information and event management (SIEM) solution for output of alerts and reports, and have minimal performance impact on network bandwidth, host memory, disk, and central processing unit (CPU).

Companies interested should email white papers to DISA's Kevin Poore at kevin.l.poore.civ@mail.mil. For questions or concerns contact DISA's Kevin Poore by phone at 618-418-6263, or by email at kevin.l.poore.civ@mail.mil. Also phone DISA's Vanessa McCollum at 618-229-9776.

More information is online at https://www.fbo.gov/spg/DISA/D4AD/DITCO/PL84110001/listing.html.

Three U.S. companies eye next-generation RF and electro-optical sensors

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio — Three U.S. technology companies are helping U.S. Air Force researchers develop new enabling technologies for next-generation electro-optical (EO) and radio-frequency (RF) sensors, communications, information processing, imaging, and signals intelligence (SIGINT) applications.

Officials of the Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, are working with Defense Engineering Corp. in Beavercreek, Ohio; optX Imaging Systems LLC in Lorton, Va.; and Lockheed Martin Space Systems in Louisville, Colo., on the Research and Development of Electro-Optical and Radio Frequency Sensors (RADERS) project.

Defense Engineering won a $3.9 million RADERS contract in August; optX Imaging Systems won a $748,315 RADERS contract in May; and Lockheed Martin won a $192,009 RADERS contract in August.

RADERS concerns 12 EO/RF technology areas:

- antenna technologies and electromagnetic (EM) scattering;
- electro-optic and infrared (EO/IR) sensor technology;
- sensor information processing and integration;
- EO/IR, spectral, and common-aperture electro-optic/radio-frequency (EO/RF) hardware and algorithms;
- waveform phenomenology, design, and applications;
- ultra-sensitive receivers for signals intelligence;
- long-range day and night hyperspectral imaging research;
- standoff high-resolution imaging;
- infrared search and track (IRST) technology;
- passive concept exploration;
- laser radar (ladar) imaging, systems, components, and applications; and
- RF sensor systems.

Defense Engineering will carry out EO/RF research in distributed radar electromagnetics and antennas for multispectral evaluation and research. Lockheed Martin, meanwhile, will carry out research in 3-D ladar targeting.

Sensors, communications, information processing, imaging, and signals intelligence (SIGINT) are the focus of Air Force technology development.

For more information contact ***Defense Engineering Corp****. online at* http://defengcorp.com, ***optX Imaging Systems*** *at* www.optximaging.com, *or* ***Lockheed Martin Space Systems*** *at* www.lockheedmartin.com.

Applied Physical Sciences continues effort to develop UUV undersea energy batteries in Blue Wolf project

BY **John Keller**

KEYPORT, Wash. — Unmanned underwater vehicle (UUV) power experts at Applied Physical Sciences (APS) Corp. in Groton, Conn., are moving forward with a project to develop a highly customized high-performance battery system prototype to enable manned and unmanned undersea vehicles to move through the water faster and more energy-efficiently than ever before.

Officials of the Naval Undersea Warfare Center (NUWC) in Keyport, Wash., announced a $992,000 contract modification to Applied Physical Sciences to continue the company's effort to develop a UUV batter prototype as part of the Blue Wolf program of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.

The NUWC Keyport Division is administering contracting for the DARPA Blue Wolf program, which aims toward at-sea testing of undersea energy, hydrodynamic lift, and drag-reduction technologies.

The Blue Wolf program will develop and demonstrate integrated underwater vehicle prototypes able to operate at speed and range combinations previously unachievable in fixed-size platforms, while retaining traditional volume and weight fractions for payloads and electronics, DARPA officials say.

Applied Physical Sciences has been involved since 2015 in a part of the Blue Wolf program that seeks to develop approaches to hybrid energy systems such as thermal, electrochemical, or energy-harvesting with two or more energy sources to improve energy efficiency measured in Watt hours per mile.

Applied Physical Sciences is developing a revolutionary battery for unmanned underwater vehicles (UUVs).

Applied Physical Sciences experts have been exploring thermal and electric sources like fuel cells and batteries that can fit within an undersea vehicle system module.

The company is developing a high-performance battery prototype customized for the future Blue Wolf unmanned undersea vehicle. Last January Applied Physical Sciences was awarded a contract modification that increased Blue Wolf contract ceiling from $4.2 million to $5.8 million.

Other Blue Wolf contractors are the Boeing Defense, Space & Security segment in Huntington Beach, Calif.; the Lockheed Martin Mission Systems and Training segment in Riviera Beach, Fla.; and the Charles Stark Draper Laboratory in Cambridge, Mass.

In addition to hybrid energy systems, the DARPA Blue Wolf project focuses on new enabling technologies

Boeing, Navy take big risk on the MQ-25 unmanned aerial vehicle (UAV)

The MQ-25 aerial refueler is the Navy's first carrier-based unmanned air vehicle (UAV) – it's also a big, risky, bet for Boeing and the Navy. Why is it a risk for Boeing? Because there is significant uncertainty about the return Boeing can expect on this program. Under the $805 million fixed-price contract awarded on August 30, Boeing will be responsible for overruns during development and on the first four aircraft. Boeing may also be obligated by additional fixed price production options for the unmanned aerial tanker (where Boeing would also be responsible for any overruns), possibly up to the planned buy of 72 aircraft. The Navy is making a big bet, too. It cannot transfer all the program risk to Boeing; if Boeing fails to execute the program, the Navy customer will not get the UAVs it wants. If Boeing can deliver the aircraft but runs over on costs, claims against the Navy can be expected. Under the fixed price incentive contact, the Navy will also share at least a fraction of the financial risk of development.

Taiwan to form fleet of armed unmanned aerial vehicles (UAVs) to patrol its coastline

Taiwan's defense budget draft for 2019 discloses the island nation's plans to deploy combat-ready armed unmanned aerial vehicles (UAVs) to protect its coastline. Tabled to the island's Legislative Yuan, the budget details the prioritization of tactical reconnaissance and armed drones to deter enemy forces on beachheads and coastal areas. The fleet of future UAVs mostly will be domestically produced. They will include Tengyun long-range UAVs developed by the Chungshan Institute of Science and Technology, as well as anti-radiation missile (ARM) drones

being developed as part of Project Jiansiang, according to the ministry. The Tengyun drones have four weapon mounts compatible with the U.S.-made AGM-114 Hellfire air-to-surface missiles. Such weapons are used primarily for precision strikes at targets within a range of 0.5 to eight kilometers. The new ARM drones of Taiwan can destroy an adversary's radar systems, or the platforms on which they are installed.

Lockheed Martin and Deakin University pursue infantry robotic exoskeleton technology

A 12-month research partnership between Lockheed Martin Australia and Deakin University's Institute for Intelligent Systems Research (IISRI) has extended the capability of Lockheed Martin's FORTIS Exoskeleton. The FORTIS is an unpowered, lightweight exoskeleton designed by Lockheed Martin that makes tools weighing as much as 36 pounds feel weightless–reducing user fatigue and improving worker safety. Using motion capture obtained from sensors on the arms and shoulders of exoskeleton operators and analyzed by robotic signal processing techniques, the IISRI team used biomechanics to test the ergonomic effects of using power tools on the human body. Deakin IISRI researchers also designed and 3D-printed new attachments to expand the functionality of the FORTIS Exoskeleton, enabling it to accommodate external loads usually mounted on the back of the human body for industrial workers, as well as for infantry warfighters.

China in race for counter-drone technology and laser weapons as it tries to catch up with U.S.

China is moving to develop laser weapons and counter-drone systems as it tries to catch up with the United States on unmanned aerial vehicle (UAV) technology for dynamic lift and drag reduction systems leading to a fast, low-drag, and energy-efficient undersea vehicle that will provide not only insights into the strengths, weaknesses, and risks in the prototype vehicle, but also provide alternative design strategies and concepts of operations.

Blue Wolf is testing on existing undersea vehicles at the U.S. Naval Undersea Warfare Center (NUWC) in Newport, R.I., and at the Penn State Applied Research Laboratory in Reston, Va. NUWC manages safety, certification, and vehicle development, while Penn State provides technical expertise.

The Blue Wolf program envisions a 21-inch-diameter vehicle with volume and weight reserved for baseline guidance, control, electronic systems, and payload section. The vehicle will use a baseline electric drive and conventional fin control. ←

For more information contact ***Applied Physical Sciences*** *online at* www.aphysci.com, ***NUWC Keyport*** *at* www.facebook.com/NUWCKeyport, *or* ***DARPA*** *at* www.darpa.mil.

UAV laser weapons considered to destroy enemy ballistic missiles in boost phase

BY **John Keller**

ALBUQUERQUE, N.M. — Power electronics experts at three U.S. defense companies are pursuing a project to develop enabling technologies for laser weapons on future unmanned aerial vehicles (UAVs) to destroy enemy ballistic missiles in boost phase.

Officials of the U.S. Missile Defense Agency (MDA) in Albuquerque, N.M., has announced contract modifications to General Atomics Electromagnetic Systems in San Diego; Lockheed Martin Space Systems in Sunnyvale, Calif.; and the Boeing Defense, Space & Security segment in Huntsville, Ala., to push forward with the Low Power Laser Demonstrator (LPLD) project.

LPLD seeks to develop enabling technologies in preparation for building a future high-energy laser weapon for a high-altitude UAV able to destroy enemy ballistic missiles in boost phase.

General Atomics Electromagnetic Systems won a $23.4 million contract extension; Lockheed Martin won a $25.5 million extension; and Boeing won a $20.5 million extension for follow-on work to the first phase of the LPLD project.

The U.S. Missile Defense Agency is working with three defense companies to develop enabling technologies for laser weapons on future unmanned aerial vehicles (UAVs).

In late 2017 the three companies won LPLD phase-one contracts to build low-power laser prototypes to help establish beam stability at long range and the ability to dwell on one spot of a ballistic missile-sized target.

In LPLD phase one, the companies addressed laser power and aperture size by integrating and testing a low-power laser on a UAV.

Now General Atomics, Lockheed Martin, and Boeing move to the next step of the LPLD project, which is to complete their tailored concept design reviews for the LPLD post-preliminary design review risk-reduction effort.

General Atomics Electromagnetic Systems specializes in high-voltage capacitors for direct current, pulsed power, high-frequency alternating current, and pulsed power systems powerful enough to support future railgun applications and all-electric aircraft carrier catapults.

The company also specializes in power-management and energy-storage technologies. Another segment of the company, General Atomics Aeronautical Systems in Poway, Calif., also designs UAVs such as the Predator, Reaper, Gray Eagle, and Avenger UAVs.

Boeing's expertise in high-energy weapons include the company's truck-mounted High Energy Laser Mobile Demonstrator (HEL MD) for use against air and ground targets. The company also developed the YAL-1 Airborne Laser Testbed, which was a megawatt-class chemical oxygen iodine laser (COIL) mounted inside a modified Boeing 747-400F jetliner.

The ability to destroy enemy ballistic missiles in boost phase is particularly important because with one shot it could destroy several independently targeted missile warheads, as well as decoys designed to foil missile defenses.

Lockheed Martin is involved in the U.S. Air Force Laser Advancements for Next-generation Compact Environments (LANCE) project to develop a compact, ruggedized, high-power laser to defend tactical aircraft flying at or above the speed of sound from enemy aircraft and missiles. LANCE is part of the Air Force's Self-protect High Energy Laser Demonstrator (SHiELD) demonstration to develop and assess a high-energy laser (HEL) for use against enemy aircraft, missiles, and other airborne threats.

General Atomics, Lockheed Martin, and Boeing may move on to a technology demonstration in the LPLD program's second phase.

In the yearlong first phase companies performed system design, and in the second phase will build, integrate, and test a functional low-power laser for beam control and stability. MDA officials anticipate a low-power flight test by 2020 and beam stability testing by 2021.

Lessons learned from the LPLD project are to help government and industry experts develop solid-state lasers strong enough to destroy enemy ballistic missiles in boost phase from UAVs operating at high altitudes.

The LPLD project's low-power laser demonstrator should help military and defense industry experts understand how to use high-altitude UAVs to destroy missiles in boost phase with lasers, and ways to aim the laser, keep it steady on target, and focus the laser sufficiently to destroy the missile at it leaves the launch pad.

On this contract General Atomics will do the work in San Diego; Lockheed Martin will do its work in Sunnyvale, Calif., while Boeing will do its work in Huntsville, Ala.; Huntington Beach, Calif.; and Albuquerque, N.M. The three companies should be finished by July 2019. ←

For more information contact ***General Atomics Electromagnetic Systems*** *online at* www.ga.com/ems, ***Lockheed Martin Space Systems*** *at* www.lockheedmartin.com, *or* ***Boeing Defense, Space & Security*** *at* www.boeing.com/defense.

to boost its intelligence and attack capabilities, according to military analysts. That includes systems to protect its drones from lasers and spoofing techniques that send false information to UAVs. One system under development is Silent Hunter, a portable drone-killing laser weapon that is said to have a firing range of as far as 2.5 miles and was demonstrated at a defense conference in Abu Dhabi in February. Officials of Poly Technologies in Beijing, the company behind the Chinese counter-drone system, say they could pierce five layers of 2-millimeter-thick steel plates from a distance of half a mile. Experts say U.S. anti-drone systems are more advanced than China's, and have a bigger range and more types of sensing technology available from a greater number of companies. The U.S. has more than 60 counter-drone systems or products that use radar, radio frequency, electro-optical, and acoustic detecting and tracking to intercept enemy drones and either stop them, hijack their communication links, or destroy them with lasers or projectiles, according to a report by the Center for the Study of the Drone at Bard College in New York.

Reaper UAV shoots down other drone in first known unmanned air-to-air kill

A U.S. Reaper unmanned aerial vehicle (UAV) shot down another drone with a missile, the Air Force revealed. The incident, which took place last year and involved an unmanned target drone, was the first case of a drone shooting down another aircraft. The event is a watershed moment in the history of aerial warfare, as the nation's UAV force begins to muscle-in on air-to-air combat -- previously the exclusive domain of manned aircraft. The test showed the U.S. Air Force that a UAV like the MQ-9 has the ability to conduct air-to-air combat, much like its manned fighter brethren like the F-15 Eagle and F-22 Raptor jet fighters. ←

Air Force to boost flexibility of reconnaissance aircraft by adding hyperspectral 3-D imaging sensor

The U.S. Air Force is planning to hire a contractor in the coming months to demonstrate a new sensor suite that blends powerful multi-mode cameras with a laser-imaging system in a compact package. Air Force officials want this new AgilePod sensor to be small enough to fit inside its AgilePod modular sensor pod, which then could go onto either a manned U-2S Dragon Lady spy plane or an unmanned RQ-4 Global Hawk unmanned aerial vehicle (UAV). AgilePod is a Lego-like system of between three and five sections, each of which houses a different sensor. The new sensor suite will include a hyperspectral imager, yet it's unclear which company could be the source of this system.

DARPA wants photonic integrated circuits for military gyroscopes and clocks

The U.S. Defense Advanced Research Projects Agency (DARPA) Microsystems Technology Office is soliciting research proposals for the development of a new class of atom-based systems using integrated photonics and trapped atoms to enable high-performance, robust, portable clocks and gyroscopes. The military researchers are asking industry to develop relatively simple portable photonic integrated circuits (PICs) for high-performance position, navigation, and timing (PNT) devices as an alternative to GPS for when satellite navigation signals are not available. A PIC or integrated optical circuit, similar to an electronic integrated circuit, integrates everal photonic (having to do with light) functions, providing capabilities for information signals imposed on optical wavelengths. ←

L-3 to design rapidly steerable electro-optics infrared telescope for small reconnaissance satellites

BY **John Keller**

WRIGHT-PATTERSON AFB, Ohio — Space electro-optics experts at L-3 Space & Sensors SSG in Wilmington, Mass., are developing a small, lightweight, and affordable infrared telescope for use on future generations of small military reconnaissance satellites operating in low-Earth orbit (LEO).

Officials of the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio, have announced a $9.2 million two-year contract to L-3 Space & Sensors for the Agile Small-Satellite Experimental Telescope (ASSET) project.

ASSET seeks to develop an infrared telescope with size, weight, and recurring costs low enough to make it suitable for small satellites — and with the ability of rapidly steering its instantaneous field-of-view over a large angular field-of-regard.

The Air Force Research Lab awarded the ASSET electro-optics contract to L-3 Space & Sensors on behalf of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.

Small satellites operating in low-Earth orbit can image with higher resolution and with smaller-aperture optics than those in higher orbits, DARPA researchers explain. Smaller optics and a smaller satellite bus lead to relatively low-cost satellites that can be designed and delivered quickly.

Providing persistent on-demand remote sensing from low-Earth orbit can require hundreds of satellites, which makes it imperative to keep their costs low. The sensor payloads of these satellites must cost no more than a few million dollars, and their sizes and weights must be small enough to keep the costs of satellite buses low.

L-3 Space & Sensors is developing a small infrared telescope for future small military reconnaissance satellites as part of the Agile Small-Satellite Experimental Telescope (ASSET) project.

At the same time, however, DARPA researchers are asking L-3 Space & Sensors to build a small-satellite infrared telescope with high performance in spatial resolution, and in its ability to re-image areas widely distributed over the field-of-regard.

This rules-out body-steering a fixed telescope using a satellite's reaction wheels or control-moment gyros. Instead, L-3 Space & Sensors engineers will focus on designing an optical system able to repoint its line-of-sight telescope without moving the satellite.

If L-3 Space & Sensors designers can build low-cost, high-performance agile telescopes, they will transform the types of missions that are feasible on small satellites, DARPA researchers say.

Towards this goal, L-3 Space & Sensors will build a rapidly steerable agile telescope prototype for small satellites with a telescope aperture of 30 centimeters, field of view of more than three degrees, design pass-band of three to five microns, and include a band-pass filter.

The space telescope will operate in the mid-wave infrared (MWIR) band with passively cooled optics to minimize self-emission. DARPA researchers are interested in using full-aperture scan mirrors to simplify thermal control and impart less reaction force during rapid motions.

L-3 Space & Sensors engineers will build a prototype optical system that, at least for now, is not for a specific satellite mission, so no spacecraft interface is necessary. Instead, they will define reasonable interfaces, estimated flight loads, and other environmental specifications to drive their design so that the prototype is suitable for a small-satellite application.

There is a possibility, however, that a space flight opportunity may become available during development, so the prototype should be usable for flight after qualification.

The L-3 agile telescope will include telescope optics, agile pointing systems, a focal plane, and basic electronics to drive electromechanical or electro-optical systems for field-of-view re-pointing.

Its focal plane will include an integrated Dewar cooler assembly, and will be large enough to provide diffraction-limited performance over its full field of view. ←

For more information contact ***L-3 Space & Sensors*** *online at* www.l3t.com, *the* ***Air Force Research Laboratory*** *at* www.wpafb.af.mil/afrl, *or* ***DARPA*** *at* www.darpa.mil.

Army orders electro-optical remote weapon stations from Kongsberg for armored combat vehicles

PICATINNY ARSENAL, N.J. — U.S. Army officials are continuing their purchases of the M153 Common Remotely Operated Weapon Stations (CROWS) II from Kongsberg Defence & Aerospace AS in Kongsberg, Norway, under terms of a contract worth nearly half a billion dollars.

The CROWS II remote weapons station, shown above, uses electro-optical sensors like daylight video camera, thermal imager, and eye-safe laser rangefinder to target the enemy.

CROWS II is a remote-control weapon system that enables combat vehicle operators to locate and shoot at targets while inside the vehicle and protected by its armor.

Officials of the Army Contracting Command-New Jersey at Picatinny Arsenal, N.J., awarded a $498.3 million five-year contract to Kongsberg for continued production, sustainment, and engineering services for the M153 CROWS.

The electro-optical CROWS system consists of a gyro-stabilized mount attached to the top of the combat vehicle, as well as its guns and grenade launcher. The weapon's sensors include daylight video camera, thermal imager, and eye-safe laser rangefinder.

CROWS II can accommodate a variety of weapons, including the Mk 19 grenade launcher, M2 .50 caliber machine gun, M240B 7.62-millimeter machine gun, and the M249 5.56-millimeter Squad Automatic Weapon.

It has been used on a variety of armored combat vehicles, including the M1 Abrams main battle tank; Humvee; Buffalo mine-protected vehicle; South African RG-31 Nyala and RG-33 mine-resistant light armored vehicles; the M1126 Stryker armored personnel carrier; the Oshkosh MRAP all-terrain vehicle; and the Joint Light Tactical Vehicle (JLTV).

CROWS II comes in two parts: the mount on the exterior of the vehicle. and the control group. The mount can rotate 360 degrees at up/down angles from -20 to 60-degrees elevation, with ballistic-corrected fire control.

The CROWS operator sits behind the vehicle driver, and controls the CROWS weapons with a display, switches, and joystick. The system's camera can identify targets nearly a mile away, has about a 95-percent accuracy rate, and can track targets moving as quickly as 35 miles per hour.

On this contract Kongsberg will do the work at locations determined with each order, and should be finished by September 2022. ←

For more information contact the ***Army Contracting Command-New Jersey*** *at* http://acc.army.mil/contractingcenters/acc-nj, *or* ***Kongsberg Defence & Aerospace*** *at* www.kongsberg.com/en/kds.

PRODUCT applications

TACTICAL NETWORKING

DRS building tactical networking terminals for military aircraft to blend sensors and weapons

U.S. Navy anti-air warfare experts needed an electronics manufacturer to build sensors and weapons tactical networking terminals for the carrier-based E-2C and E-2D airborne early warning aircraft. They found their solution from the DRS Laurel Technologies segment of Leonardo DRS in Johnstown, Pa.

Officials of the Naval Sea Systems Command in Washington announced an $8.8 million order to DRS Laurel to build AN/USG-3B Cooperative Engagement Capability (CEC) equipment sets for E-2C and E-2D military aircraft.

The CEC is a tactical sensor and weapons network for anti-air warfare that combines information from sensors operating over broadly distributed geographic areas in a common tactical picture for battle groups at sea. It improves overall situational awareness, and enables fleet commanders to work closely together to attack enemy forces from long ranges.

The AN/USG-3 is the airborne designation of CEC deployed in E-2C and E-2D aircraft. Other CEC terminals are aboard Navy surface warships; U.S. Marine Corps command posts, aviation command-and-control centers, and surveillance aerostats.

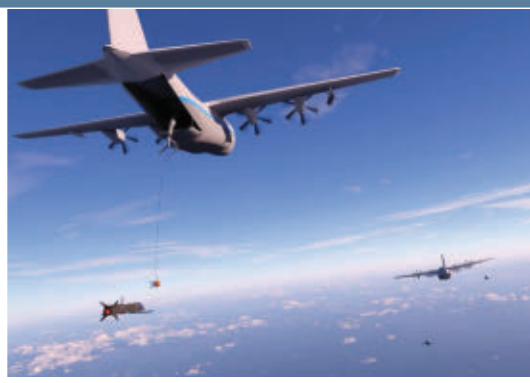
CEC blends sensors and weapons into an integrated real-time network that expands the battlespace; enhances situational awareness; increases depth of fire; enables long intercept ranges; and improves decision and reaction times.

It extracts and distributes sensor information such that the superset of this data is available to all participating CEC-equipped units by fusing the distributed data from shipboard, airborne, composite tracking network ground-mobile units, Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System (JLENS), and coalition partners into one fire-control-quality air track picture.

The system uses line-of-sight data distribution to share radar-measurement data among sensors and weapons to create one distributed integrated air picture. It combines surveillance and targeting information such that the combined system is greater than the sum of its parts.

The jam-resistant CEC obtains target track information to form one real-time composite track to help coordinate theater air and missile defense to engage incoming cruise missiles.

On this order DRS Laurel will do the work in Laurel, Fla., and should be finished by February 2020. For more information contact **DRS Laurel Technologies** online at *www.leonardodrs.com/locations/drs-laurel-technologies-johnstown-pa*, or **Naval Sea Systems Command** at *www.navsea.navy.mil.* ←



POWER ELECTRONICS

Milpower Source to provide power electronics for DARPA Gremlins swarming drones project

Military systems integrators at Dynetics Inc. in Huntsville, Ala., needed mission-critical power electronics for a U.S. military research program that seeks to build swarms of drone aircraft. They found their solution from Milpower Source Inc. in Belmont, N.H.

Milpower Source is supplying Dynetics with several kinds of power converters for the Gremlins program of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va.

DARPA Gremlins will rely on relatively inexpensive unmanned aerial vehicles (UAVs) in volley quantities to saturate enemy defenses, using military C-130 aircraft to launch drone swarms of networked and cooperating unmanned aircraft for electronic attack and reconnaissance missions from standoff ranges, and then recover surviving drones when their missions are completed.

"We addressed the operational requirements through our advanced engineering design processes to exceed stringent environmental and mechanical requirements, primarily weight, without sacrificing performance," says Joseph Widman, the Gremlins program manager at Milpower Source.

Dynetics is one of four companies designing UAV technologies for drones that are inexpensive enough so that occasional losses would not compromise the overall mission. These drones should be able to communicate and cooperate with one another, so surviving drones could assume the roles of those unmanned aircraft lost during the mission.

The other three companies working Gremlins technologies are General Atomics Aeronautical Systems Inc. in San Diego; the Lockheed Martin Corp. Aeronautics segment in Fort Worth, Texas; and the Composite Engineering Inc. Unmanned Systems Division in Sacramento Calif.

For more information contact **Milpower Source** online at *https://milpower.com*, **Dynetics** at *www.dynetics.com*, or **DARPA** at *www.darpa.mil/program/gremlins*.

LASER TARGETING

U.S. Army chooses DRS to build the LLDR 3 target designation and laser range finder

U.S. Army navigation and targeting experts needed electro-optical all-weather day-and-night target designation and laser range finder systems to help forward observers guide smart munitions to their targets. They found their solution from the Leonardo DRS Network & Imagining Systems segment in Melbourne, Fla.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., announced a $231.5 million 10-year contract to DRS for the Lightweight Laser Designator Rangefinder (LLDR) 3 program.

The LLDR 3 is to be a man-portable, crew-served, ground-based target designation device for precision long-range target acquisition, target location, laser designation, and laser spot imaging with an all-weather day and night precision targeting capability.

It is to be a modular, tripod-mounted target observation, location, and designation system for forward observers as part of a fire support team. The LLDR 3 also will help guide laser seeker-equipped aircraft to high-value targets.

The electro-optical system will have three separate modules: a targeting locator module; long-range thermal imaging module; and a laser designator module.

DRS will design and integrate 15 units, tested and qualified for production, no later than September 2020, followed by initial production and full-rate production of the LLDR 3. The program will last for 10 years.

For more information contact **DRS Network & Imagining Systems** online at *www.leonardodrs.com/locations/leonardo-drs-melbourne-fl*, or the **Army Contracting Command-Aberdeen Proving Ground** at *http://acc.army.mil/contractingcenters/acc-apg*.

SENSORS

Air Force asks Raytheon to build and upgrade electro-optical AN/DAS-4 multispectral aircraft sensor

U.S. Air Force electro-optical surveillance experts needed next-generation multispectral targeting sensor systems for the MQ-9 Reaper attack unmanned aerial vehicle (UAV) and other reconnaissance aircraft. They found their solution from the Raytheon Co.

Officials of the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, announced an $281.9 million contract to the Raytheon Space and Airborne Systems segment in McKinney, Texas, to build and upgrade AN/DAS-4 multispectral targeting system (MTS) Model B high-definition and target location accuracy turrets.

The AN/DAS-4 multispectral system offers four high-definition cameras covering five spectral bands; a three-color diode pump laser designator and rangefinder; laser spot search and track capability; automated sensor and laser bore sight alignment; three-mode target tracker; and built in provisions for future growth, Raytheon officials say.

The contract calls for Raytheon to provide 127 AN/DAS-4 MTS-B high-definition and target-location accuracy turrets; 40 DAS-1A to DAS-4 turret unit upgrades; one lot of initial shop replaceable unit spares; one lot of capacity increase production support; and one lot of data.

The AN/DAS-4, the latest variant of the Raytheon MTS sensor family, incorporates greater fire control and target location accuracy technology than previous MTS versions for precise coordinates.

The AN/DAS-4 MTS enables mission commanders to use high-definition data from an airborne tactical sensor to identify and engage targets with much greater accuracy than previous-generation systems could, Raytheon officials say. This sensor system also is going aboard the U.S. Navy MQ-4C Triton long-range maritime patrol UAV.

This advanced electro-optical and infrared (EO/IR) system provides tracking and laser designation for the Griffin and Paveway missiles, as well as all tri-service and NATO laser-guided munitions. MTS sensors offer several fields of view, electronic zoom, and multimode video tracking.

Multispectral sensors divide images and video into several light wavelengths — typically three to 15 spectral bands — across the elec-

tromagnetic spectrum, including light from frequencies beyond the visible light range such as infrared and ultra-violet.

Dividing images into several different wavelengths enables the sensor to extract additional information the human eye fails to capture with its receptors for red, green, and blue.

The L-3 Technologies Advanced Laser Systems Technology (ALST) segment in Orlando, Fla., is providing the eye-safe laser rangefinders for the Raytheon MTS.

On this contract Raytheon will do the work in McKinney, Texas, and should be finished by September 2020. For more information contact **Raytheon Space and Airborne Systems** online at *www.raytheon.com*, or the **Air Force Life Cycle Management Center** at *www.wpafb.af.mil/aflcmc*. ←

COMPUTER BOARDS

X-ES and Lynx integrate 3U VPX embedded computing board and secure software operating system

Extreme Engineering Solutions (X-ES) in Middleton, Wis., is announcing the integration of its secure-by-design XPedite7674 3U VPX embedded computing board with the LynxSecure Safety Bundle secure software from Lynx Software Technologies in San Jose, Calif., for aerospace and defense trusted computing applications. The LynxSecure Safety Bundle is an open-systems architecture that unlocks the potential of multi-core processors such as the Intel Xeon D to deliver second-generation Integrated Modular Avionics. Lynx and X-ES have created a board support package (BSP) for LynxSecure Safety Bundle on XPedite7674 for military and aerospace embedded computing applications. The board offers as many as 16 processor cores and extended-temperature support, designed with X-ES' SecureCOTS technology. For more information contact **Extreme Engineering Solutions** online at *www.xes-inc.com*, or **Lynx Software Technologies** at *www.lynx.com*.

SECURE DATA STORAGE

Self-encrypting solid-state drives (SSDs) for military trusted computing introduced by Mercury

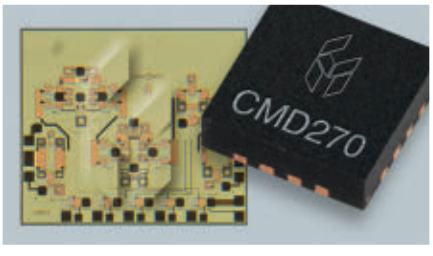
Mercury Systems Inc. in Andover, Mass., is announcing customer engagements for the company's ASURRE-Stor portfolio of self-encrypting solid-state drives (SSDs) for aerospace and defense trusted computing applications. This drive features as much as 512 gigabytes of user-accessible storage capacity in a rugged 2.5-inch 7-millimeter form factor optimized for laptop computers and workstations that store sensitive data. This device was designed to the specifications of the Commercial Solutions for Classified (CSfC) program, Federal Information Processing Standard (FIPS) 140-2 standards, and the Common Criteria Full Disk Encryption FDE-EE and FDE-AA collaborative Protection Profiles (cPP). Mercury officials say they expect to receive all necessary certifications by this November for the new device to be

included in the CSfC component index. Developed by the National Security Administration (NSA) and the Central Security Service (CSS), the CSfC program protects sensitive data by implementing two compliant commercial security components simultaneously in layers. For more information contact **Mercury Systems** online at *www.mrcy.com*. Additional details on the CSfC program are online at *www.nsa.gov/resources/everyone/csfc*.

RF AND MICROWAVE

Amplifier and phase shifter for military RF and microwave applications introduced by Custom MMIC

Custom MMIC in Chelmsford, Mass., is introducing the CMD270P3 and CMD174 low-noise amplifier (LNA) and phase shifter monolithic microwave integrated circuits (MMICs) for military high-performance RF and microwave applications. The CMD270P3 is a C Band, 4-8 GHz LNA housed in a leadless 3-by-3-millimeter plastic surface mount package. The LNA delivers greater than 16 dB of gain with a corresponding output 1 dB compression point of +18 dBm and a noise figure of 1.7 dB. The CMD270P3 is a 50-ohm matched design eliminating the need for external DC blocks and RF port matching. It is for electronic warfare (EW) systems and communications receivers. The CMD270P3 also is an alternative to CMD185P3, based on pin and performance compatibility. The CMD174 die is a gallium arsenide (GaAs) MMIC 5-bit phase shifter that operates from 3 to 6 GHz and provides 0 to 360 degrees of monotonic phase coverage, with a LSB of 11.25 degrees. For more information contact **Custom MMIC** online at *www.custom-mmic.com*.



DATA RECORDING

Rugged small-form-factor (SFF) digital data recorder for unmanned applications introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the rugged Talon RTX 25xx series high-performance small-form-factor (SFF) digital data recorder for unmanned aerial vehicles (UAVs), aircraft pods, tight equipment bays, military vehicles, and most outdoor environments. Optimized for low size, weight, and power (SWaP), sealed

half-ATR recorders are available with several input options and can hold as much as 30.7 terabytes of removable solid-state drive (SSD) storage. Designed to operate in temperatures from

-40 to 60 degrees Celsius, these recorders provide real-time streaming data rates as fast as four gigabytes per second for ultra-wide bandwidth RF or high-speed recording. Engineered to operate in tough environments, the RTX recorder's chassis keeps all electronics sealed from the external environment. The half-ATR chassis uses military standard circular connectors for I/O to control RF emissions while protecting the recorder's electronics from humidity, water, dust, sand, and salt fog. For more information contact **Pentek** online at *www.pentek.com*..

SENSOR PROCESSING

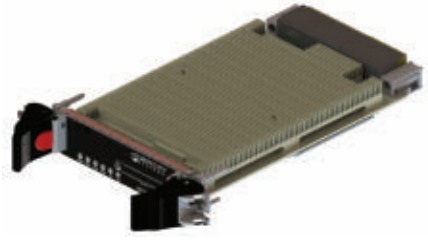
Embedded computing for sensor processing in electronic warfare (EW) introduced by Abaco

Abaco Systems in Huntsville, Ala., is introducing the SRS6000 multi-channel synchronous RF and microwave receiver system for embedded computing sensor processing in high-channel-density electronic warfare (EW) and signals intelligence (SIGINT). Target applications include multiple-input-multiple-output (MIMO) radar, beamforming, direction finding, and multi-channel listening. The SRS6000 uses field-programmable gate arrays (FPGAs) to help systems designers accelerate development and get to a solution quickly by obviating the need for in-house development that can be time-consuming and costly, company officials say. The SRS6000 out of the box delivers the ability to synchronize as many as 32 1-gigabit-per-second A/D converter channels with a picosecond jitter. It also is scalable, with the potential to daisy-chain as many as eight sensor processing systems for a total of 256 synchronized channels in the most demanding applications. The SRS6000 also features an auto-calibration capability to adjust its calibration routine automatically in response to changes in cabling or setup. Migration to a deployed, rugged 3U VPX system is straightforward. For more information contact **Abaco Systems** online at *www.abaco.com*.

BOARD PRODUCTS

3U OpenVPX embedded computing board for artificial intelligence (AI) introduced by Mercury

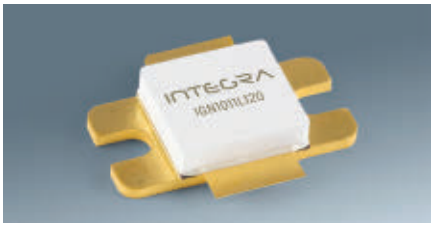
Mercury Systems Inc. in Andover, Mass., is introducing the EnsembleSeries LDS3517 embedded computing processing blade for advanced on-platform processing, machine learning, and artificial intelligence (AI) applications. The LDS3517 blade is suited to on-platform cognitive electronic warfare (EW), next-generation radar, machine learning, and AI applications that require small, powerful and scalable processing engines. Each blade combines an Intel Xeon D server-class processor, a Xilinx UltraScale field-programmable gate array (FPGA), and a mezzanine site in a 3U OpenVPX form-factor. Wafer-stacking and system-in-package (SiP) miniaturization technologies enable the latest general and FPGA processing capabilities, their supporting memory, and a mezzanine expansion site to fit into this compact form-factor. Optionally configured with embedded BuiltSECURE trusted computing systems security engineering, and packaged with modified-off-the-shelf-plus (MOTS+) technology, the LDS3517 compute blade can support military missions n a wide variety of enviroments. For more information contact Mercury Systems online at www.mrcy.com.



RF AND MICROWAVE

RF and microwave transistor for identification friend-or-foe (IFF) avionics introduced by Integra

Integra Technologies Inc. in El Segundo, Calif., is introducing the IGN1011L120 IFF transistor for electronic warfare (EW), radar, avionics, defense communications, and intelligence, surveillance, and monitoring (ISM) applications. The transistor offers 120 Watts peak output power using gallium nitride (GaN) and silicon carbide (SiC) technology. Designed for identification friend-or-foe (IFF) avionics applications, the IGN1011L120 is a high-power GaN transistor, specified for use under Class AB operation. This transistor operates at 1.03 to 1.09 GHz, and supplies a minimum of 120 Watts of peak-pulse power, at 50 volts bias voltage and 6.4 percent duty factor. Assembled via chip-and-wire technology using gold metallization, this unit is housed in a metal-based package and sealed with a ceramic-epoxy lid. For more information contact **Integra Technologies** online at *www.integratech.com*.



AVIONICS

MIL-STD-1553-equipped rugged computer for avionics introduced by Kontron

Kontron America Inc. in San Diego is introducing the COBALT 901|400 series embedded computing system with MIL-STD-1553 avionics databus connectivity for data-intensive electro-optical and infrared (EO/IR), advanced voice, video, data link processing like Link 16, and the latest situational awareness applications. Designed as a mission-ready rugged computer for a wide range of military aircraft applications, COBALT with MIL-STD-1553 provides complex serial data bus subsystem support. The rugged

small-form-factor system is for high density multi-protocol airborne embedded applications. The 1553 data bus is increasingly deployed in applications beyond avionics flight control to new intelligence, surveillance, and reconnaissance (ISR) designs such as military target acquisition and satellites. Because of this, there is a need to transmit high data rates over existing MIL-STD-1553 bus infrastructures while allowing concurrent operation with 1553 interface speeds in legacy systems. For more information contact **Kontron** online at *www.kontron.com*.

MISSION COMPUTERS

Open-architecture electronic warfare (EW) mission computer introduced by Curtiss-Wright

The Curtiss-Wright Corp. Defense Solutions division in Ashburn, Va., is introducing the MPMC-9323/EWS Silver Palm open-architecture commercial off-the-shelf (COTS) electronic warfare (EW) and RF tuner mission computer for countering emerging battlefield threats in SIGINT, COMINT, and ELINT applications. To address today's emerging EW threats, system integrators seek to deploy the maximum number of RF channels, supported with supercomputing-class processing in a chassis small and lightweight enough to minimize the platform's SWaP burden. Curtiss-Wright is collaborating with Silver Palm Technology LLC in Ijamsville, Md., to design a compact, EW/RF tuner mission computer that uses an open architecture optimized for low size, weight, and power consumption (SWaP) to lower the cost of ownership and reduce program risk. This compact design for electronic warfare (EW) and other RF and microwave applications can ease the deployment of EW hardware solutions to the warfighter and speeds the development for system integrators. For more information contact **Curtiss-Wright Defense Solutions** online at *www.curtiss-wrightds.com*.

DIGITAL SIGNAL PROCESSING

System-on-module (SoM) for RF and microwave signal-processing introduced by Pentek

Pentek Inc. in Upper Saddle River, N.J., is introducing the model 6001 Quartz eXpress Module (QuartzXM) high-performance system-on-module (SoM) for digital radio frequency memories (DRFM) systems, triggered waveform and radar chirp generation, and triggered radar range gate engine applications. The module is based on the Xilinx Zynq UltraScale+ RF system-on-chip (RFSoC) field-programmable gate array (FPGA) with eight integrated RF-class A/D and D/A converters. Measuring 2.5 by 4 inches, the QuartzXM model 6001 includes all the circuitry needed to maximize the performance of the RFSoC. The model 6001 can be housed on the Pentek 3U VPX model 5950 or it can be deployed on a custom carrier. The Pentek Quartz architecture for RF and microwave applications positions the RFSoC as the cornerstone of the design. The RFSoC's programmable logic and processing system can access control and data paths, and integrates eight RF-class A/D and D/A converters into the Zynq FPGA fabric along with quad ARM Cortex-A53 and dual ARM Cortex-R5 processors. For more information contact **Pentek** online at *www.pentek.com*.

TRUSTED COMPUTING

Cyber security for rugged trusted computing introduced by Crystal Group

Crystal Group Inc. in Hiawatha, Iowa, is introducing the rugged Platform Agnostic Security Solutions (PASS) trusted computing system with advanced cyber security technology for a wide range of computationally intense, network complex, and expanded data storage applications operating in severe environments. Crystal Group PASS includes a rugged FIPS 140-2 compliant data-at-rest storage devices; rugged-

dized Ruckus ICX switches with NIAP certified IP-security modules for network encryption and Media Access Control Security (MACsec); and conformal-coated Seagate 2.5-inch dual-port SAS drives that are compatible with any Crystal Group platform: server, workstation, JBOD, or RAID data storage system. To further protect data at rest and in motion, Crystal Group manufactures its products in vertically integrated, NIST compliant, AS9100D certified, U.S.-based facilities, tracing every component — from the raw materials through production processes to the delivery of the final warrantied product — to ensure an end-to-end U.S. supply chain of custody and help prevent security vulnerabilities. For more information contact **Crystal Group** online at *www.crystalrugged.com*.

RF SWITCHES

High-power PIN diode RF switches for radar and electronic warfare (EW) introduced by Pasternack

Pasternack Enterprises in Irvine, Calif., is introducing a line of single pole double throw (SPDT) high-power PIN diode RF switches for radar, electronic warfare (EW), civil and military radios, and test and measurement applications. The switches consist of seven different models that offer power handling and isolation with broadband performance and fast switching speed. For transmit and receive applications, these solid-state PIN diode switches are for connecting from an antenna to a receiver or for a transmitter with frequent changeovers. They provide input CW power handling (hot switching) capability to 150 Watts, high isolation levels to 75 dB typical, and frequency coverage ranges from 20 MHz to 2700 MHz. These PIN diode switch models are all 50 Ohm designs with integrated TTL logic circuitry. Typical performance includes less than 0.4 dB insertion loss, as much as 75 dB of isolation, maximum switching speeds as low as 150 nanoseconds, and some models specify maximum peak power levels to 500 Watts. For more information contact **Pasternack** online at *www.pasternack.com.*

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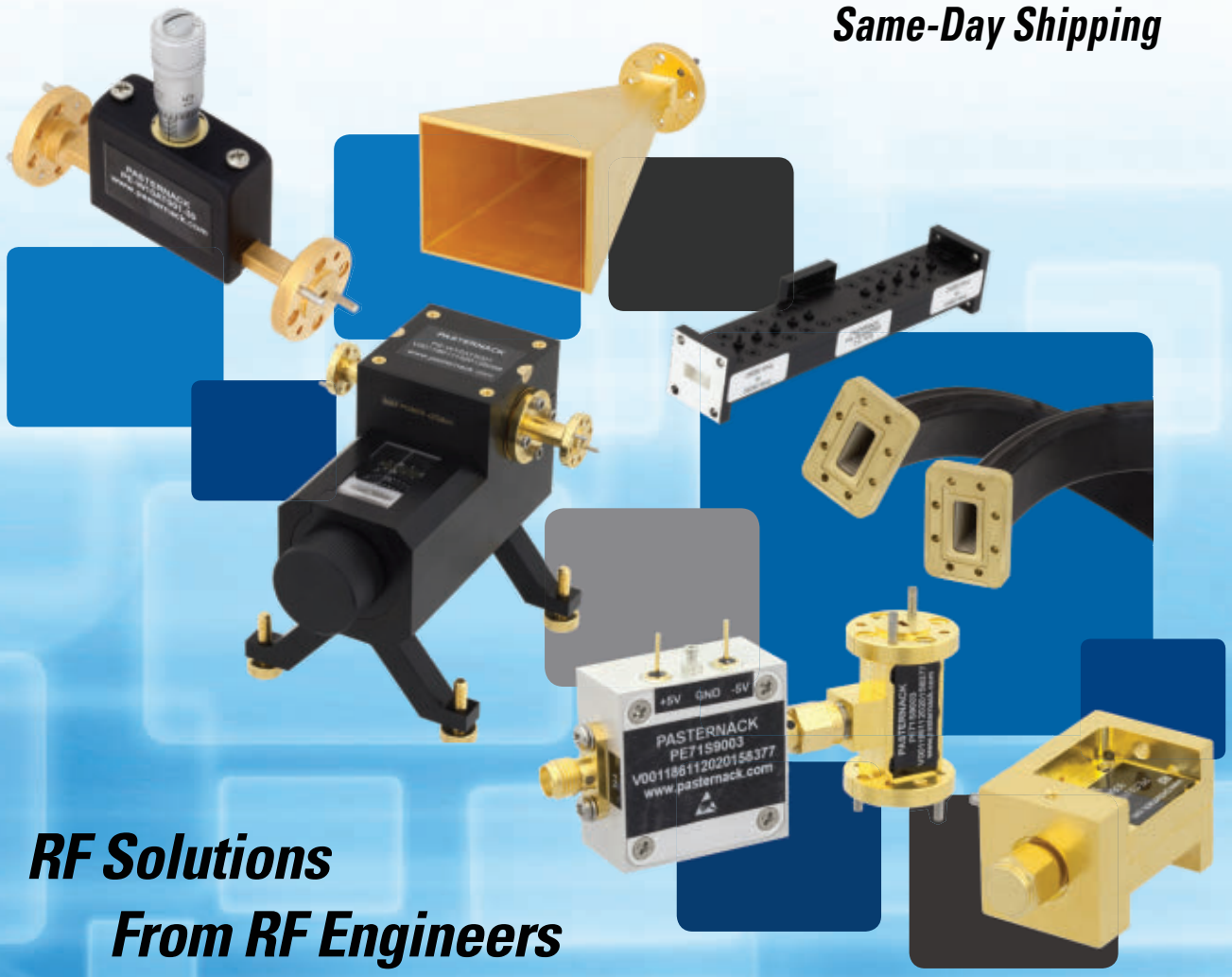

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